Mary Bromiley

Equine Injury, Therapy & Rehabilitation

3rd Edition

Blackwell Publishing

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FCSP, SRP
Chartered Physiotherapist

Drawings by Penelope Slattery

Photographs by Penelope Slattery and the author

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It should be clearly understood by anyone practising the techniques or giving therapy, as described in this book, that to do so without veterinary permission from the vet normally in charge of the animal, constitutes a legal offence.

It is very important to be aware that there are risks attached to the giving of all forms of therapy and also to personnel, when working with horses or ponies. Neither the author nor publisher can be held responsible in any way for injury sustained to any person or animal if they administer therapy or rehabilitation in the manner described, after reading this book. Neither can the author or publisher be held responsible for any adverse effects or injury resulting from the inappropriate use of massage, therapy machines/ apparatus, aids and exercises for therapy and rehabilitation.

Contents

Foreword

I have suffered many injuries through car accidents and falling off horses: a pin through my right ankle, a broken femur with a pin in my knee etc. They say I limp, but I believe God has made me suffer so that I can understand the way horses can feel, even with the most minor injury. Any one who lands on stones, uneven, or hard ground with an injury, however minor, experiences the jarring effect.

However minor an injury, a horse cannot perform to its best. Mary advises us on suitable therapies, whether the horse has had a fall or a specific injury, in order to keep the horse in good shape.

I was sent a horse towards the end of its career that had major problems. Mary looked, pointed out all the many defects and I was upset, but she said 'don't worry, we will have to rebuild him'. I thought she was being rather optimistic, but she said to go back to basics and start at the beginning, long rein over poles, get him to use himself, build his back up on the weak side with weights, lots of long, slow work. The horse in question was Carvills Hill and his history – he went on to win the Rehearsal Chase at Chepstow followed by the Welsh Grand National, a weight carrying performance not equalled and in record time, ridden by Peter Scudamore, whom Mary advised on the best way to make Carvills Hill use himself. He then achieved a phenomenal third consecutive win, the Hennessy Gold Cup at Leopardstown when he was ten years old. It was all down to Mary, her technique, her patience and eye for detail of every muscle on the horse. The latest high profile winner is Celestial Gold; Mary helped him win the big race at Aintree 2006.

I am extremely fortunate to have Mary work for me, sharing her wealth of knowledge and unparalleled expertise which is hugely beneficial when preparing the equine athlete and has helped me to train, to date, over 4000 winners.

Martin Pipe CBE
Fifteen times champion National Hunt Trainer

Preface

An ongoing relationship has existed between man and horse since domestication of the latter began, as conclusively demonstrated by archaeological excavation, some 6000 years ago.

For domestication, dictionary definition, 'trained to live with and be kept by man', substitute 'source of multiple usage'; food, transport, and later, following the invention of the wheel, the engine for vehicle/chariot. Archaeologists suggest the relationship may have actually been mutually beneficial, a two-way adaptation, rather than man dominance. A type of compatible evolution, the horse possibly recognising stewardship by man, reduced the ever-present danger of attacks by predators, man realising a source of semi-tame meat was advantageous.

When tamed and ridden, the speed of the horse was also advantageous, at full gallop, times of up to 70 k per hour have been recorded. Another plus was the fact that unlike the domesticated, cloven-footed species, camel, ox, sheep, and goat, the horse was able to survive, due to an unique digestive ability, on poor-quality forage; the equine caecum able to break down the cellulose contained in stalks, stems, leaves, and coarse grasses indigestible in other species. The horse can also digest even when on the move, unlike the cloven-footed species, who not only require a better type of fodder, but even if this is available, require long periods of recumbency to 'chew the cud', a process of regurgitation required to achieve fermentation. This factor reduced their usefulness as a means of transport.

Mechanisation has changed the role of the horse; no longer required, except in a few remote areas, as a means for transport and survival, the animal has become, not just a source of pleasure, but a competition adjunct, enabling man to extend his prowess through equestrian sports; polo and racing both brought back from the Mongolian steppes; dressage, originating from movements taught for combat survival; chariot racing has been replaced by competitive driving. Show jumping, eventing, endurance riding, the list continues to expand, the most recent being horse-drawn surfing.

This transition from necessity to pleasure has tended to distort the true nature of the horse, due to the incorrect assumption that human thought processes and concepts, particularly when preparing for athletic prowess, also apply to the horse. Man and horse are two very differing species and an appreciation of this fact is essential for those working with horses, particularly those who work as trainers and therapists for with every type of physical activity there is the possibility of injury. This book attempts to increase the understanding of those involved with horses, by explaining, in relatively simple terms, the interaction and reliance of the body systems one to another, the construction of the musculoskeletal system, the general effects of injury, and the repair processes of tissues following damage in a species differing from man.

Added to this information, the text contains, as far as they are currently understood, the facts about therapy machines along with a description of the varied methods of aiding repair, this in order to enable the reader to make an informed choice from the available options; it may entail simple applications of heat, cold, massage, or possibly the use of sophisticated machines. Also described is the advisability of, and reasons for, controlled activity.

Acknowledgements

My grateful thanks go to the members of the veterinary profession who have trusted me with their patients, and to all the owners, trainers and head lads who, over the years, have given me support and help by allowing me to work with them and their horses. Thanks also go to my two daughters Pelly and Rabbit who work with me and without whose help the rehabilitation would be impossible.

Dedicated to my late Father
Robert Hamilton Miller,
Veterinary Surgeon and Medical Practitioner

1 The Musculoskeletal System Explained

Introduction

The goals following tissue breakdown are similar in both man and horse; to restore the pre-injury state of the whole by persuading the affected tissue to repair as rapidly and efficiently as possible. The first consideration, when something goes wrong is, 'Why did it happen'? Sometimes the answer is obvious, but in most cases a broad-based investigative route is required to source the primary cause of the problem.

A quick illustration to demonstrate that treatment of the obvious may not constitute a cure. A patient presented with a tennis elbow, appropriate treatment resolved the problem, three weeks later she was back needing further treatment. In-depth discussion unfortunately failed to identify the cause. Shortly after her fifth treatment she was spotted wrestling with an up-and-over garage door. It was suggested that the garage door mechanism be oiled and she did not reappear for treatment. When the account was paid an enclosure stated, 'Quite an expensive oil can!'

To ensure successful treatment outcome the many different characteristics of man and horse need consideration. The 'tree' of evolution has many divisions but species follow two main routes: those which kill in order to eat (predator) and those that are eaten (prey).

Man is a predator (killer), the horse a prey (food source). Domestication has required that the predator, man, sits on his prey the horse, small wonder that things can go wrong particularly when it is appreciated that the prey, despite domestication, retains all its endowed survival instincts, these include the flight reaction in response to fear and the requirement to survive a presumed attack by fighting.

All predators are born helpless, all prey species are fully functional within minutes of birth and this is not the only difference between the two types of species (Figs 1.1 and 1.2; Table 1.1).

Figs 1.1 and 1.2 Human baby and foal the same age.

Symbiosis between human and veterinary medicine does exist despite there being specific differences between species. In order to be successful when working with injury these variations should be understood and appreciated.

It is also essential to remember the limitations of the basic horse, particularly with regard to learning ability, rather than rely on man's imposed interpretation of its thought processes and behaviour.

Table 1.1 Man versus horse.

Man	Horse
Species: **predator**	Species: **prey**
Biped	Quadruped
At birth	
Helpless	Fully functional within 15/20 mins
Cortex partly programmed	Cortex fully programmed
Recumbent, no balance	Stands, moves, perfect balance
Primitive reflex responses	Survival reflexes, fright, flight, fight, fully operative
Maternal recognition?	Maternal recognition, smell. Sight?
Diet	
Early diet milk. No teeth	Milk, supplemented by grazing Teeth developed
Carnivore/herbivore	Herbivore
Anatomical variations	
Brain weighs approx. 3 lbs/1.3 kg	Brain weighs approx. 1.5 lbs/0.65 kg
Vertebral architecture for mobility	Vertebral architecture for stability
Intravertebral discs (spine)	Fibro cartilage discs (spine)
Collar bone links arm to body mass	No collar bone, forelimb (arm) attached by muscle only
Muscles distal limbs and feet	No muscles distal limbs or feet
Gall bladder (fat metabolism)	No gall bladder
Muscle composition well researched (cell)	Muscle composition poorly researched (cell)
Profusion of non-return valves, in veins, distal limbs	Poor supply/absence non-return valves, in veins, distal 1/3 limbs
Moderate skin sensation	Hypersensitive skin
Some body hair	Total body hair covered
Efficient ability to lose heat	Poor ability to lose heat
Extra pyramidal tract (fine movement control)	No tract after C2 sensation/ appreciation of space via whiskers
Conscious/calculated thought processes	Responds to harnessed reflexes
Full spectrum colour appreciation	Limited colour appreciation
Frontal vision only, unless head moved	360° vision

The concept of treatment and rehabilitation following athletic injury is now an acceptable part of veterinary medicine and is the task of suitably qualified physiotherapists. The physiotherapist is part of a team headed by the veterinary surgeon in charge of the case.

By law the vet must make the initial diagnosis and write giving permission to the physiotherapist in order for her/him to administer appropriate therapy. This requirement applies to any person offering or practising any form of therapy (Veterinary Act, see Appendix I).

Originally, the physiotherapist had only his/her hands to work with, but with the arrival of the machine era, physiotherapists were taught the effects the varied devices had on tissue. An in-depth knowledge of anatomy and physiology allows for the choice of machine most appropriate for the condition diagnosed, and furthermore, an understanding of healing gives the knowledge needed to change machines as the recovery pattern dictates.

Therapy machines have, in the main, been developed for use in the human field, with no adaptations for use in veterinary medicine other than the reshaping of pads or the changing of machine names – for example, a therapeutic ultrasound machine has been renamed a Vet Sonic.

Although recently a few trials have been instigated it should be understood that the exact effects on the tissues, be they those of man or horse, resulting from the stimuli delivered from many of these human-oriented machines are still unknown. However, fractures, sprains, strains, arthritis, muscle tears, bruising and painful backs, are all common to humans and horses, and electrotherapy is being widely used to treat athletic injuries in both species, despite the fact that benefits remain largely speculative. Unfortunately, if technology is available it will be used even if the end result is not known.

Therapy machines are available for purchase by the layman, but little has been written describing the best time during the healing process to use the machines, the contra-indications to usage, or the dangers of over dosage and usually the only available literature are the manufacturers' pamphlets.

Reliable information can be found in science-based textbooks, but these are written solely for professionals, qualified members of the medical or veterinary profession. Understanding the text requires in-depth, specialist knowledge. In an ideal world, only professionals should use the machines but many have been sold to the layman and unfortunately, they are often used to the detriment rather than to the advantage of the patient.

It is very important to realise that there can be no exact criteria as to treatment times or dosage – each case should be judged on the individual circumstances.

It is also important to recognise that no one machine can be expected to fulfil all requirements, each has a specific effect. The purpose of all therapies, including the use of machines, is to enhance the natural, inbuilt, healing abilities of the body, with the aim of restoring full function to the injured area and thus minimising secondary trauma.

Nearly all tissues, other than central nervous tissue, have the ability to reconstruct to their original state. The programme for healing follows a set pattern which is instigated, in the main, as a result of specific chemical signals. For example, blood leaking from a damaged vessel is considered free blood. Free blood within or adjacent to bone changes the normal chemical balance of the area, messages flash to appropriate recovery units, cells migrate to the area of damage and construct, to a pre-set pattern, which includes very precise timing, the new bone. Over time, and in response to exercise stress, the damaged bone remodels, eventually resembling its pre-damage configuration. Research has demonstrated that the use of therapeutic ultrasound given for, or during, the first ten days post injury will enhance the mobilisation of the first set of bone repair cells, the *osteoclasts*. Given *after* ten days, therapeutic ultrasound reverses the repair programme because signals from the machine have interfered with the natural, body induced, sequence of events. This reverse effect might be useful for treating a splint when the object is to dissuade the body from creating an unsightly bone mass but is of little use in, for example, a knee injury when a slab fracture of a carpal bone has been diagnosed and is healing.

There are many unscientifically based claims that machines accelerate healing and these have yet to be proven. Some of the machines may induce an earlier start to the natural repair processes of the body thus enhancing the natural succession of tissue response. However, health and performance go hand in hand, no type of therapy can cure a problem or enhance performance if the original cause of the problem or poor performance is not sought. This requires team work involving a large number of people and an understanding of the inter-relationship which exists between all the body systems

Members of the team

The horse

Horses are amazingly adaptable but conformation cannot be changed and consideration must always be given to this fact since conformation may limit performance. Conformation is determined by genetic make up and attempts to change or correct a naturally adopted gait can lead to inappropriate strain within associated structures, often resulting in lameness.

Muscles take time to model in response to demand as does bone. Horses are often asked to progress too rapidly, before their musculoskeletal system is adequately prepared. There is a big difference between being conditioned and being fit.

The hypothesis, now described as Wolff's Law, of Julius Wolff (1836–1902) has never been disproved. He stated 'adaptive changes in the structure and biomechanical properties of bone occur in accordance with functional demands'. The skeleton and the soft tissues need adequate preparation time to ensure that at cellular level their structures have remodelled and adapted to fulfil requirement.

There is no point in trying to teach the horse a new task until it is physically capable of performing the task. This is particularly important, given the fact that if muscles are inadequately prepared, they become fatigued and fatigue leads to discomfort. Because the horse is endowed with survival instincts, when discomfort is felt, the animal will alter the way it recruits muscle, imperceptibly changing from an economic movement pattern to a painless movement pattern, thus creating secondary areas of stress. The new pattern will also be logged in the movement centre of the brain as normal and therefore remaining even when the discomfort resolves. Should this happen in man voice direction and visual example are employed to re-establish normal movement.

The veterinary surgeon

The veterinary surgeon is the most important person in the health team. It is sensible to have a horse examined pre purchase by your own vet. Should anything go wrong the vet will have the advantage of already knowing the horse. Unfortunately, there is often a reluctance to consult a vet, rather as man tends to avoid the doctor lest something unpleasant may be heard. Vets and doctors are bound to tell the truth, be that pleasant or unpleasant. However, leaving a problem may, and unfortunately often does, result in irreversible changes.

The veterinary profession is generally very amenable to enlisting help from team members with expertise in complementary professions, farriers, dentists and trainers. To be asked to help when all else has failed is not so much irritating as frustrating.

The rider

Riders damage horses rather more often than a horse damages its rider, usually because muscle fatigue is overlooked during training and a horse is asked to repeat a task again and again. Try press ups and see how long you can repeat the exercise before you tire, relate this to the hour of concentrated flat work demanded from your horse.

Beginners, new to horses, often think two novices can develop together. Sadly, this usually leads to confusion in the horse and disappointment in the rider.

Experienced riders will often 'feel' all is not well when on a horse; over time their body instincts have become so tuned that these have become, without conscious thought, a source of information. These experienced riders are easy to help because the information they provide should help the appropriate team member both to identify and deal with the primary cause of the problem.

The groom

A good groom is the horse's nanny. Their input is essential to all other members of the team provided they have been taught to observe. Small observations make for improved help from other team members. The dentist needs to know if the horse is quidding its food, the nutritionist the state and smell of the urine and droppings, the masseur if the horse is cold backed and the physiotherapist if lameness wears off after warming the horse up.

The dentist

Comfort in the mouth is essential, any evasion caused by discomfort will affect the head position. There is important inter linkage between head, neck and back. The position of the head, and consequent break over in the neck affects through tension created in the nuchal ligament the supraspinous ligament which supports the back. Thus the position of the head determines the ability of the horse to lift the back. This lift, in association with muscle groups taking origin from the nuchal ligament, enables the horse to carry the rider without being hollow.

Teeth should be checked at least twice a year, and preferably every three months in young stock.

The blacksmith

No foot no horse.

The foot is designed to absorb, in part, the compaction forces generated by foot fall during movement. These can reach unbelievable peaks when body weight is momentarily born on a single limb, following the airborne phase. The absorption capacity of the foot is helped by the unique arrangement of its own internal structures including the laminae and ligaments.

The supporting tendons with their ability to create and store elastic energy each time the foot bears weight, also create a type of spring, but if the foot is out of balance appropriate to the individual, i.e. unhealthy, under run or untrimmed, then the tendons are subjected to abnormal stress.

The frog, sited between the heel bulbs, acts as a pump creating the force required to drive venous blood up the distal limb against gravity in a part of the body where, other than tendons and fascia, no soft tissues exist. The health of the foot is an essential element for general health and performance.

Vital neural messages from the feet enable the horse to coordinate the movement of the four limbs, often at high speeds and over varied terrain, to use a variety of gaits, to jump obstacles, swerve to avoid collision, change leads and remain in balance in spite of rider weight.

The nutritionist

In evolutionary terms the horse is designed to eat herbage and when allowed a natural diet does very well. However, herbage is not just grass, it is a mix of plants which includes herbs in season, twigs from hedgerows and varied grasses, enabling the horse to ingest all required nutrients, carbohydrates, proteins, minerals and vitamins.

Many horses are inappropriately over fed through kindness or necessity, for example the show hunter is required to be well topped, often to the detriment of feet and joints.

Horses which eat earth when in a paddock, are generally looking for missing minerals.

Most feed merchants employ or can recommend a nutritionist who will advise on a diet appropriate for breed, life style and work requirements.

The trainer

The trainer can observe from the ground, seeing movement patterns, unlike the rider who has to feel them.

A trainer should be able to assess the muscle condition of the horse with which they are working as well as recognise any conformation limitations. They should also be able to advise on specific exercises in order to improve the functional ability of individual muscles.

Pole work is, for example, discussed in many training manuals, and the virtues extolled as being useful for balance, suppling and rhythm, but the muscle groups which are being targeted are not stated. It is no good promoting rhythm, achieving this on a straight line and then losing it on a corner because the stabilising muscles of abduction and adduction were not considered.

The masseur

The task of the equine masseur is to enhance muscle function and prevent injury as opposed to treating injury. Because of their underpinning knowledge, equine masseurs recognise through touch fatigue, hydration, tension, filling and subtle temperature variations. The feel of the coat is an excellent indicator of general health and the rider can be alerted to changes in muscle.

Physiotherapist

The physiotherapist is required in cases involving injury to the musculoskeletal system. Their job is to enhance tissue recovery by using electrotherapy appropriate to the state of the recovering tissue.

Many physiotherapists are also masseurs and some become involved in retraining either by suggesting or implementing training programmes.

If a system is in equilibrium, and an external action tends to alter the equilibrium, the system will adapt to oppose the external action (Le Chatelier's Principle).

Therapy machines deliver a variety of electrical and/or compressive signals to tissue, upsetting/changing the behaviour of the cells lying in the path of the current. It is for this reason that it is essential to consider if this type of therapy is pertinent, and ask 'Will changing cell behaviour be of benefit or could it be detrimental'?

Interdependence of the body systems

Trying to visualise the complexity of a living being is as daunting as trying to comprehend space. A grasp of the essentials is, however, necessary in order to understand the problems associated with injury (Table 1.2).

Cells

The basic unit of life is the cell, it is cells bonded together which form the different tissues of the body, these tissues in turn create the varied body systems. All cells contain fluid, *intra-cellular fluid*, and are suspended in fluid, *extra-cellular fluid*.

Table 1.2 The body's systems and their functions.

System		Function
Skeletal system	bones	
Joints	articulation	Locomotor
Muscles	movement	
Respiratory system	lungs	Oxygen/gas interchange
Vascular system	heart/veins/arteries	Conveyance
Lymphatic system	ducts and nodes	Filter system Disease defence
Nervous system		
Central	brain/spinal cord	Overall control
Motor	muscle	Movement activities/sensation
Autonomic	organs	All involuntary activities
Digestive system	stomach/intestines	Food uptake Waste disposal
Urinary system	bladder/kidneys	Liquid filtration
Reproductive system		

Efficient function requires the intra- and extra-cellular fluid to be in an appropriate state of balance, electrolytes play an important part in this balance. The cell membrane, or outer wall, ensures the cell contents and the all-important nucleus remain within the boundaries enforced by the membrane. Just as the brain retains overall control of the body so the nucleus controls its cell. Contained within the nucleus is the genetic code appropriate to the cell, as well as function commands which determine growth, repair and reproduction.

The cell membrane is porous allowing the movement of liquid and substances both into and out of the cell. Internally, the jelly-like cytoplasm, consisting of approximately 70% water, suspends substances such as salts, sugars, fats and amino acids. A precise chemical and electrical balance, appropriate for each cell type, is necessary to ensure efficient cellular function.

Some cells are described as 'free', these cells are not clumped together to form tissues. Free cells are transported around the body in the blood, for example the oxygen-carrying red cells erythrocytes, others, lymphocytes, can migrate via the extra-cellular fluid.

Despite the fact that the equine body contains approximately 400 trillion cells there is constant intercommunication, essential for the exchange of information, between them all, at all times, from the animal's first breath to its last.

Bones

Bones are of differing designs, their shape and size varying with their functional requirements. With the exception of the teeth, bone is the hardest tissue in the body. It provides the framework, the support of the body, and protects certain internal organs. It provides sites of attachment for muscles and tendons as well as constituting the levers which the muscles move. The structure of bone allows great strength: it is subject to compression, tension, twisting and bending strains, and is able to withstand these stresses by virtue of a certain amount of elasticity.

Long bones, or limb bones, have a central cavity, which acts as a factory producing certain cells. At the distal end of a long bone, before maturity, is an epiphyseal plate. This is a cartilage-type plate from which the long or limb bones grow. At maturity this plate has completed its function and turns into exactly the same structure as its parent bone. The bones of the skull, the ribs and the shoulder blades are known as flat bones. Sesamoid bones are small, rounded masses found in certain tendons at points of friction. The largest of these sesamoid bones is the patella located on the front of the knee in man and on the front of the stifle in the horse. All bones are covered by an outer skin or periosteum this giving support to the blood vessels which feed the bone and also allows for the attachment of the fibres of muscles, tendons, ligaments and the capsules of joints.

Joints

Joints are the meeting places between bones. Some meeting places, like those of the bones of the skull, have no movement (articulation) between them. Another example is found in the pelvis at the sacroiliac joints. The majority of joints, however, are *synovial joints* (Fig. 1.3) and allow for free movement between the bone ends. In this type of joint the ends of the bones are covered with a cartilage, *hyaline cartilage*. The cartilage is smooth and has a very low coefficient of friction, ensuring a slippery surface which allows for easy movement. Hyaline cartilage acts in part as a shock absorber and assists in the lubrication of the joint by producing synovial fluid, also known as joint oil.

Joints are enveloped by a sleeve or *capsular ligament*. The cells on the inner surface of this tissue produce synovial fluid or joint oil. Working alone, the capsule would be unable to support and restrain the movement between the ends of the opposing bones, support is therefore assisted by ligaments.

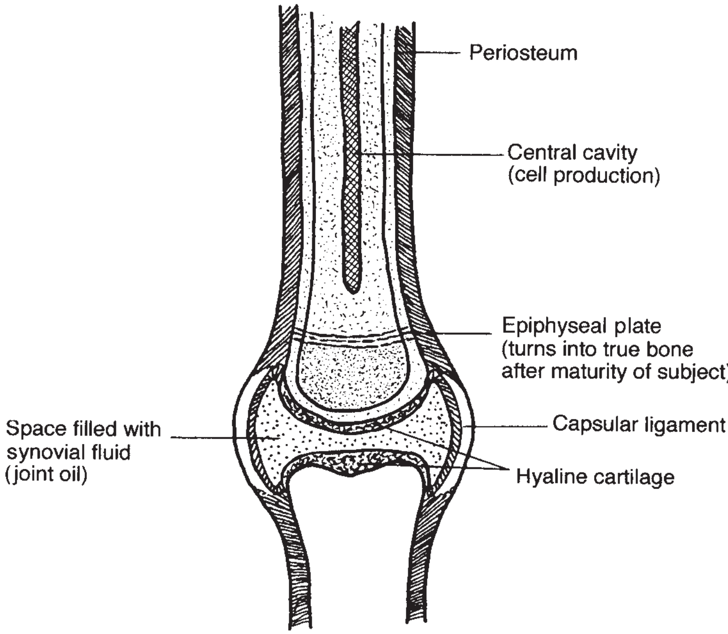


Fig. 1.3 Diagram of a synovial joint.

Ligaments

Ligaments are often confused with tendons but ligaments are concerned only with joints. The capsular ligament surrounds a joint and, as the name suggests, encapsulates it. Specialist cells on the inner surface aid joint lubrication by producing synovial fluid (joint oil). On the outer side of the capsular ligament, and spanning the gap between bone ends, bands of tissue, *collateral ligaments*, support joints and restrict their movement to the required range ensuring efficient economic function. These ligaments work in partnership with local muscles. Rooney (1980) presented work which demonstrates that as the collateral ligaments are stretched through joint movement they 'load' with energy, and this energy can be used to assist muscle action in returning the joint to its normal anatomical position.

When ligaments are subjected to severe overstretch they do not regain their original state. They are also slow to recover after being torn and may need to be stitched. Receptors sited within the dense tissue matrix of ligaments are quick to record any change within the tissue components and register their findings as pain.

The function and presence of *proprioceptors* (sensory nerve endings) in ligaments is still not fully understood, but recent research (Delforge

2002) has shown that disturbance of their activity is secondary to ligament strain, atrophy also occurring in local muscle groups. This atrophy is probably due to disruption of the normal intercommunication between the ligaments and muscles. An over stretched ligament is said to be sprained. Severe ligament sprain leads to joint instability.

Muscle

The type of muscle which moves one bone upon another and produces the movement required for activity is known as skeletal muscle. It is of a different construction from the muscle which controls the heart, *cardiac muscle*, and also differs from the type of muscle tissue which forms the hollow internal organs; the *bladder*, the *intestines* and the blood vessels. Composed of a series of components or muscle *spindles*, skeletal muscles are highly elastic. They are controlled by *motor nerves* and they function as the result of signals transmitted via motor nerves. In any one muscle only a proportion of the total mass is working at any one time.

In books on anatomy, muscles are described as having an *origin* (a starting point) and an *insertion* (an ending). The origin may be stated to be *proximal* to an adjacent structure. This indicates that the origin is nearer to the central body mass. *Distal* indicates a site further from the central body mass.

Muscles are attached to the bony skeleton in a manner similar to the attachment of seaweed to a rock. The fibres at the origin and insertion blend with the outer covering of the bones, the *periosteum*. Functional requirements and skeletal arrangement may require a bulky muscle to transform its tissue type, often becoming narrower and increasing in density, the tissue is then renamed *tendon tissue*. A classic example is found in the equine leg which has large parent muscles in the upper limb and tendons in the lower.

To date three types of fibres have been isolated and described in the horse although there is evidence to suggest the complete number of different fibres has not yet been identified. The proportion of slow and fast fibre types is inherited.

- Slow twitch (ST) = Endurance: aerobic fibres
- Fast twitch (FT I) } = Speed: anaerobic fibres
- Fast twitch (FT II) }

Slow twitch (ST) fibres can only function efficiently in the presence of oxygen. *Fast twitch* (FT) fibres can function without oxygen.

Horses taking part in endurance sports tend to have a high proportion of slow twitch muscle. An adjacent high concentration of blood capillaries to deliver the necessary oxygen for optimum performance also ensures that the waste created during activity is removed efficiently, reducing the build-up of undesirable by-products, one of which is *lactic acid*. Correct training will increase capillary density.

Fast twitch (FT) fibres are capable of functioning without oxygen, but can only sustain this ability for a relatively short time. The muscles of the American quarter horse are composed of nearly 100% fast twitch fibres.

Tendons

Tendons (Fig. 1.4) have the ability to sustain enormous loads because of their high tensile strength. Their fibres are not as elastic as the fibres of the parent muscle. At rest, the fibres of the DD and SDFT exhibit a crimp-like appearance, and under stress this crimp disappears reappearing only when the stretch force is removed. Today's racing and competition requirements impose stress and strain on tendon tissue. The dissipation of the heat created within the tendon during excessive exertion requires an efficient vascular supply. Unfortunately, as the cannon bone lengthened through natural selection, the veins and arteries did not develop adequately, thus the tendons of the equine limb might be considered to remain victims of evolution.

Functionally, tendons have the ability to concentrate the pull of their parent muscle on a small area. In the horse, tendons on the lower limbs also assist in the support of joints, for example, aiding the *suspensory ligament* in the support of the fetlock. Man has no structure comparable to the deep and superficial digital *flexor tendons* found in the lower limbs of large animals, the nearest human equivalent being the *Achilles*, or heel, tendon. The longer the cannon bone, the greater the stress on the tendon, particularly at full speed.

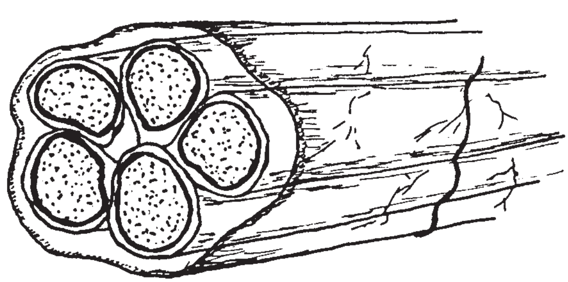


Fig. 1.4 Diagram of a tendon in cross section. The structure resembles a parachute cord.

The respiratory system

In the horse, exterior air travels via a series of tubes to the lungs. After entering the body through the two external nostrils the air is sucked up the nasal passages, through the mobile *larynx* at the angle of the jaw, then into the *trachea* or windpipe lying just below the neck vertebrae. At the base of the neck the trachea enters the chest cavity dividing first into the two main *bronchi* then subdividing into many branches, the whole resembling the branches and twigs of a tree. Tiny *bronchioles* terminate in small sacs called *alveoli*, and their walls support a plexus of blood vessels. The uptake of oxygen from the inhaled air into the blood and the dumping of unwanted gas and moisture from the blood take place within the alveoli.

Oxygen is a vital requirement for the correct working of the body system. The amount of oxygen within the tissues of the lungs, and therefore available for collection, depends on a number of factors.

- Rate of respiration – the speed at which the breathing takes place.
- Depth of respiration – the extent of the expansion of the chest cavity.
- State of nasal passages and larynx – delivery of an adequate volume of air can be reduced substantially by problems in the upper airway.

The angle of head to neck and the restriction of rib movement in the ridden horse are both factors which reduce the arrival of air within the lungs. The greater the flexion at the poll, the greater the constriction imposed upon the upper airway at the angle of the jaw (Fig. 1.5 (a) and (b)). Tight girths, the clamping of the rider's lower leg to the horse's side and an incorrectly fitting saddle which restricts the movement of the ribs at the point where they joint the backbone (the *costovertebral articulation*) all reduce the expansion of the thoracic cage within which the lungs are sited.

The heart

The speed at which the oxygen passes to the working areas depends on the rate and strength of the heartbeats. Thus the respiratory and circulatory systems are inextricably linked.

The heart is a large muscular organ with four chambers, its function being to propel blood through the body by alternate contraction and relaxation. A specialist muscle, it is supplied with a circulatory system of its own, the *coronary system*, and a highly complex nervous system. This nervous system automatically controls the rate and depth of heartbeat; that is, the individual cannot control voluntarily the

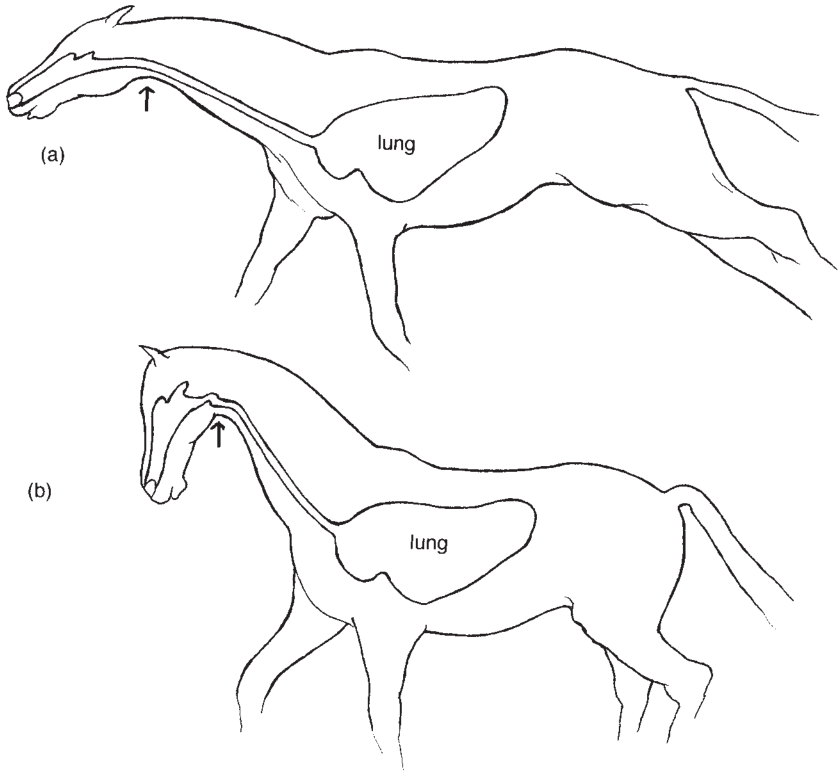


Fig. 1.5 (a) Minimum restriction to air flow; (b) maximum restriction to air flow.

performance of the heart. The organ responds rapidly to organised stimuli, for example, a sudden release of *adrenaline* accelerates the heart rate – in nature the fright/flight reflex.

The beat rate of the heart in the resting horse is normally 30 to 40 beats per minute. In the human the beat ranges between the low 60s and the middle 80s. (The significance of heart rate and its return to normal in exercise will be discussed later, see pp. 61–3.)

Circulation

The circulatory, or *vascular*, system forms the transport mechanism of the body and can be compared to a conveyor belt. It is a closed-circuit system, the flow of blood through the arterial section achieved by the pumping action of the heart. Blood flow in the venous section is, in part, dependent on pressure resulting from muscle activity. The blood fluid, or plasma, suspends many types of cell: some carry oxygen, some nutrients, some remove waste products, others form a defence mechanism. The mechanism of clotting and stopping blood loss after injury is also initiated by cells suspended in the blood fluid.

The values of all blood-borne cells is a known fact, as are the values of the chemical components, it is by reading and analysing these values that the health of the horse is ascertained. The blood picture is sometimes described as the health barometer.

Another important function of the circulatory system is the control of body temperature achieved by dilating or contracting the surface or superficial vessels. A body which is too cold cannot function in response to neural signals instigated by the thermal regulating centre. In the brain, the superficial surface vessels narrow or contract, centralising the blood and thus ensuring the maintenance of the correct temperature, known as the core temperature, of the vital organs, the brain, the heart and the lungs. Conversely, to maintain correct temperature should the body become overheated, the surface vessels dilate and in this way are able to lose heat through the skin by evaporation.

Circulatory flow is of the greatest importance after injury. It can be regarded as the transport system bringing the healing agents to, and removing the waste and debris from, the injured area.

Blood leaves the heart and is forced through the *arteries*. The arteries break down from large-diameter tubes to the tiny vessels of the capillary bed (Fig. 1.6). In the *capillary bed*, the vital exchanges between the tissues and the blood take place. The capillaries have very thin walls, described as *semi-permeable*. These walls are highly selective and determine the passage of materials to and from the surrounding tissue.

As the arterial system ends in the capillary bed, so does the venous system arise. The vessels regroup and form tiny *veins* which, in their turn, branch and form the large veins of the circulatory system.

Blood in the *arteries*, known as *arterial blood*, carries nutrients and oxygen to the tissues. Blood in the *veins*, *venous blood*, transports waste, passing through various cleansing organs as it goes. Then, via the heart, it returns to the lungs, ready to give up carbon dioxide and collect the next load of oxygen.

The return of venous blood is greatly assisted by muscle contracture. Arteries have strong muscular walls and the effect of the heartbeat is to push blood through them. There is no suction method to draw the venous blood back to the heart but the very fact that more arterial blood travels forwards with each heartbeat creates pressure within the circulatory system. To cope with the return of blood via the veins, the vessels are supplied with small valves. These cup-like valves fill, and close off sections of vein between each heartbeat, ensuring a one-way flow. When subjected to pressure by contracting vessels, the veins, whose walls are less muscular than those of the arteries, are

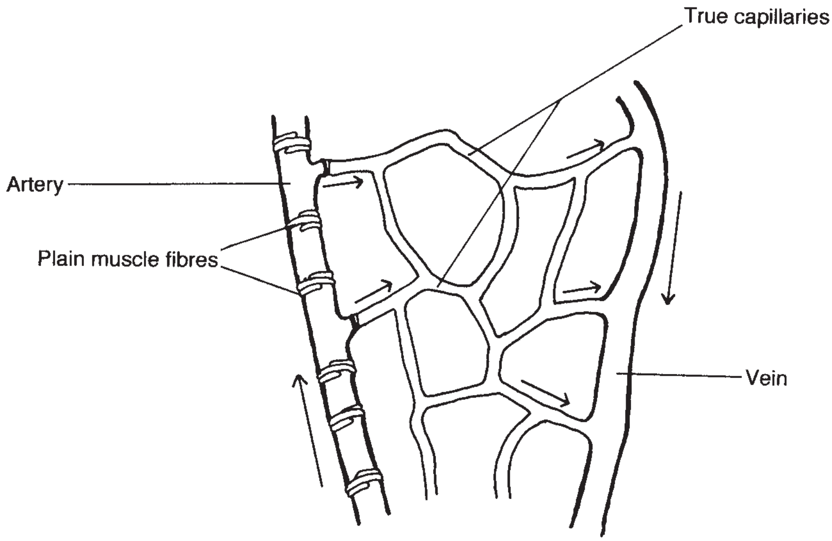


Fig. 1.6 Capillary bed.

compressed, allowing blood to be squeezed from section to section. The venous system is assisted by the *lymphatic system.*

The lymphatic system

Anatomically, the lymphatic system is proving to be far more complex and its functions of greater importance than previously understood, other than by those specialising in immunology.

The system consists of an extensive network of vessels containing the clear fluid known as *lymph* and in certain areas sprouting concentrations or clusters of cells, known as *lymph nodes*. The system filters and removes debris from all interstitial areas in connective tissue and from the *vascular* (circulatory) system. It is of prime importance for body defence and immunity, producing *lymphocytes*, the defending cells of the body. The walls of the vessels are able to absorb more readily inflammatory exudates and macromolecules than are the walls of the capillaries. The harmful debris which has been collected then travels via the extensive network of vessels until it eventually empties into the *cranial vena cava* at the thoracic inlet.

The lymph nodes house *reaction centres* which specialise in the production of *antigens* and *lymphocytes*, both of which play a part in combating and destroying bacteria or harmful toxins. The movement of lymph fluid is very sluggish despite numerous valves to prevent back flow. Muscle activity, respiratory movement and the peristaltic activity of the intestines all aid the flow of lymphatic fluid.

Injury increases the amount of free fluid normally contained within the lymphatic network, adjacent to the area of tissue breakdown. Reduction of muscular activity contributes to a reduction of fluid movement within the system. In this situation, mechanical compression such as massage assists the progression of lymph within the vessels of the system.

The nervous system

The nervous system provides the communication network for the body and can be described as a series of highly complex and interlinking computers, the central computer being the brain which is composed of specialist nervous tissue.

Some of the functions of the body can be controlled by conscious thought, other functions are not controlled, and continue as an automatic occurrence due to the computer-like behaviour of central nervous tissue.

The brain has an extension known as the *spinal cord*. This extension is well protected by the bones comprising the *vertebral column*, the brain itself being protected by the bones of the skull.

At each intersection between the *vertebral bodies* (bones of the spine), a pair of nerves emerge. These nerves consist of hundreds of tiny filaments and if seen in cross section under a microscope would resemble a main telephone wire which has been cut through vertically. The nerves divide and sub-divide within the body, each nerve, or *axon*, protected by an outer sheath and each branch preparing for a specific function.

Nerves end in different types of tissue and, according to their predetermined functions, take messages to an area, carry messages from an area, and record a wide variety of information.

Nervous tissue is very susceptible to pressure. If continuous pressure is applied nerves may cease to be able to pass messages, or *conduct*. This may leave an area of the body without sensation and/or the muscles in that area may have an ineffective communication relay. This is known as an *impaired nerve supply* and will cause a muscle to waste, or *atrophy*.

The skeleton

The bony skeleton (Figs 1.7 and 1.8) serves as a framework for other body tissues to build on, and also acts in part as a protection for some of the vital organs. The skull houses the brain, the central vital computer

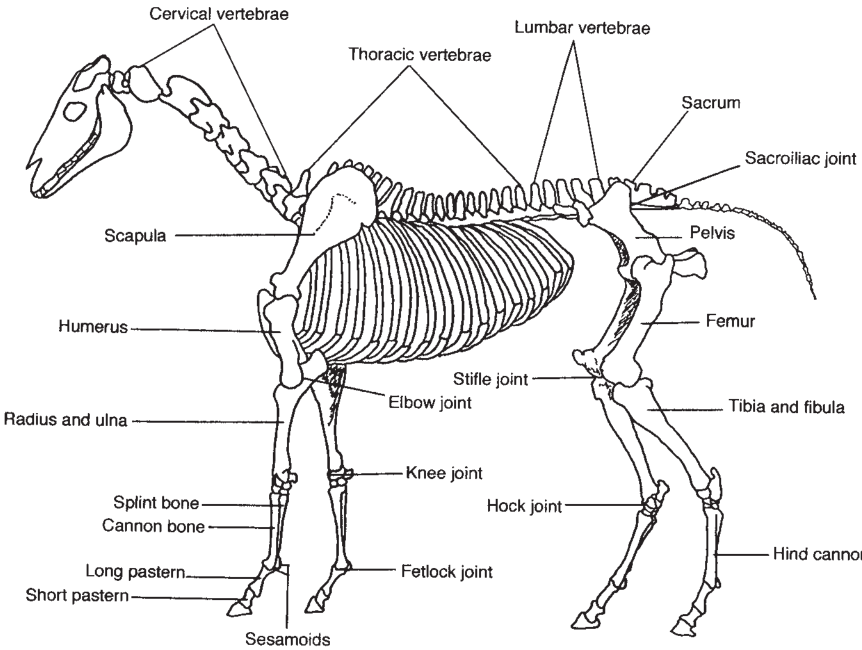


Fig. 1.7 The skeleton of the horse.

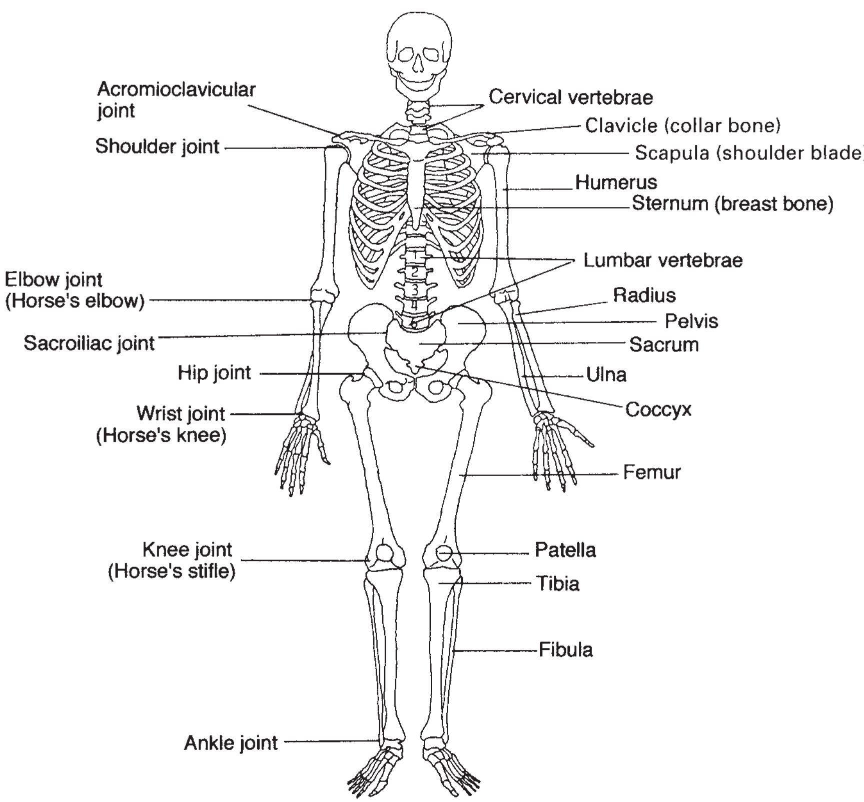


Fig. 1.8 The human skeleton.

composed of specialist-type nerve tissue called *central nervous tissue*. An extension of the brain, protected by the bones of the back or vertebral column, is known as the *spinal cord*. (Damage to the tissue of the brain or the spinal cord is final, no repair or recovery is possible. Depending on the level of accident the loss of a particular function or series of functions will occur as a result of this damage.)

The first set of bones of the vertebral column are the neck bones (seven *cervical vertebrae*). Movements in the cervical area of the horse are up, *extension*, *down flexion*, and from side to side, *side flexion*. As in the human, the majority of rotation occurs between the first two vertebrae.

In the human there is more rotation between the first two cervical vertebrae and the skull than in the horse. The human can also move up (extension) and down (forward flexion), and from side to side. The cervical vertebrae join to the chest, or *thoracic* area. From the bones of the thoracic vertebrae arise the *ribs*, curving forward, shaped rather like bucket handles and meeting the breast bone, or *sternum*, at the front to form the bony chest cage. This cage is partitioned by the *diaphragm*, a large sheet of muscle whose function is to aid breathing.

Rotation is present in the human thorax, with side bending and some forward and backward bending. There are muscle arrangements which produce these movements. The four-point balance of the horse and the muscle arrangement allow movement to occur both up (*dorsiflexion*) and down (*ventroflexion*) and from side to side, but there is no muscle arrangement which creates these movements: they occur only because the vertebral column is a jointed structure.

The lungs lie in the upper (human) or forward (horse) compartment of the thoracic cage, with the heart cushioned between them. Below (human) or behind (horse) the diaphragm are the abdominal contents.

The last thoracic vertebra joins the first *lumbar vertebra*. The lumbar vertebrae form the low back (human) or loins (horse). The vertebrae bridge the gap between the chest, or thoracic cage, and the *pelvis*, the last lumbar vertebra joining a triangular block of fused bone, the *sacrum*, which ends in the small bones of the tail, or *coccyx*.

The two halves of the pelvis (*pelvic bones*) curve round and meet the triangle of fused bone, the *sacrum*, at the *sacroiliac joints*, so named because the upper part of the bone of the pelvis is called the *ilium*. The sacroiliac joint has no muscular control and, although termed a joint, is merely the meeting place of two bones. It appears to act as a type of primitive shock absorber.

The hind limbs

The hind limbs of the horse and lower limbs of the human are locked to the pelvic girdle through two sockets: the *acetabulum*, two depressions, shaped like deep saucers, into which fit the ball-like heads of the upper bones of the limb called the *femur* or thigh bones (the strongest bone of the body in both horse and human). Below this bone, any similarity between human and horse ceases.

The thigh of the human ends at the knee; the two bones below, the *tibia* and the *fibula*, lock at their base to form and grip the first bone of the foot, the *talus*, and form the ankle joint. The bones of the human foot are arranged and shaped in a series of arches and levers, designed for forward and upward propulsion and also to absorb and dissipate the shock of meeting the ground. In front of the knee of the human is a sesamoid bone, the patella, encased within the tendinous ends of the large muscles which lie on the front of the thigh called the *quadriceps*. Sesamoid bones are often present on either side of the first joint of the big toe in the human.

The equivalent structure to the human knee in the horse is the stifle. From there the tibia and fibula fused, angle backwards and end at the hock. The horse stands on a single central bone, the *cannon*, with two accessory bones, the *splint* bones, lying on either side but serving no structural function. The cannon bones angle slightly forward, meeting the *long pastern* at the fetlock joint: behind this joint there are two sesamoid bones, the *proximal sesamoids*. The first *phalanx*, or long pastern, articulates at its distal end with the second phalanx, or *short pastern*, in its turn balanced on the *pedal* or *coffin* bone.

The forelimbs

In the human, the arm is hung from a yoke-like structure consisting of the shoulder blade or scapula (lying on the back of the chest) and attached to the collar bone, or *clavicle* (lying on the front of the chest).

The collar bone, in its turn, is attached to the sternum, the central front bone of the thoracic (chest) cage. There is a depression on the scapula which allows movement of the head of the upper bone of the arm, the *humerus*.

The forearm of the human consists of two bones, the *radius* and the *ulna*. Movement at the elbow joint is in two planes, bending (flexion) and straightening (extension). The ability of the human to turn the palm of the hand in two directions occurs between the radius and the ulna, at a joint below the elbow joint known as the *radio-ulnar* joint. The distal ends of the radius and ulna articulate with the small bones of the wrist, which in their turn articulate with the bones in the hands and fingers.

In the horse, the forelimb supports two-thirds of the animal's body weight. There are no collar bones; the arrangement of the shoulder blades (scapulae), ligaments and muscles enables the weight to be slung,

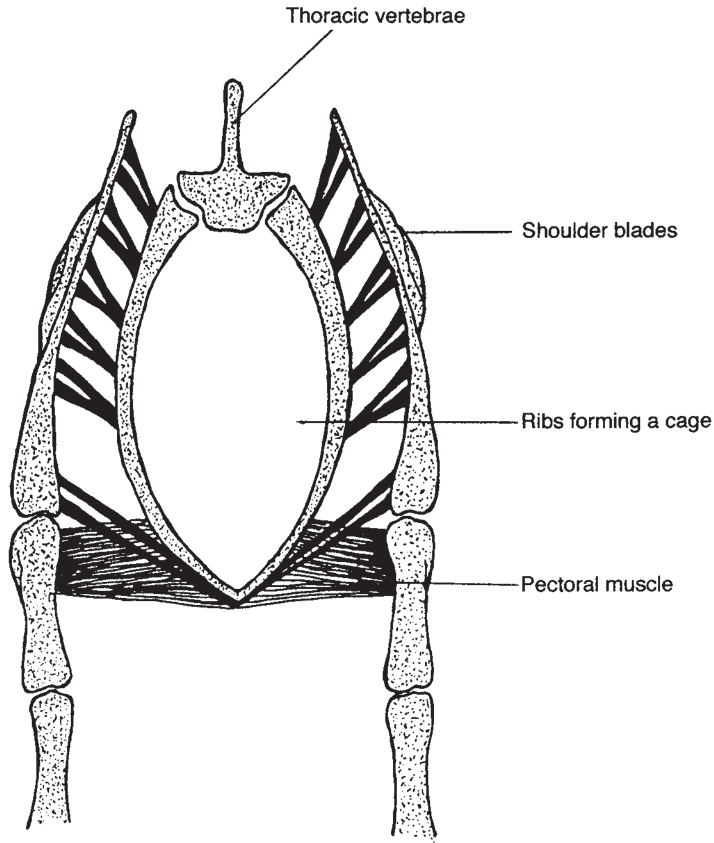


Fig. 1.9 Diagram to demonstrate the suspension structure of the forehand of the horse.

as in a cradle, between the two forelimbs (Fig. 1.9). The humerus angles backwards from the distal end of the shoulder blade, and meets a fused radius and ulna (bones of the upper limb) at the horse's elbow. The knee of the horse corresponds to the human wrist; below the knee, the bone arrangement is the same as that of the hind limb.

Skeletal muscle

As discussed above, the bony skeleton not only provides the frame or structural base for the attachment of skeletal muscle, i.e. those muscles which produce movement, but also itself relies on the skeletal muscle groups for support. Ligaments alone cannot hold up the skeleton: they rely on a partnership with the muscles.

The sites of attachment, the arrangements of the groups, the angle of lie of the fibres, and the direction of pull which occurs when muscles shorten or contract, determine all movement sequences.

By passing over joints, muscles assist in the stability of the joint as well as creating movement. In some cases, fibres from the muscle blend with the fibres of the joint capsule. This combination provides protection, since, if the joint becomes forced towards the movement range beyond its anatomical normal, the excessive tension on the joint capsule is moderated by the contraction of the overlying muscle fibres.

No one muscle works on its own: all movement is a group effort. For movement to occur many activities take place. Vast quantities of information are collected, recorded and analysed by the nervous system in a manner which can be likened to the interaction of banks of computers all interlinking, all dependent one upon the other and, in the case of the body, controlled by certain centres in the brain.

A tiny proportion of the total number of activities and functions carried out by the body are conscious. The vast majority are reflex, that is, they occur without conscious effort or thought.

Muscles can only produce effective, efficient movement patterns if they are in balance: that is, the strength of one group is complementary to its partner groups. Both sides of the body must work in harmony and there must be equal power between the left and right sides.

Injury, no matter if it is to bone, joint, ligament, tendon, nerve or to a muscle or group of muscles, causes degeneration and impaired function of the muscles which have been injured or which control the section of the body which has been injured.

This muscle degeneration or atrophy occurs for any one of a number of reasons, among them:

- *disuse atrophy* – due to pain, the area is not used;
- *loss of nerve conduction* – a muscle with no communication system, unable to relay or receive messages, atrophies rapidly;
- *destruction of the muscle structure* – crushing, bruising, tearing or the presence of chemical toxins (secondary to cellular damage) causes muscle tissue to deteriorate;
- *ischaemia* – loss of blood supply due to disruption of circulatory flow;
- *excessive exercise* – due to lack of fuel, muscle tissue breaks down.

Reflex movement patterns

All movement patterns occur as a result of learning. The baby falls endlessly while learning to walk: the foal learns faster, but is hesitant and uncontrolled in early life. Gradually, reflex patterns are established, that is, movement sequences occur as an automatic response to a set of circumstances, with the brain, via the nervous system, activating the necessary responses.

A point which is consistently overlooked is the fact that the foal is recording responses to stimuli from the moment it is born. The foal gets used to a halter, gets used to being led, then as it develops, it often begins to out walk the handler, even with a central D ring, restraint through the lead rope tends to force the animal to turn the head towards the handler, as horses are generally led from the left, the head angles left. No one worries, the foal is turned away to mature, handled for foot trimming, little else is demanded of it, then comes the time for breaking in. On goes the cavesson, the foals brain says 'pressure at the poll, pressure on the nose means, turn head left'. This pattern was imprinted when the foal was being led and is probably the reason for the often-heard statement, 'horses are one sided' – early imprinting has produced a one-sided response.

In the case of the ridden horse, responses should occur as the result of signals given by the rider. Injury and subsequent lay off may cause these previously automatic responses to be lost – there is a 'computer failure'. Inability of the rider to appreciate this causes many problems, often, the rider expects the horse to perform to command to the exact standard which had been achieved at the time of injury.

Start slowly and re-educate to avoid disappointment.

2 Injury – Effects, Repair and Causes

Common musculoskeletal injuries

Bone damage

Damage to bone equals loss of support in the framework/leverage system. Bone breaks are known as fractures. There are many different types of fracture. In a complete fracture, the line of the break passes through the bone in its entirety; bones may be broken in one or more places, they may also be crushed, or just cracked.

Bone is slow to heal but, provided the ends are approximated – that is, opposite each other – and movement between the bone ends, or between the bone particles/pieces is eliminated, healing will normally occur.

Diagnostic imaging has progressed, whereas previously the density of equine tissue masses meant that only rather poor quality X-rays were available, now with the advancement of technology perfect images can be obtained. In most referral centres there is the capacity to use magnetic resonance imaging, computed tomography, ultrasonography, nuclear scintigraphy, thermography. The advances in technology have expanded diagnostic parameters which have resulted in significant advances in the knowledge of musculoskeletal disease (Fig. 2.1).

Images of the neck and back are now possible; problems with or injury to soft tissue, as well as bone and joints, can also be identified, resulting in improved treatments.

Repair phases of the recovery of bone are similar to those of soft tissue. In the case of bone, the end result is probably the most perfect for similarity of original structure. Complete fractures usually need to be immobilised for good repair. In a weight bearing limb this was, in the past, almost impossible but, with the expansion of veterinary orthopaedic surgery, and improvements in anaesthesia, the use of pins and plates are now commonplace. By the use of pins, plates and screws,

Fig. 2.1 The bones of a foot imaged using a portable radiography system.

a great number of horses, whose injuries would formerly have required that they be euthanised are now operated on and saved.

Sore shins

Incomplete fractures, such as minute cracks, can be treated without the need for the limb to be immobilised. Of these, the most common condition is that of sore shins. Localised stresses (an occupational hazard of athletic bone) cause minute cracks in the cannon bone. Early radiographs often appear normal but subsequent examination may show *callus* formation where the tiny cracks are trying to heal. In American terminology, this condition is called *bucked shins*.

Early lameness denoting this condition may be minimal, but the pain may suddenly rise to a crescendo, with lameness and hypersensitivity to touch. A history of pain and tenderness should lead to at least three weeks of reduced activity. Shock wave therapy has proved beneficial.

Sites of bone inflammation

Other bone sites can cause problems, often giving rise to unexplained lameness in the early stages of bone inflammation. The patella ligament in the horse is the conjunction of three ligaments which are inserted into the tibial tubercle, as in the human model. Irritation of this bone area, described as Osgood-Schlatter's disease, occurs in teenage human athletes and is considered to be associated with strong muscle traction on immature bone. In the young horse a similar inflammatory response appears to occur, suggesting, as in the teenage athlete, possible skeletal immaturity, with the bone unable to withstand the massive contractile forces of the quadricep muscles.

A curb occurs at the insertion of the extensors of the hock conjoined as the common calcaneal tendon.

Stress fractures which continue to give trouble, however minor, should not be ignored, the state of general maturity, diet, in particular mineral requirement, and exercise protocol, all require consideration, lest a spontaneous, complete fracture occurs.

Damage to the periosteum

The *periosteum* is the outer covering, or the outer skin, of the bones. Muscles, ligaments and tendons are contiguous with the periosteum at their origins and insertions. Tears, pulls or knocks cause rupture of small blood vessels, with consequent local bleeding. This free blood acts as a chemical irritant and in response to the chemical signals new bone grows, forming small ridges or lumps. These may interfere with normal function if adjacent to a joint or tendon. Bleeding between the bone and the inelastic periosteum also causes severe pain (Fig. 2.2).

Damage to the epiphyseal plates

The long bones of the horse have not achieved full development before the age of two; in some breeds growth continues for several years.

Long bones, or limb bones, grow from specialist-type plates called *epiphyseal plates*. Under certain stress conditions, in particular diet related, and with over-training, these plates become irritated and inflamed. This condition is termed epiphysitis – that is, inflammation of the epiphyseal plate.

Damage to bursae

Bursae are small sacs of fluid, positioned at various points of the body, in areas of possible friction. Their function is to stop the underlying bone rubbing, and so damaging, the under surface of an overlying muscle or tendon. Bursae can become inflamed. If this occurs, they swell, causing severe pain and restricted movement.

The navicular bursa is the culprit in some cases of foot related lameness.

Fig. 2.2 Periosteal bruising to front of cannon hind right. Action in the fetlock joint of the injured side was severely compromised.

Fluid contained in the supraspinous bursa, positioned at the highest point of the withers, and damaged, in earlier times by ill fitting tack, tracked down between the posterior thoracic spines, with no available exit route often becoming infected and causing the condition described as wither fistula. The condition can occur following wither fracture.

There are two bursae sited at the poll, the cranial and caudal nuchal bursae, a horse which pulls back may damage either or both of these if the restraint tie does not break. Bruising results in discomfort to pressure and the horse may become bridle shy and/or head shy.

Damage to joints

The terminology to denote joint damage is *arthritis* (arth = joint, itis = inflammation). An inflamed joint is an *arthritic joint*. Unless the word arthritis has a descriptive adjective attached, the term does not necessarily mean that there will be irreversible joint changes.

One irreversible joint change is called *osteoarthritis*. In this case, areas of bone or the bones involved in the formation of a joint have formed irregularities on their circumference. These areas of irregular bone growth impede the normal movement of the joint. Unfortunately, the inflammatory processes in this condition are not confined to bone alone; the synovial fluid (joint oil) and the hyaline cartilage, coating the articular surfaces of the joint in question, may also be affected. Other types of arthritis may be described as traumatic, septic or infective.

Joints are *sprained* when put through a range of motion greater than they were anatomically designed to perform. This excessive movement may damage the supporting ligaments and surrounding muscle tissue.

Damage to ligament

Ligaments support joints. Overstretched ligaments therefore lead to loss of stability in their joint. In the case of the *suspensory ligament* stability is lost at the fetlock joint and below.

Damage to inter-osseous ligaments

These ligaments lie between two adjacent bones (inter = between, osseous = bone); for example, between the splint and the cannon bone. Tears of an *inter-osseous ligament* cause pain in the first instance and development of new bone in the second; depending on the position of the new growth, interference with normal function may occur. Some degree of pain is usually present in the early active stage of injury.

Damage to muscle

Muscle damage causes ineffective, incorrect and unbalanced movement patterns. Fatigue, bruising, loss of nerve communication and a variety of conditions, for example motor neurone disease and polysaccharide storage myopathy all damage muscle.

Muscle *atrophy* (loss of muscle tissue) occurs as a result of disuse, loss of communication due to damage to motor nerves or damage to the joint or joints which the muscle influences.

Damage to tendon

Damage to a tendon at the area where the structure inserts to bone or at the muscular tendon junction, occurs in the most part, due to over stretch forces associated with a weak or fatigued parent muscle.

The deep and superficial digital flexor tendons of the limbs may be damaged as a result of impact or more commonly appear to break down as a result of strain, following excessive loading.

To date, no treatment method or chemical stimulant has stimulated the components of the digital flexor tendons in a manner which has caused the original fibre type to reform following damage.

Very recent research looks more promising because considerable advances have been made in the understanding of the factors involved in tendon physiology at molecular level. It is also possible that stem cell therapy may turn out to be of benefit.

Damage to nerve

All body functions are dependent on a normal nerve supply. Any form of damage involving the specialist nerve tissues of the brain or spinal cord, the central nervous system (CNS), results in paralysis. The extent of the paralysis is determined by the area or level at which the damage has occurred, and it is the function of the body parts distal to the communication breakdown which are affected. Damage is irreversible and recovery does not occur. In the horse, pressure on the spinal cord causes Wobbler syndrome, the horse becoming incoordinate.

Damage to the nerve complex within the body mass, the peripheral nervous system (PNS) (that is the neural complex arising from the spinal cord but sited without the brain and/or spinal cord) is not always final.

Pressure upon, or severance of, nerve tissue equals loss of communication. Depending on the type of nerve involved, functional loss varies. For example there may be loss of skin sensation, or loss of appreciation of position in space of a limb or part of a limb. If the relative motor nerve is damaged then muscles shrink, i.e. they waste or atrophy.

Remarkably little is known about aiding recovery or influencing the autonomic nervous system (ANS). It is theorised that acupuncture methods influence the system as does skin rolling.

Injury and repair

Injury is a catastrophe. No matter which structure is the prime site, all the body systems are affected to a greater or lesser degree. The ancient Chinese description of the need for the perfect balance between the systems is very apt, for without balance within the musculoskeletal and associated systems athletic ability is seriously impaired. Contrary to the popular belief that 'rest is the only cure' and/or 'time is the only healer', up-to-date knowledge derived from experimental work on tissue in laboratories world wide shows that controlled, early activity can in selected circumstances be beneficial.

The application of modern technology in the form of machines enhances and assists the body's rebuilding mechanisms, provided that the correct machine is used at the correct time and that early treatment is followed by graded exercise.

To try to imagine what happens when injury occurs, envisage a bomb falling on a city and the consequent devastation – heaps of debris, leakage of liquids, escape of gases, disruption of communication – all leading to loss of function of the area. Rebuilding the area needs a carefully prepared plan of campaign if the city is to be restored to its original state. In living tissue, pain is an added complication. Pain produces many side effects and hinders, by invoking muscle spasm, the circulatory flow to the area, thus complicating the repair process. If preparation is rushed following injury, there may be loss of performance ability, leading to a lack of confidence in both the horse and the rider – particularly when performing a task similar to that from which the injury resulted.

As with the example of the bomb-damaged city, a plan of campaign for rehabilitation is necessary. The plan will vary depending on the severity of the injury and the response of the individual to the treatments given. However, there can be no hard and fast rules laid down, as is possible when reconstructing a building.

The reaction of the body tissues, whatever the cause of the injury, is immediate and similar – to rebuild. Reparative measures far in excess of those required are activated and, given the best possible conditions, damaged tissue will attempt to reproduce to its original state. Healing of the tissue is divided into three phases which overlap: the first is *inflammation*, the second, *proliferation* and the third, *remodelling*.

Inflammation

At the site of injury, the structure involved has broken down. Small blood vessels rupture, blood escapes into the area of damage and fluids and cells leak from tissue spaces adjacent to the broken structures. Tissue around the site may also be stretched or torn. Depending on the severity of the injury, the nerve pathways involved may cease to conduct.

Obvious signs at this phase are swelling, warmth, loss of full function and pain; the latter exhibited both on exerting pressure and during attempted movement. Pain is caused by the presence of toxic substances in the area of sensory nerve endings and/or increased pressure on pain-recording nerve endings.

The irritant chemicals, the result of cell destruction, and the free blood in the tissue act as stimulants for the arrival of an excess of fluids bearing cells. Some of the fluids seeping through vessel walls may damage normal tissue surrounding the site of injury.

Other specialist cells migrate rapidly to the area of damage and begin the task of clearing away *debris*, or dead tissue. The migrating cells continue to irritate the surrounding tissue; this irritation acts as a stimulant to ensure the continuous flow of blood to the site. The problem then arising, and which is due to the immobility of the local tissues (the result of the pain and swelling or because immobilisation is called for), is that the venous return, dependent as it is on muscle contraction, is impaired. The area becomes engorged; the lack of rapid clearance of these excess fluids and cells leads to the formation of a *haematoma*.

Should the fluids and cells not be reabsorbed from the surrounding area, sections of overlying tissue become adherent to each other. *Adhesions* restrict movement; worse still, when stretched, they break down and the entire healing process has to recommence in an area adjacent to, but not involved in, the original incident.

Proliferation

After approximately a week following injury, new blood vessels have started growing throughout the area. These are only primitive at the early stages but they are capable of transporting blood. The less solid the haematoma the more able these new vessels are to work their way through the tissue. Remember, the circulation is the 'conveyor belt' taking away the damaged and destroyed tissue and bringing in the repair materials. Building cells arrive via the new blood vessels and begin to lay down rope-like fibres of *collagen* – the tissue from which all body tissues are constructed – and a *scar* is formed. Seen under a microscope, approximately ten days after injury, the tissue alignment often looks like a badly darned sock. Once the body 'computers' are satisfied that the gap between the broken ends has been bridged by the scar, remodelling begins.

Remodelling

Remodelling is the final stage of repair and can take many months. There are no set times which can be applied to the process. Tissue will always try to reproduce itself after injury in a state as near to the original as possible. During this phase, small fibres attempt to push through the temporary repair and recreate the original tissue type.

Bone remodelling

Bone has a remarkable ability to reshape its original features following a clean break and provided certain criteria are met:

- opposing bone ends must remain in alignment;
- the blood supply must be adequate;
- the injured area must not be unduly stressed;
- infection must be avoided.

Improvement in veterinary anaesthesia has paved the way for improved orthopaedic procedures, with screws, pins and plates saving the lives of many cases despite the ever present difficulty of post-operative immobilisation.

Exceptions are the *accessory carpal* bone, sited behind the knee, and the *sesamoids*, sited at the distal ends of the fore and hind cannon bones. These rarely unite, forming a fibrous rather than bony union.

Unfortunately many injuries to bone involve a joint. If the articular surfaces of the bones are involved or damaged then full recovery is less of a certainty, although arthroscopic removal of bone chips from damaged joints has proved very valuable.

Muscle remodelling

Damaged muscle will remodel to an exact pre-injury state provided the haematoma which forms at the time of injury is correctly organised. In order for this to occur treatment is necessary for the:

- promotion of the absorption of excess material from the injury site;
- prevention of adhesions;
- prevention of scarring;
- maintenance of power in the unimpaired tissue and in the antagonistic (opposing) groups.

Research shows that the tensile strength of new tissues will not match that of the surrounding tissue for approximately six weeks after apparent recovery.

Nerve tissue remodelling

The peripheral nervous system (PNS) can be visualised as an electrical, domestic ring-main system, with the nerves conducting messages of all types along their fibres in a manner similar to the passage of electricity along the domestic cables in your house. The central core of the nerve is insulated, as electrical wires are, by an outer covering or sheath. Excessive pressure on the sheath prevents the passage of the electric current, and the nerve ceases to pass messages until the pressure has been removed.

Should a nerve be severed, provided the two cut ends are reunited (i.e. in touch with each other, requiring micro surgery) although temporarily unable to pass messages, in some instances nerves do repair and regain function.

Central nervous tissue, comprising the brain and spinal cord, is composed of a very much more highly sophisticated tissue serving both as a generating centre and a switchboard. The protection given to this tissue by the skull and the bony canal of the vertebral column in most cases provides adequate protection from injury.

Confusion often arises when, following an accident, the term 'broken back' is used. A broken bone in the back repairs given time, and, provided the spinal cord is not involved, full functional recovery is possible.

If the spinal cord is involved in such a manner that it has been cut or pressed upon, then the picture becomes very serious. The affected area is unable to conduct messages and so communication is lost between the central switchboard (brain) and the areas of the body serviced by the sections of the spinal cord below the area of damage.

A broken neck involving the spinal cord results in total paralysis caudal to the level of the break: a broken back involving the spinal cord results in total paralysis caudal to the level of the break – for example, loss of the use of the hind legs in the equine. American surgeons working on human cases have devised a surgical procedure which allows the passage of messages by bypassing the area of spinal cord damage. This operation has improved limb function in cases where some movement was possible post accident. Concurrently, researchers in Japan and Israel have treated damaged areas of the spinal cord with therapeutic lasers, and this method has also improved function in patients with partial cord lesions. These methods would not be suitable in the cases of equine cord damage.

Possible causes of injury

Human athletic injuries occur as a result of:

- lack of fitness;
- poor conformation;
- poor equipment;
- poor technique;
- accident.

Of these, accident in fact forms the smallest number of incidents, injury most often occurring as a result of the other causes.

The above causes are all applicable to the horse, and to them must be added:

- the rider;
- the rider's weight;
- the rider's ability and fitness.

Lack of fitness

Fitness and *preparation* for the task or tasks the horse will eventually be required to perform must go hand in hand. A horse is born with a brain which soon after birth learns to react to external stimuli. Training a horse involves increasing the ability of the animal to respond and react to a series of new stimuli invoked by the rider, many of which his natural living conditions would never demand. Some horses learn fast, some slowly; their apparent mistakes are often a result of their being asked to perform a task to which they have not previously been exposed, despite the fact that they may be physically fit. Fitness is not just the ability to gallop a mile and not be exhausted, it is the ability to gallop a mile on uneven ground, even crossing a series of obstacles en route in a balanced, controlled way while carrying a mobile weight – the rider. No mean task.

Good conformation, fitness for the task, a sound basic training and the rider's ability to help when needed – and leave well alone when not – are the basic essentials for avoiding injury.

Poor conformation

Horses come in many shapes and sizes. Down the ages, cross- and line breeding have endeavoured to produce the best possible shape for the task the particular breed is to perform. Amongst other things, an 'eye for a horse' is the ability to look at an animal and decide if its overall conformation is suitable for the discipline for which it will be trained. The old saying 'you cannot make a silk purse out of a sow's ear' along with 'never buy trouble, it comes soon enough' could be well borne in mind when considering the purchase of an animal.

Inappropriate conformation nearly always causes trouble when an animal is pressed to its limit. Much could be said about conformation, but it should be taken into consideration if an injury has occurred. For example, the hocks: a horse with a straight hock will find it hard to achieve the engagement required for the piaffe, the hock joint in certain horses precludes the required range of movement. In the human model some riders find it easy to 'open their hips' others find it impossible, this situation arises from variations in the amount of movement available in the hip joint.

Limbs should be of sufficient strength to carry the frame. Long cannon bones and a short forearm are more susceptible to break down than short cannon bones and a long forearm. The longer the cannon, the greater the length of, and therefore the greater the stress on, the tendons.

A well-developed second thigh, or *gaskin*, is essential for the support of the hock. Hocks are the focal point for manoeuvrability when a horse endeavours to leave the ground. Good hocks are a must: curbs, spavins and thoroughpins will arise from weak hocks.

Remember, injury in one area may well have occurred because of a problem in another area. Recent papers have shown that some horses, said by their owners to have 'backs', were suffering from a variety of limb problems which caused them to work out of balance. The back condition was secondary – treatment of the limb problem cured the back!

Poor equipment

A horse tries first to avoid and then to evade pain, and in so doing will form bad habits which are difficult to break. Incorrect biting, badly fitting saddles, over tight boots or bandages are all contributory factors in the pattern of eventual injury.

Poor technique

The inexperience or inability of the rider to teach the horse results in poor technique. Basic schooling is essential in order to avoid injury, whatever the eventual discipline of the horse.

Accidents caused by the horse alone are rare; accidents usually involve rider mistakes or unexpected external events.

Stable injuries

The greatest cause of self-imposed accident leading to injury is a horse getting cast. He is not clever enough to judge the distance between himself and the box wall. As he rolls over, he cannot complete the roll, his centre of gravity being too close to the wall, and he gets stuck. In these cases the horse is very often positioned in such a way that, even if he is far enough away from the wall to push his hindquarter outward, his head and neck are jammed.

Chain reactions have been mentioned previously. The horse has to be able to lift the head and side flex the neck to trigger the chain of reflexes which allow the ensuing coordination of the movements required to enable the animal to get up from the lying position.

Another point worth remembering is that if the wall has no purchase points, the hind leg slides upwards in an uncontrolled manner while trying to push the body away from the wall, often causing severe damage in the hip and pelvic area. Anti-cast strips are well worth fitting to the interior walls of loose boxes.

A second cause of self-imposed stable injury is insufficient bedding, particularly on a floor without ridges. As the horse rises after lying down, the metal shoe, in contact with the floor, slides across the slippery base, causing injury in the pelvic area. Any readers who have worn steel heel clips on their shoes must at some time have lost their footing on a slippery surface.

Turning sharply leaving the box may cause the horse to hit the door upright, the point of hip (*tuber coxae*) can be bruised or in severe cases so badly damaged that when the attached muscles contract they pull the point of the hip off (avulsion fracture *tuber coxae*).

All-weather surfaces and gallops

The components of a living body, the bones, joints, ligaments and muscles, display an 'adaptive response' to the working conditions to which they are subjected. Most remodel to withstand the stresses and strains of work, always provided they meet similar conditions on a regular basis.

All-weather surfaces are a tiresome innovation but necessary due to increased road traffic and the explosion in the ridden horse population. There were problems with early 'mixes' but as these became apparent manufacturers made adjustments. Despite this, use of the Tornado camera has demonstrated a differing foot impact pattern when compared to turf. Each type of 'all-weather' surface poses its own associated problems; none really retain a constant density under different weather conditions; and all need careful, constant maintenance. All-weather surfaces are here to stay and just as associated injuries have manifested in the human when using these types of tracks so do they occur in the horse. Although hailed as a breakthrough in human athletic competition it rapidly became apparent that there was a considerable increase in the number of injuries, particularly if athletes trained on one type of surface and then competed on another.

This should be taken into account by riders and trainers, for example, if a horse is normally worked on a poly-track mix and then changes to sand to compete, or even for a lesson, it has to cope with the fact that the sand creates a different resistance. Consider the difference you would experience if you ran on a well-maintained lawn (poly track) then changed to soft, deep, dry sand. I suggest a changed foot fall in the sand and tired muscles.

When considering putting in an all-weather surface, consider the structure of the base – this is one of the keys to success. If the base is too hard the impact shock bounces back, too soft and the surface becomes too deep. The all-weather material does break down and has no repair facilities, unlike turf. Providing the root system is intact, grass re-grows and its underlying porosity is maintained by worms and beetles working below the surface.

When thinking of possible reasons for the break down of surface materials used for riding, it is interesting to note that at gallop the load on the supporting limb at midstep of a 1000 lb horse is 2600 lb. On poorly maintained surfaces, when the hoof of the support limb penetrates the surface and hits a firm base, the load rises to 26 000 lb. This loading is close to the critical (i.e. breakdown) level for all the limb components.

'Effective maintenance, efficient drainage' – these are probably the four key words for the success or failure of all-weather surfaces.

Most 'ride well' when they have been allowed to settle after the initial laying, but the compactive forces delivered by the moving horse cause break down of the original components and reduce porosity even when used at walk. Shavings laid as a floor for a horse walker are pulped to dust in less than a month. A change in texture creates 'false' ground for several strides; often on a bend there may be little or no grip and the landing foot finds no safe hold.

The body is endowed with a myriad of in-built safety or *reflex* actions. The function of these reflexes is to avoid damaging the host. A simple illustration of this is the rapid, unpremeditated removal of a hand from a hot object. If an equine limb suddenly feels unsafe, as it meets the ground, there is a flash command for help often resulting in a dramatic skip and associated action change, as an opposing, or contralateral, limb attempts to assist to retain balance. This change may avoid a fall but injury often results. While this may not manifest as an immediate, obvious lameness it may well change the normal balance of synchronised movement, resulting in a major problem at a later date.

If choosing a new all-weather surface, look for a material which retains porosity, gives a good indentation on compression to give grip, and does not change its structural components under impact. Obviously, the base must be well drained as well. The 'Rolls Royce' of surfaces, designed by Martin Collins, have proved their abilities: laid as polo grounds, galloping tracks, race tracks and arenas both indoor and outdoor, they retain their original characteristics. A good surface pays dividends.

Tooth problems as a cause of injury

Problems within the horse's mouth are often neglected. Regular dental checks should be as much a part of good health management as regular shoeing. Unfortunately, the horse dentist is a rare bird. It is impossible to examine the back teeth, the cause of most troubles, effectively without a gag (see Fig. 2.3).

The lower jaw is narrower than the upper and therefore the back teeth of the horse do not meet in perfect alignment. In addition, the chew action is a cross sweep, grinding one row of teeth across the other. Gradually, sharp edges are created on the outer edges of the back teeth

Fig. 2.3 Tooth gag in place.

of the upper jaw which, going unnoticed, may cut the insides of the cheeks. In the lower jaw these edges form on the inner side of the teeth, rubbing against the tongue, often making it sore and sometimes causing small ulcers. The edges, often razor sharp, must be filed to round them off. This is skilled work, as although ivory is a very durable substance it is possible to damage teeth while filing them.

Dental cavities are rare, but gum infections cause abscesses involving teeth, and these give rise to pain. Fractures of teeth occur either as a result of the animal picking up and chewing on a hard object by mistake, or by being 'caught in the mouth', which is the result of incorrect biting and/or handling of the bit by the rider. The pain experienced must be similar to that felt by the human when biting on an unexpected solid object whilst chewing, as the horse's tooth has a nerve supply similar to that of the human.

A horse with a painful mouth will do his best to evade pain, resisting and fighting against contact with the bit. In doing so, his head position will change and the horse will become 'out of balance'; remember how important the head position is for the support of the back.

Pain in the mouth affecting the correct chewing action will affect nutrition. Incorrectly chewed food is not digested and absorbed, as it should be; if you think saving on dentistry is an economy, consider the rise in your food bills as you endeavour to 'feed up' your 'poor' horse.

Check mouths on a regular basis: six months is the maximum time that should elapse between dental checks. In addition, two-year-olds should be checked to see if the outer 'shells' of their back teeth are loose and have not shed naturally. Wolf teeth need to be removed when they are fully through the gum.

In a young horse with a particularly sensitive mouth, a rubber bit may be advisable; but whatever type of bit is used, it must fit. All horses have different shaped mouths and what fits one may not fit another. Think how you feel if the dentist takes an impression and misjudges the size of your mouth, over-filling it with the impression mould.

A horse which is unhappy in the mouth will not give of his best, and will learn both bad habits and an incorrect way of going. These factors may eventually contribute to some form of musculoskeletal injury particularly as fixing the jaw will create tension in the neck and if the neck is tense, then due to the influence of the nuchal ligament the back will tense.

The foot and shoe as a possible cause of injury

Long gaps between shoeing or a horse turned out with untrimmed feet – both are false economies. No foot, no horse: a good foot is one of the determining factors in the ability of the animal to stay sound and perform well (Figs 2.4 and 2.5).

The direction of hoof growth is downward and forward, if the toe is allowed to grow too long and the heels are too short, the critical angle of the pastern is changed. Damage to the flexor tendons may occur due to the increased strain. The angle of the hoof to the ground should be between 45° and 50° in front and 50° and 55° behind (Fig. 2.6).

The size of the foot is also important. A large horse with small, weak feet will not perform as well as the animal with a foot in proportion to his overall size.

The small foot with contracted heels interferes with the normal action of the 'frog'. At every step the pressure on the frog of a correctly trimmed hoof compresses the plantar cushion, aiding in the returning of venous blood from the foot and lower part of the limb. Imbalance between the inner and outer heel of the foot causes an imbalance of stress on the joints of the limb, with all the ensuing problems caused by the uneven stress to weight-bearing surfaces.

Fig. 2.4 Untrimmed foot with imbalance of heel growth.

Fig. 2.5 A foot which has been so badly balanced for so long that it has become deformed.

Corns are another source of pain to the horse, though in many cases the pain can be termed sub-clinical – that is, there is no apparent lameness. Inspection of the wear of the shoe will often guide the intelligent owner to these problems, which are minor to begin with but if undetected will soon become major problems.

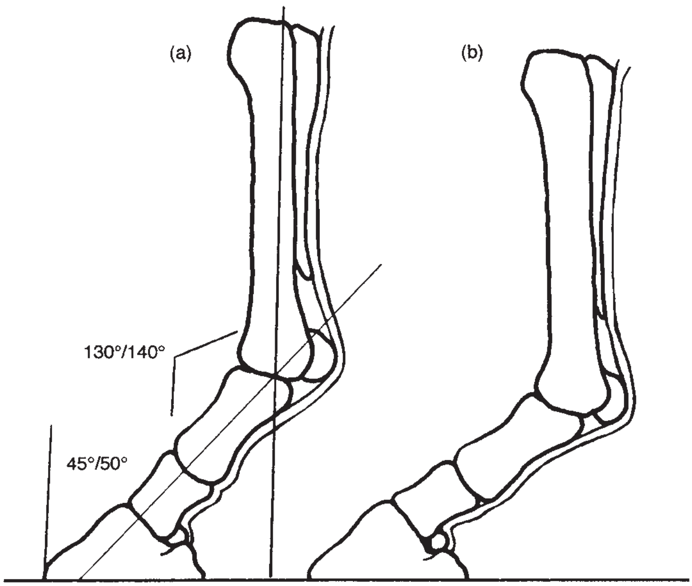


Fig. 2.6 (a) Correct foot-to-ground angles; (b) Incorrect foot-to-ground angle. Major cause: the toe of the foot has been left too long changing the angle, with resulting major injury to the suspensory apparatus of the limb.

No farrier resents intelligent discussion and he will welcome helpful information about the horse's way of going. The horse cannot talk, but you, the owner, through careful observation can often do it for him.

It is easier for your farrier if you have an area with a level floor which can be used for shoeing and, if the horse is having problems, a level area on which the horse can walk both away from and towards him. Just as some humans are 'pin-toed' or walk at 'ten-to-two' so some horses plant a foot in or out. Shoeing and trimming must allow the horse to move as nature and his conformation dictate.

Video filming shows the hooves rotating from side to side as the limb ends the airborne phase of motion and the foot feels for the ground, so, not only is the heel–toe balance critical but the inner and outer side of the foot must also be balanced for each horse; the inner, or medial, side of the foot appears to meet the ground fractionally ahead of the toe, then the outer or lateral side. The splint bones are a part of the weight-bearing surface of knee articulation so hoof imbalance may cause splints.

Shaving and paper bedding cause problems with the natural moisture content of the hoof wall unless the sole and wall are regularly oiled; dry or brittle feet make shoeing difficult which in turn leads to incorrect foot usage with resulting damaging skeletal stresses.

Saddles as a cause of injury

The part of the back bone (vertebral column) of the horse which stretches from withers to loins is constructed as a beautifully sprung beam. When the horse is being ridden this 'beam' must have the space to absorb shock. This shock absorption occurs as the result of bounce, or a minute amount of collapse and recoil throughout the beam. For those who have had the luck to ride a balanced athletic horse bareback, the sensation is somewhat similar to bouncing gently on a Lilo or a waterbed.

It is impossible for a horse to achieve its full potential unless the saddle is comfortable. Pads are not the sole answer although much is claimed by manufacturers. However, pads made of natural materials, such as sheepskin numnahs, can undoubtedly make life more comfortable for the horse.

There are a number of points to consider when buying a saddle, the sensible approach is to visit a tack shop, explain what you hope to achieve and look at their selection. If the shop uses a trained saddler you can ask for a visit and request that he/she brings a selection of saddles.

Remember if the gap between the two panels on the underside of the saddle is narrow, with the panels sitting close to the beam, the natural bounce will be restricted and the horse forced to move with a stiff back.

Just forward of the horse's loins are two reflex points. If these lie beneath the rider's seat bones when the saddle is in place, pressure exerted over these points, by the rider sitting deep, forces the horse to raise the head and hollow the back. The horse cannot avoid this action, just as if you have grit in your eye you cannot stop your eye watering. Stimulation of these reflex zones may result in the feeling that the horse is going to buck, it may even do so.

The evoked reflex is part of the primitive fright/flight survival reflex associated with a predator landing on the back of the wild horse. As the back hollows the head will automatically rise. It follows that a saddle fitted in a manner which creates pressure over reflex areas of the back will result in a raised head and a hollow, stiff back. No gadget can cure this posture although many are used; removal of pressure from the reflex points is the only cure.

Saddles with under panels which narrow approximately half way along their length, then broaden out, form a waist. This can create a fulcrum with the cantle lifting as the rider rises at trot and lowering as the riders sit and the pommel doing the same. The saddle actually rocks up and down and even though this movement may be small it can result in an area of localised bruising in the area associated with the waist.

If this occurs the horse will tend to stiffen throughout the back, may then resent being saddled, and will almost certainly dip away when the saddle is put on, will resent being mounted and will become termed ‘a cold-backed horse’. Unfortunately unless the situation is rectified, the horse may develop kissing spines due to the hollow posture adopted. When the back retains a normal configuration, the long dorsal processes of the thoracic vertebrae (dorsal spines) are kept apart, if the back hollows the tips of the spines become closer and may even impinge one upon another, they touch or ‘kiss’. Painful, localised inflammation results and horses become unrideable.

Many saddles are termed ‘general purpose’, but the term is a misnomer when it comes to competition, for rider position differs in nearly every discipline and the design of saddle should cater for this, even if this means buying more than one saddle.

When choosing a saddle, remember that the greater the area of the horse’s back which is in contact with the under panels, the easier it is for the horse to carry the rider. Weight is distributed over a larger area. This principle is adopted by people on skis in order to stay on top of the snow (Fig. 2.7).

The under side of the saddle should mould to the horse, while the upper side should fit the rider. A woman’s pelvis is wider than a man’s so when the horse is a family animal one member of the family may

Fig. 2.7 A Piriani saddle tree. B ↔ B: area over posterior superior spines of the vertebrae. X ↔ X ↔ X: a large panel distributes weight over a considerable area and is away from the centre of the back ensuring flexibility of the spine (softness).

not be as comfortable nor get equal results in a competition phase as another.

The panels need to be evenly stuffed. Wool is the best material because it does not compress as some man-made materials do.

'Soft' or half-tree saddles were originally designed for working (galloping) racehorses; unfortunately they are too often used for exercising. There is no attempt at lateral weight distribution, the tree ending behind the withers, and the natural bounce of the back is severely curtailed. The animal is forced to change its natural gait to accommodate the situation, as it attempts to relieve or avoid pain. Once the change of gait has become accepted as normal it remains, often to the detriment of performance.

One of the latest saddle designs is the treeless Torsion, consisting of a leather pad, rather than a conventionally built saddle. It was designed some ten years ago for endurance and long distance riders. Since the success of the design many other disciplines have adopted the saddle. The design allows the rider to feel the horse beneath him or her and, with suitably placed pads to lift weight from the spine, the saddle moulds to the back of the horse like a woollen blanket.

All too often horses, sent for rehabilitation, have a history of an inexplicable change of gait, this followed by stiffness in the back, usually noticed because of an inability to bounce in a combination; a shortening of stride; the complaint they no longer track up; stiffen in the neck.

A change of weight distribution, effected by a change of saddle, generally has dramatic results although if the horse has been left too long secondary changes often need to be addressed.

Regrettably there is no saddle, unless purpose built for the individual, which puts the rider in the 'correct' position. So what is the correct position? It is different for each rider, different for each gait and the comfort of the horse should come first. Saddles are expensive but consider how vet's bills could have been avoided if damage is secondary to and resulting from using a poor quality saddle.

3 Problem Assessment

The Veterinary Surgeons Act states clearly that no person, other than a qualified veterinary surgeon or the owner of the animal, may treat that animal unless permission is obtained from the consulting veterinary surgeon. See Appendix I, pp. 185–6.

To state this and then discuss an examination procedure would seem an anomaly, but every therapist and owner should design and stick to a comprehensive routine method of examination/observation in order to identify a problem, remembering that the therapist can only do so following veterinary clearance. *Never cut corners in your planned routine or jump to conclusions in what appear similar situations. Every case is different.*

Remember you are dealing with living tissue, the situation is not static. Significant changes may have taken place since the vet's visit and it is necessary to observe and report on any findings or changes which may have taken place. This helps both the patient and the vet. Your examination should take place before the horse has been exercised. After exercise, due to the increased circulatory flow, stiffness may wear off, the pain may diminish and your diagnostic picture becomes far from clear.

Observation, an in-depth knowledge of musculoskeletal anatomy, including surface anatomy, biomechanics and an appreciation of what is normal are of invaluable assistance when trying to solve a problem. It is also essential to be able to link individual and group muscle activity to every movement sequence.

The aims of good treatment and rehabilitation are:

- to determine the *site of origin* of the problem (Figs 3.1 and 3.2);
- to assist the normal repair process of the body through the use of the appropriate machine;
- to try to prevent recurrence of the problem through retraining and re-education.

Ideally, the rider should be involved in both the re-education and the retraining, and they themselves may need help. A rider with a bad back gives a horse a bad back!

Fig. 3.1 Horse presented with shoulder problem. Note angle of dorsal border scapula.

Fig. 3.2 Site of origin of the problem – foot imbalance. Note the difference in the height of the heels.

Soft tissue examination

The principles of soft tissue examination for the human needs to be adapted for animals. In the human, examination includes questions, answers, observation, active, passive and resisted movement. The greatest loss when dealing with animals is the inability to question the patient, but you can question the person who looks after the animal.

In the case of a horse, if one person rides and another looks after the animal try to talk to both; each will help to paint a picture of the circumstances which gave rise to the problem.

The following are the type of questions which need to be considered when searching for an underlying problem.

Poor performance

Was the horse adequately prepared for the competition, work demands or race type?

There is a significant difference between a horse being:

- fit (cardiovascular efficiency);
- conditioned (muscles and skeleton adequately built/trained);
- prepared (been exposed to, practised the tasks required).

Had there been any signs of stiffness or lack of willingness in performance prior to the accident/breakdown/incident?

An intuitive rider will be able to feel movement differences. A trainer/therapist should be able to spot minute changes in movement and to relate those changes to the structures involved by observing:

- joint movement;
- muscle activity;
- preferred lead;
- preferred diagonal;
- head position.

Has there been any previous history of accident?

No matter how far in the past an incident, any information is invaluable, for example 'yes, the horse broke the lead rope when tied up, but that was a year ago'. Further discussion often reveals 'yes, the horse was stiff on the left rein after that.'

If there is a leg problem, has there been any noticeable heat in the affected leg over the past few months?

Often the answer is 'yes, but nothing significant, and was OK the following day'. This might indicate that the horse has been over using the leg which is now obviously a problem. Question why?

Has the horse been reluctant to go downhill/uphill?

Downhill reluctance might indicate discomfort in feet, fetlocks, knees or the shoulder complex.

Uphill reluctance might indicate an inability to push from behind (engage). A visual lack of development of the muscle group comprising the hamstrings may be evident. Question why is the horse not using that group?

Has the horse evaded the bit?
Sore mouth, sharp teeth; wolf teeth emerging; shells; badly chosen, ill-fitting bit.

Has the horse refused badly or consistently?
Discomfort in the neck (far more common than appreciated), hurts to land, back is painful? Check saddle fit.

Pelvic discomfort?

Has the horse slipped on landing?
Front or back leg/s involved when slip occurred or was it on a turn? Consider ab- and adductor muscle groups.

Has the horse been cast recently?
Consider pelvic discomfort

Has the horse travelled badly to a competition recently?
Pulled back in lorry, emergency stop occurred. Re-enact mentally position of horse and forces involved, consider which muscle groups might be affected.

Has the horse been kicked or received a knock?
Out in the field playing, while being ridden, barged another horse. (Often the greater the distance from the kicker the greater the damage, power is at the end of the reach).

Has the horse banged into a jump or been knocked by another horse while jumping or galloping?
Palpate for discomfort for the former, re-enact mentally for the latter, considering position of horse at time, what were the muscles doing, was the horse landing, in the air, taking off, on a corner?

Has the horse felt resistant or one-sided when being schooled?
Does this relate to any of the previous questions, i.e. teeth, head position?

Has the horse changed legs continuously while galloping?
Foot discomfort, transient heat in a leg.

Discomfort in the poll area. (Danish research suggests the first two cervical nerves are involved in coordination).

Has the horse shown signs of a cold back?
Head and neck discomfort, head and neck position, kissing spines, saddle fit.

Observation

Do not have the horse moved. If rugged, do not take the rugs off, just look over the door of the box and note:

(1) Where is he standing in the box?
(2) Is the bed dug?
(3) Has he been sitting on a wall? Dock area of tail may be rubbed. Are the walls marked, suggesting that he does sit against a wall?
(4) Has he rolled recently? Are there shavings/bedding in tail hair, on rugs, in the mane?
(5) What is the weight distribution:
   (a) even on all four legs?
   (b) predominantly resting on one hind leg?
   (c) pointing a foreleg?
   (d) note the angle of pastern to the floor in each leg; are the angles similar in both forelegs, or in both hind legs? If you consider that the weight distribution is uneven, a difference in the angle may well mean uneven weight distribution, but check whether the floor is level, or on a slope. Ask an assistant to pick up the opposite leg and note the angle of the pastern of the leg on which the horse is now forced to put weight. Is it similar to that which the opposite leg adopted? In either fore or hind limb, if the angle changes and the fetlock drops, there could be a problem with either the *superficial deep digital flexor tendon*, or the *suspensory ligament*.

When a head collar has been put on and the horse's quarters turned away, go to his head and make yourself known to him. Let him sniff you; rub his face or scratch his neck; let him get used to your smell and voice. Note the following:

(1) Condition of the coat: is it dull and lifeless, or shiny?
(2) Is the eye dull or bright?
(3) What is the horse's general demeanour?
(4) Does he look as though he might be in pain? (Tight belly line, pain wrinkles above nostrils.)
(5) Is there a smell of ammonia in the box? (Urine incorrect.)
(6) Type of droppings, are they dry, sloppy or do they contain whole undigested food grains? (Think about diet/teeth.)
(7) Can you pick up a handful of skin? If not carry out a skin pinch test. (This will give a rough guide to hydration level.)

Have the rugs removed. If the light is poor and if it is possible to do so, have the horse moved into a good light on an even floor. Deep straw, bad light and uneven floors cast shadows and change weight distribution, causing observation mistakes.

When the horse is moved into a good light, continue your observation. The examiner should be able to visualise rationally in order to:

Assess general conformation

Conformation is useful in appreciating possible performance limitations, for example a horse with a very straight or trailing hind leg conformation, will find it difficult to achieve piaffe.

Assess the shape

Look at the overall shape, is the horse narrow or square?
Assess the length and set of head and neck.
Long back, short back, broad, roach, sway?
Set of tail and tail carriage.
Long cannon, short cannon?
Strong or weak second thigh.

Contours

Consider from the body mass, the shape of the underlying skeleton. For example what is the shape of the pelvis forming the platform for the hindquarter musculature? The relative distances from tuber sacrale to tuber coxae and from tuber coxae to tuber ischia will indicate pelvic shape.

The underlying skeletal platform determines the contour formed by the muscles using the area as their base. The greater the distance from tuber coxae to tuber ischia the longer the platform for muscle build, this usually results in long sloping hindquarters. A short platform usually results in a more rounded contour. Observe the visible bone landmarks, are they level and similar in shape? Possible damage, involving the sacroiliac joint or ilial wing is suggested by the relative position of the tuber sacrale.

Angle of limb parts

Straight or over angled pasterns. Observe knee angles; back at the knee or offset. Hock angles. Straight or laid back shoulder.

Muscle build

Which muscle groups appear normal, or appear to be over built? For example a horse pulling from in front, rather than pushing from behind, will appear to have an upside down neck, the *brachiocephalic muscle* is over working.

A horse lifting a front leg to advance the limb, rather than using the correct swing action, will appear short of neck due to increased bulk in the *cranial fibres* of the *trapezius muscle*. It is also important to observe, standing in front of the horse, the adductor muscles, the pectorals, which are often overlooked (Fig. 3.3).

Fig. 3.3 Loss of pectoral muscle front left. The horse had shortened the stride length, leading to uneven diagonals. This had resulted in lumbar back pain for which manual adjustment had been given for three months.

Are the muscles of the hindquarter masses built symmetrically? Stand behind and look at the quarters; is the top line even or uneven? Look at the development of the muscles of the flank, (the *quadriceps*), the hindquarter muscles, (*gluteals*), the position of the bone landmarks, point of hip (*tuber coxae*) and jumper's bump (*tuber sacrale*) – use a milk crate if it is a tall horse (Figs 3.4 and 3.5).

Set of head and neck

The angle at which the head is set will determine, to a degree, the amount of comfortable flexion available, as will the width between the lower jaws at the throat. The main airway, the trachea, if subjected to constriction may result in early oxygen debt. Horses try to avoid this by sticking their nose forward so opening the angle at the jaw, allowing the bend in the trachea to round out.

It is essential to compare one side with the other, stand first on one side, then on the other, and look at the outline and muscle build; are both sides apparently similar or dissimilar?

Fig. 3.4 Fracture of the ilial wing hind left.

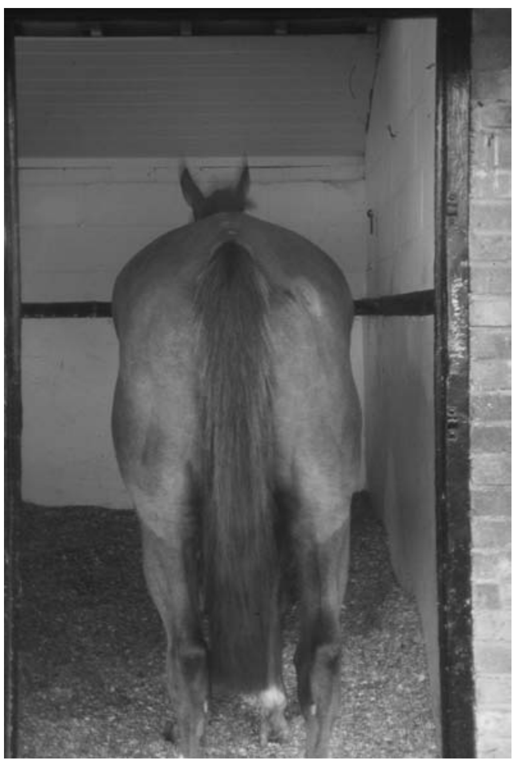


Fig. 3.5 Asymmetry of the tuber coxae.

Learn to appreciate through your fingers shape, temperature, texture, tension, filling, dips, scar tissue.

All these observations should become rapid and routine.

Even if you have been asked to just treat a forelimb, the injury may well have been caused by damage or malfunction in some other area.

Before starting the active part of your examination, feel the affected limb and note warmth, swelling and the texture of the structure under your fingers.

After observation and palpation, unless you are treating a fracture, a complete break down of tendon, post-operative repair or some condition which requires minimal movement, you are ready to start the active part of the examination.

Active examination

The animal should be walked away and back, then trotted away and back. You should position yourself so that it is possible to see movement from in front, behind and the side. Lameness denotes pain or limb dysfunction; learn to listen for an irregular beat denoting lameness, as well as being able to see a frank lameness.

Active movement

Active movement involves muscle, joint and ligament. From the pattern of the walk and trot, you should be able to identify, if not the structure at fault, at least in which area of the body pain is being experienced – left side, right side, forequarter, hindquarter, spine, neck.

Range of movement

Does the horse over track? Do the limbs swing through or does one circumduct, that is swing inward or outward? Does the horse plait? Is there a shortened stride, or are the stride lengths even, with discomfort apparent only on weight bearing?

Some typical movement patterns

A lame horse usually nods his head as he trots. If lame in front, his head usually drops as the sound leg meets the ground, the head rising, sometimes sharply, as the painful leg meets the ground.

Lameness arising from the shoulders or withers can cause a rather unstable, short stride in front, almost as if the horse is tied in at the elbow.

Pain in a knee or both knee joints can cause a horse to move as though it has a pelvic problem. Hind-leg lameness may cause a horse to lower his head as the painful leg meets the ground, while discomfort in the loins (*thoraco-lumbar*) area produces a 'shuffly' hind-leg action, with the hind feet tracking only half the normal distance forward. In some cases this is more apparent on one side than the other. In many cases the toes of the hind feet are dragged along the ground, almost as though the hock is not functioning correctly.

Hamstring discomfort often results in the horse being reluctant to put the foot of the affected side to the ground, or just putting the toe on

Fig. 3.6 Typical stance following damage to m. biceps femoris right hind.

the ground. Weakness or damage of m. biceps femoris tends to result in a toe out hock in position (Fig. 3.6).

The back and neck

If you have any suspicion that the horse is suffering from pain arising from his back, after the active phase return the horse to the stable or an enclosed area and proceed to look at the back movements. Movements in a horse's back are not very great, but a horse with a normal spine is capable of *dorsiflexion* (hollowing), *ventroflexion* (arching) and *side-flexion* (Fig. 3.7).

- *Dorsiflexion*: stimulate by pressing down on either side of the back just behind the withers. The horse will normally dip his back.
- *Ventroflexion*: stimulate by putting your hand underneath the abdomen and pressing just behind the girth line. The horse will normally arch his back.
- *Side flexion*: stimulate by running your finger along either side of the spine, first on one side and then on the other, approximately a hand

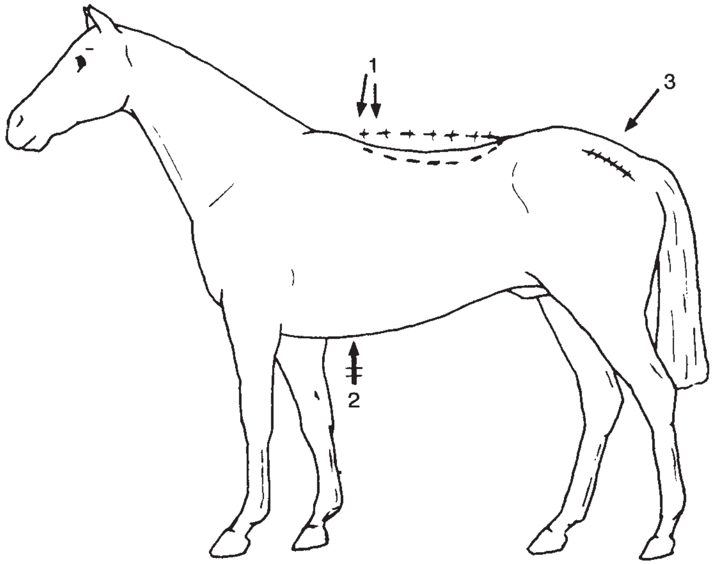


Fig. 3.7 Normal movements in the back of the average horse; (1) pressure behind the withers on both sides causes dipping or dorsiflexion; (2) pressure behind the girth causes humping or ventroflexion; (3) drawing the finger firmly down the quarters as on the diagram causes side flexion. Worry when one or more movement is absent or causes pain.

span from the spine. The horse will normally bend away from the pressure.

- *Neck*: using a carrot or 'treat' see if the horse can move the neck and head freely. The nose should reach the rib cage, even the flank. Reluctance or inability to side flex, turn the neck (*cervical spine*) or early rotation of the head denotes a problem, as does evasion of poll palpation.

Most horses, like most humans, tend to be slightly one sided, but it is very easy to distinguish between a lack of movement or a reluctance to perform movement.

Passive movement

This is the approved method of investigating joints. By manually performing joint movement, you eliminate muscle involvement. By applying over pressure at the end of the movement range, you stress the joint capsule and associated ligaments. Pain elicited on passive examination must, logically, arise from structures involved in the joint being moved.

To employ this part of the examination correctly, a very precise knowledge of the movement range of each joint is necessary, as is the ability to isolate and stress one joint at a time. Unfortunately, in the horse this is impossible. A classic example of this is the hock flexion test when fetlock, hock, stifle, hip and sacroiliac joints are all involved. However the 'end feel', even if the joint cannot be moved in total isolation, can be useful, for example, a 'dry' joint feels creaky as it is moved suggesting the lubrication is poor.

Observation follows testing the joints, and in particular the weight distribution should be considered. The pastern angles will tell you the predominately weight-bearing limb of each pair of limbs. If you think that the weight bearing is uneven, ask an assistant to pick up the opposite leg and note the angle and range of movement occurring in the pastern of the limb, through which the horse must now bear weight. If there is a considerable fetlock drop there might be a problem within the suspensory system of the limb. (See Fig. 4.3, p. 74)

Resisted movement

In the human, we pass from active and passive movement to resisted movement. Resisted movement is performed in such a way that no joint action takes place, the resistance being applied to produce *isometric contraction* (isometric = contraction of muscles without movement) of individual muscles. If pain is elicited, the damage (*lesion*) is considered to lie within the contracting muscle.

The only method of invoking isometric contraction in the horse is through the use of a muscle stimulator. First advocated by the late Sir Charles Strong, this method will often assist in isolating the muscle involved. Such an examination takes time, and this is where a physiotherapist can be of great help to a veterinary surgeon.

Once the site of the origin of the pain and the type of tissue involved have been established, and any secondary damage noted, then appropriate therapy can begin. As the chosen therapist you should discuss the programme you advise with the vet with whom you are working, giving reasons for your decisions. If the vet agrees, explain the regime to the owner, including exercise if appropriate.

If necessary talk to other health team members – saddler, dentist, farrier, trainer, nutritionalist, masseur. Remember, the aims of any therapy are:

- to determine the site of the origin of the problem;
- to assist the normal repair process of the body by the use of the appropriate machine;
- to try to prevent recurrence through retraining and re-education.

For owners and therapists, the old adage 'diagnosis is the difficult bit, treatment is easy' is worth remembering. The medical doctor has the advantage of conversation and modern technology; the veterinary profession has owner observation, and the profession has undoubtedly profited by making use of the advancements in human diagnostic 'machines'.

It is sometimes useful for an owner to understand the role of the various imaging aids, when the vet in charge of the case suggests that further investigation is advisable.

Everyone understands nerve blocks. An injection is administered in order to temporarily remove sensation from the structures in the area serviced by the targeted nerve. Reduction or disappearance of lameness following an area being 'blocked of sensory perception', indicates that it is the structure, or structures in that area, which are giving rise to the discomfort. Identification of the exact tissue/structure may require further investigation.

Imaging as an aid to diagnosis

Diagnostic imaging has progressed in the past two decades beyond all expectations. The use of modern radiographic techniques include, in addition to conventional X-ray, the use of digital imaging, nuclear scintigraphy (bone scanning), thermography (heat seeking), arthroscopy (internal investigation via an inserted camera), and the most recent technique, magnetic resonance imaging (MRI), currently confined, other than in some highly specialised centres in the USA, to the limbs rather than the whole horse. Using this variety of techniques in diagnosis has led to significant advances in the understanding of equine musculoskeletal disease.

Most of these specialist technologies are only available, just as in human medicine, in a limited number of veterinary referral centres. The reading of the images, just as in the human field, also requires specialist training, those reading the pictures or graphs requiring precise anatomical knowledge.

Sophistication of diagnostic ability therefore requires that the horse be taken to a veterinary centre, rather than the vet visit the horse at home.

X-ray

Conventional X-rays are still the primary method used for the diagnosis of bone-associated problems. Due, in the equine, to the mass of soft tissue covering the bones of the vertebral column, the pelvis and lower neck, these areas are still poorly shown using conventional X-ray. It must be appreciated that X-rays do not image soft tissue structures, that they can only give a two-dimensional image of a three-dimensional object, and also that there are a number of variations within the normal range of bone shape and density.

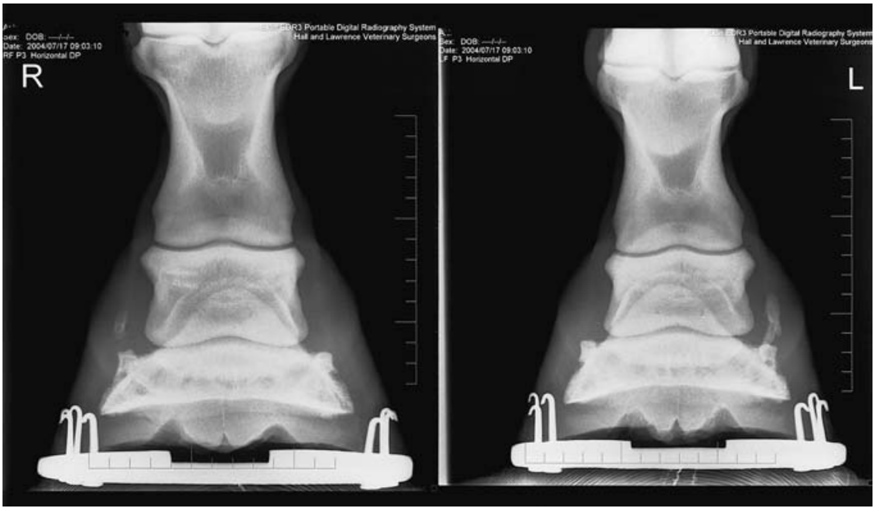


Fig. 3.8 Digital imaging of the front feet taken to help a farrier who was concerned about the horse's foot balance.

Advances in technology have allowed for very clear imaging, as can be seen in Fig. 3.8.

Nuclear scintigraphy

The technique involves injecting a radioactive isotope into the body, followed by scanning with a gamma camera. Sites of abnormal bone activity are recorded as images showing 'hot spots' allowing for diagnosis of the source of the problem. This technique is used to detect areas in the back and pelvis. The methodology is also a means of whole body scanning, enabling the detection of painful sites in bone, when identification by other methods, such as the use of nerve blocks, has failed to identify the source of pain. Diagnostically, the site of pain is often remote from the symptoms observed.

Ultrasonic scanning

The ultrasonic scanner is used to scrutinise soft tissue structures, in the main tendons and ligaments, but muscles, the heart, abdominal organs can also be scanned, as can a growing foetus.

The sonic beam emitted by the scanner interacts with the varied density of the tissues through which it is passed, sending a pattern to the computer. The visual image identifies the architecture of the scanned tissue allowing the diagnosis of injury by appreciation of altered fibre pattern, areas of thickening and hypoechogenic areas denoting areas of tissue breakdown.

As it is a non-invasive imaging technique, and is well tolerated, healing can also be monitored.

Thermography

The use of an infrared camera will portray a visual, thermal image of a selected body area.

In order for accurate interpretation when this method of investigation is used, the horse must stand evenly balanced, with its limbs placed symmetrically, and preferably in a temperature-controlled environment. Sun streaming through a window or roof light onto one part of the body would change the temperature in the locality.

While extensively used by some practitioners, as with all diagnostic 'aids' the system has limitations if used as the single method of diagnosis, sensitivity to deep-seated lesions is limited, the presence of 'cold spots' has not really been explained and interference with cutaneous nerve supply can radically alter skin temperature.

Arthroscopy

Visual exploration of the interior of a joint (synovial space) has become common in the diagnosis and treatment of orthopaedic disease. Infection is one of the dangers of joint investigation, but arthroscopy is classed as minimally invasive. The advantages of being able to see structures whose state cannot be recorded by other means is invaluable, as is the ability to remove debris created by internal damage to the joint.

Heart rate computers

The usefulness of the ability to monitor the heart rate during exercise and recovery is well established and understood in the human athlete. In the horse, the significance of the readings logged and their use in interval and associated methods of training is the subject of considerable controversy.

Heart rate increases not only during exercise (it will be suggested that heart rates be monitored during therapeutic swimming sessions for example), but also as a result of pain.

As already stated, effective treatment is not possible without accurate knowledge of the site of injury. The ability to examine an animal described as having 'lost form', but which has no areas of heat or other obvious clinical signs or findings, and to determine, by the use of a

Table 3.1 Expected equine heart rate readings compiled by the manufacturers of the American EQB meter. Tests carried out on dirt over 'clocked' distance.

		Rates per minute
Standing		40
Walking		80
Trotting	(234 metres/minute)	120
Trotting	(290 metres/minute)	140
Galloping	(348 metres/minute)	160
Galloping	(500 metres/minute)	200

heart rate monitor, the changes in heart rate during palpitation, passive joint movement and muscle testing, can only be of benefit.

There is a large variation of heartbeats to the minute within the acceptable normal range. It is useful to know the heart rate of individual animals before loss of form or suspected injury.

Many large training yards log individual temperatures daily; unfortunately, as yet few bother with heart rates – even if the normal resting heart rate is not on record and is slightly elevated due to pain, there will still be a significant temporary rise when pain is increased during examination.

The values discussed in Table 3.1 relate to work described in the USA from trainers using the EQB meter, and also the results of Frederick Fregin, formerly a Professor in Equine Cardiology at Cornell Veterinary School, from work by Snow & Vogel (1987) described in *Equine Fitness*.

Heart beats have been recorded as high as 285 beats per minute (bpm). Rates of 250 bpm are not uncommon in racing thoroughbreds. Old horses (fifteen years and up) have much higher rates during exercise; young horses in training for the first time also have much higher working heart rates.

Remember, changes in your horse's heart rate day-to-day and week-to-week are as important as the absolute rate at any time and therefore, you must keep records. Every horse is an individual and will not have the same exact response as another to exercise.

Horses' heart rates can and do change very suddenly, especially from 30 to 130 beats per minute. Such changes do not indicate a problem with your heart rate computer.

N.B. Heart rates do not relate to work or fitness alone; they are affected by fear, excitement, and pain. A sick horse (for example, a horse with a temperature) will have higher than normal heart rates. Also, if the heart rates of your horse do not coincide with the above, see the troubleshooting guide in your Equistat®-user instruction manual and check your horse! Check the tack, the legs and feet and shoes, etc.

Below are some comments on expected equine heart rate readings for horses aged three to fourteen years, as supplied by EQB (rates for horses younger or older than that are generally higher).

- Standing: resting rates in the stall can range anywhere from as low as 25 bpm to 120 bpm if the horse is startled by a strange person or object in the stable. When tacked up, with a rider, most horses range from 40 to 60 bpm (or higher if the horse is anticipating work).
- Jogging: a horse that has been ridden for at least six months will usually jog slowly (trotting 234 metres/minute) at between 115 bpm to 130 bpm. The same horse may do an open trot (290 metres/minute) with a heart rate as high as 155, averaging around 140 bpm. Gentle inclines seem to add about 10 to 15 bpm to these averages and steep inclines as much as 50 bpm, usually around 35 bpm.
- Cantering: an easy hand canter (320 metres/minute) will often exhibit in some horses a lower heart rate than an open jog, the range, once again in a reasonably fit individual, being 130 to 155 bpm.
- Galloping: in hand, but not too quickly (under a two minute lick), at 348 metres/minute, a reasonably fit horse will average around 165 bpm, often on a flat, uniform surface it can be as low as 150 bpm or, depending upon attitude, as high as 180 or 190.
- Very fast working or galloping: 500 metres/minute or a two minute lick or faster. Depending upon the horse's stage of conditioning, ability, attitude, lameness, and other general health, after going on the initial 1/8 mile (in which hearts will peak sometimes 30 to 40 bpm above what they will then even out to), 200 beats per minute is a good average. Very fit, talented horses often will work 3/8 mile in 36 seconds with a maximum rate under 200 bpm and recover to 100 bpm in a minute or less. Longer works will cause higher maximum rates and longer recovery times.

N.B. Heart rates in excess of 250 beats per minute indicate some kind of exercise intolerance, whether because of attitude, health, age, condition, lameness, incorrect tack, or other problems.

In order to use a heart monitor correctly, the speed over a measured area of ground must be 'clocked' using a stop watch. The values discussed above relate to work described both in the USA and the UK by Snow & Vogel (1987) in *Equine Fitness*.

4 Common Sites of Injury in the Horse

Common sense first aid is the priority at the time of accident. Then, draw breath. There is an unfortunate tendency to rush in with every aid available in a frantic endeavour to achieve immediate recovery. Unfortunately, this approach often exacerbates the problem, one 'aid' reversing the effects of another, with the over-treating of an area never giving the natural healing process a chance. Brilliant blistering of areas has been achieved by treatment overdoses! Try to take an unemotional, rational view; get a diagnosis, calculate the approximate time required for recovery, choose the best apparatus available, and go to work. If repair is achieved in a time which was shorter than expected, then this is a bonus.

Listed in Table 4.1 are the most common sites of injury in the horse (see Fig. 4.1), the aims of treatment, the machines to achieve the aims in order of professional preference, and the names of the muscles that may require stimulation after the injury described.

N.B. All machines have an analgesic, pain-killing effect. The absence of pain is not an indication of complete recovery.

Chapter 5 gives detailed information on the presumed effects of therapy machines referred to in Table 4.1.

Table 4.1 Common sites of injury in the horse.

Condition	Aims of treatment after first aid	Suggested machines	Muscles probably involved. Stimulate
1. *Bicepital bursitis* Inflammation of the bursa lying in the bicepital groove near the point of the shoulder. As the foreleg retracts the bursa is compressed, with resultant pain and shortening of stride. Not usually a 'nodding' lameness.	Reduce inflammation Reduce pain	Ultrasound (3 MHz head) Magnetic field therapy Massage	Deltoid Triceps Pectorals
2. *Elbow* Capsulitis of the joint following overstretching injury. Bruising (capped elbow) may be due to insufficient bedding or the horse catching and bruising his elbow at exercise.	Establish and remove cause Reduce inflammation Reduce swelling Maintain full range of movement	Ultrasound (3 MHz head) Magnetic field therapy Passive stretching	Extensor Carpi radialis Superficial pectoral
3. *Knee* (a) Direct trauma with bruising and/or lacerations.	(a) Reduce swelling Avoid infection Avoid proud flesh Maintain full mobility	Cold between treatments, e.g. Bonner-type bandage Laser and compression Ultrasound Passive flexion with fetlock flexed	Deltoid Pectorals Triceps
(b) Capsulitis due to excessive stress.	(b) Reduce inflammation Maintain full movement	Ultrasound Magnetic field therapy	
(c) Flake fractures may occur as the result of hyper-extension (loose bodies).	(c) After surgical removal of chips Promote healing Avoid adhesions	Laser Passive movements with fetlock flexed	
N.B. X-ray knee problems.		ULTRASOUND MAY BE CONTRAINDICATED	

Table 4.1 (*Continued*)

Condition	Aims of treatment after first aid	Suggested machines	Muscles probably involved. Stimulate
4. *Splint bone* (a) Inflammation of the inter-osseous ligament between the splint and cannon bone. Fusion of the two bones is the end result. Causes: concussion, trauma, uneven shoeing with resultant uneven stress. (b) Fracture of bone, usually by direct trauma, may require surgical removal.	To promote early fusion with minimal bone formation Maintain fitness	Cold between treatments, e.g. Bonner-type bandage Laser Magnetic field therapy Massage ULTRASOUND MAY BE CONTRAINDICATED Swim	
5. *Sore shins* (Fig. 4.2) (a) Inflammation of the periosteum on the front of the cannon bone. (b) Hairline fractures through the front of the cannon bone. Causes include concussion, direct trauma, nutritional bone diseases. N.B. Sore shins are more common in the fore than the hind limbs. Severe cases may 'buck'. X-ray is advisable to determine severity.	Reduce inflammation Promote healing Maintain fitness Reduce concussion	Cold between treatments, e.g. Bonner-type bandage Laser Magnetic field therapy Massage ULTRASOUND MAY BE CONTRAINDICATED Swim Specialist pads, e.g. E-Z® Strider/Sorbothane	

6. *High ringbone* Unwanted bone is laid down at the upper end of the short pastern.	Reduce inflammation Minimise new bone growth Reduce concussion	The value of machine therapy is debatable Swim Specialist pads, e.g. E-Z® Strider/Sorbothane
7. *Low ringbone* Unwanted bone is laid down at the lower end of the short pastern. Unless the new bone interferes with joint movement, it is of no consequence.		
8. *Sandcrack* A split in the outer wall of the hoof may involve the coronary band. Caused by direct trauma, badly trimmed, unshod feet, injury to the coronary band.	Promote healthy hoof growth Specialist shoeing to support crack	Laser to coronary band
9. *Overreach* A cut or cuts caused by striking the heel of the forefoot with the toe of the hindfoot.	Prevent infection Promote healing	Laser Ultrasound (3 MHz head) Magnetic field therapy
10. *Sidebones* Unwanted bone formation in the lateral cartilages, possibly as a result of concussion. If the bone growth interferes with the movement between the foot and short pastern, specialist shoeing is called for.	Promote healing with minimal bone formation	Ultrasound (3 MHz head) Magnetic field therapy

Table 4.1 (*Continued*)

Condition	Aims of treatment after first aid	Suggested machines	Muscles probably involved. Stimulate
11. *Fetlock joint*			
(a) Capsulitis due to sprain.	(a) Reduce inflammation Maintain full movement	Cold between treatments, e.g. Bonner-type bandage	Deltoid Triceps Pectorals
(b) Bruising due to direct trauma.	(b) Reduce bruising	Ultrasound (3 MHz head) Magnetic field therapy Massage Passive stretching Swim	
(c) Degenerative arthritis can occur in older horses.	(c) Improve the integrity of the joint capsules	Ultrasound (3 MHz head) Magnetic field therapy Passive stretching Swim	
(d) Fractures of the pastern or lower end of the cannon will involve the joint.	(d) Promote healing	Magnetic field therapy	
12. *Sesamoid bones*			
(a) Inflammation of one or both of the proximal sesamoids. Often concurrent with problems in the fetlock joint.	(a) Reduce inflammation Maintain full movement Maintain fitness in acute stage	Cold between treatments, e.g. Bonner-type bandage Laser Ultrasound Magnetic field therapy Massage Passive stretching Swim	
(b) Fracture of one or both of the proximal sesamoids. X-ray is advisable.	(b) Promote healing	Magnetic field therapy	

13. *Windgalls (windpuffs)*			
There is a distension of the synovial sheath between either the suspensory ligament and cannon bone or the long pastern and ligament joining the sesamoids. Cause: overstress of the limb, concussion or incorrect angulation of joint of the foot and pastern. N.B. Tends to be more common in the hind than the forelegs.	Reduce inflammation before the condition becomes chronic Remove cause if possible	Ultrasound Magnetic field therapy Elastic stocking when stood in	
14., 15. *Flexor tendons and/or suspensory ligament* (Figs 4.3 and 4.4)			
The superficial, the deep, or both may be involved. Partial or complete rupture may occur. Bowing is present (Fig. 4.4). In all cases, support of the fetlock joint is reduced. Severe cases may be supported by casting.	Support the area Reduce the swelling Reduce inflammation Promote healing Maintain muscle strength in shoulder	Support and cold, e.g. Bonner-type bandage; follow with tube-grip Ultrasound (3 MHz head) Massage Laser Magnetic field therapy massage Magnetic field therapy will penetrate a cast – no other machine will be of use if a cast is used	Deltoid Triceps Pectorals Supraspinatus Infraspinatus Extensor carpi ulnaris

Table 4.1 (*Continued*)

Condition	Aims of treatment after first aid	Suggested machines	Muscles probably involved. Stimulate
16. *Check ligament* Damage can occur in association with tendon and/or suspensory injuries, or as a separate issue.	Reduce inflammation Promote healing Maintain fitness	Treat as for tendons	Stimulate as for tendons
17. *Speedy cut* Cuts caused by striking one leg with shoe or hoof of another leg.	Prevent infection Promote healing	Laser Ultrasound (3 MHz head) Magnetic field therapy	
18. *Thoraco lumbar and/or pelvic problems* Opinions vary widely as to the reasons for damage in the spine and pelvis. The problems are thought to be ligament tears, with associated muscle weakness. Fractures (hairline cracks in particular) have been observed in many bone specimens, along with arthritic and other body changes.	Reduce pain Re-educate muscles Re-educate movement	Ultrasound (1 MHz head) Magnetic field therapy Deep massage Swim	Longissimus Glutei
19. *Trochanteric bursitis* The bursa lies under the tendon of the middle gluteal muscle and above the	Reduce inflammation Maintain muscle strength	Ultrasound (I MHz head) Magnetic field therapy	Gluteal muscles Semimembranosus

greater trochanter of the femur. Pressure caused by the contraction of the gluteals compresses the bursa, giving rise to shortening of stride and, on occasions, severe lameness.	Re-educate movement after reduction of pain	Deep massage Muscle stimulation after reduction of pain	Semitendinosus Biceps femoris
20. *Stifle joint* The stifle joint corresponds to the human knee; the patella corresponds to the human knee cap. Most stifle problems result from the patella deviating from its normal anatomical position. These movements may cause the joint to 'lock'. Any dislocation of the patella causes extensive ligament stretching and associated muscle weakness.	Reduce dislocation if present Reduce inflammation if present Maintain muscle strength	Ultrasound (3 MHz head) Laser Massage Muscle stimulation	Semitendinosus Semimembranosus Biceps femoris Vastus lateralis
21., 22. *Spavin* Bog spavin – capsulitis of the hock. The result of stress or poor conformation.	Reduce inflammation	Laser	
Bone spavin – unwanted bone forms, usually on the inner surface of the hock, interfering with articulation of the joint; or there is erosion of the articular surfaces followed by new bone growth. N.B. In the author's experience, the hock is the most unpredictable joint to treat. Treat all cases, whatever the condition, with great caution.	Reduce inflammation Maintain joint range	Massage	

Table 4.1 (*Continued*)

Condition	Aims of treatment after first aid	Suggested machines	Muscles probably involved. Stimulate
23. *Thoroughpin* A swelling of the sheath of the deep flexor tendon of the hock due to trauma or strain.	Reduce swelling	H. Wave Cold (Bonner-type bandage) Ultrasound (3 MHz head), with caution Massage	
24. *Curb* Thickening of the plantar tarsal ligament, usually caused by over-exertion. Poor conformation is a contributory factor.	Reduce inflammation Control swelling	Cold (Bonner-type bandage) Laser Ultrasound (3 MHz head) Massage Swim	
25. *Capped hock* Swelling of the bursa over the point of the hock, usually caused by trauma or sitting against the box wall.	Reduce inflammation	Cold (Bonner-type bandage) Ultrasound	
Bruised or torn muscles If left untreated, bruising in a muscle will 'scar'; that is, a dense area of fibrous tissue with no elastic properties will form. This will reduce the efficiency of surrounding muscle tissue and, when the muscle is at full stretch, the tissue above or below the scar will be over-stressed and in its turn will tear.	Reduce the bruise (haematoma) Maintain maximal muscle efficiency Prevent adhesions	Cold Laser Ultrasound Magnetic field therapy Massage	Stimulate muscle groups

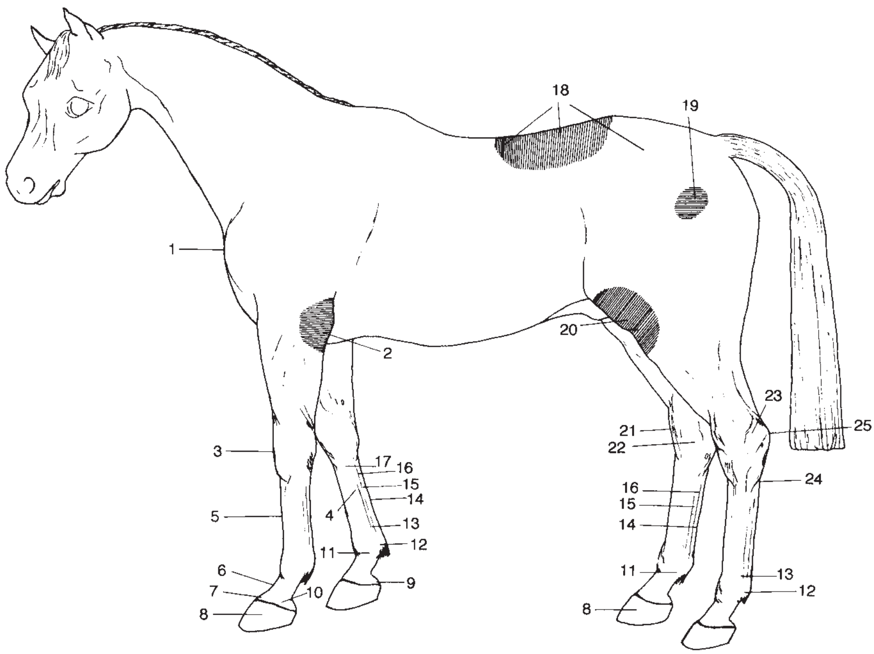


Fig. 4.1 Common sites of injury in the horse. The numbers refer to the points in Table 4.1.

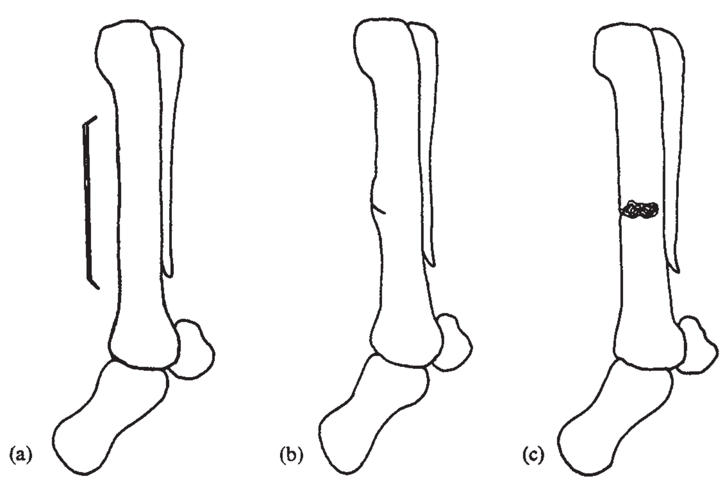


Fig. 4.2 (a) Sore shins (area of pain); (b) micro-fracture with buck; (c) stress fracture.

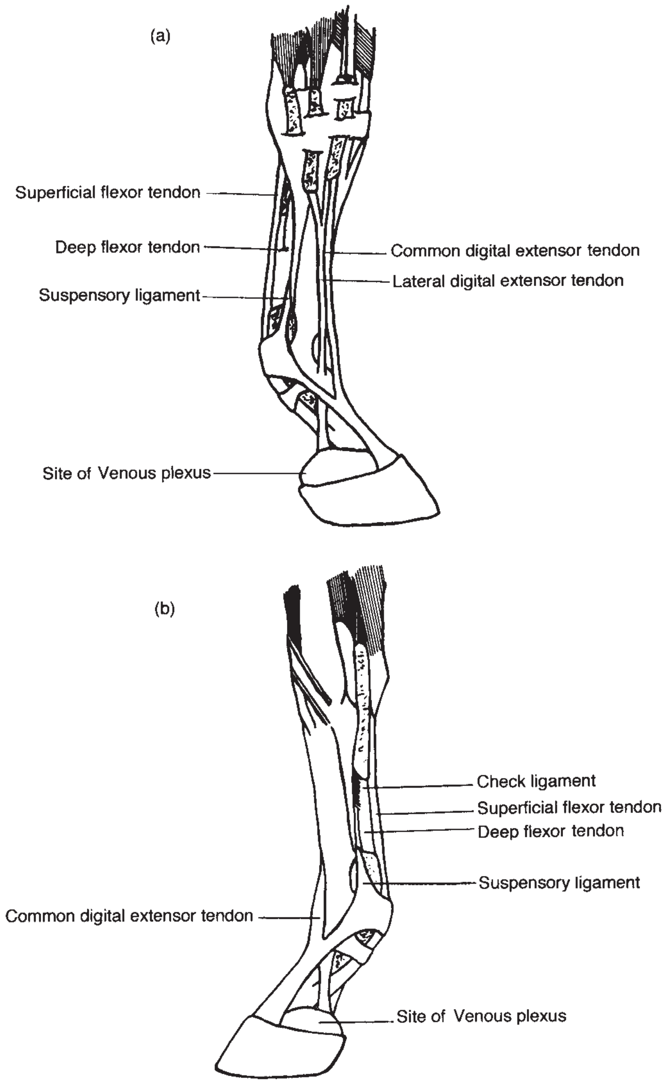


Fig. 4.3 Diagram of the tendons of the foreleg: (a) medial aspect, and (b) lateral aspect.

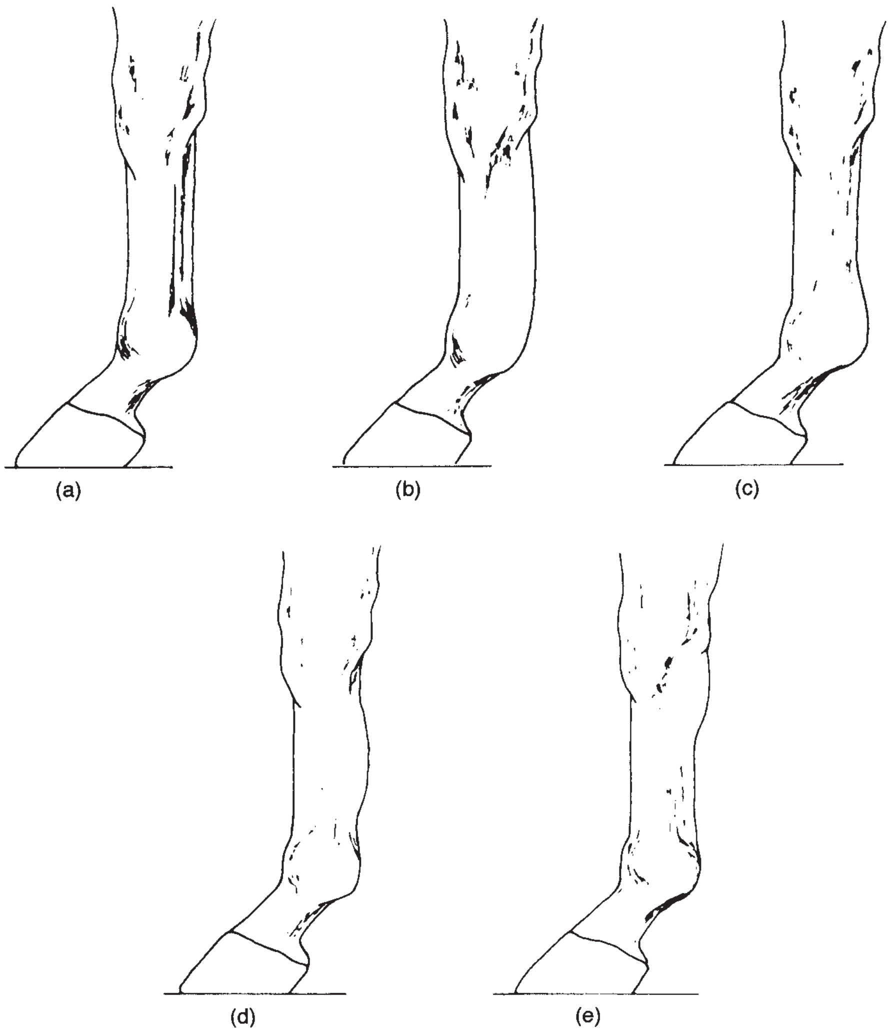


Fig. 4.4 Tendon injuries: (a) normal tendon contour; (b) bowed tendon; (c) low bow; (d) middle bow and (e) high bow.

5 Therapy

No therapy can be effective until after accurate diagnosis; to this end the confines of the Veterinary Act (1966, Section 19; Section 24) apply to all offering treatment to animals by whatever means (see Appendix I, pp. 185–6).

Examination and subsequent diagnosis requires training and skill. These are supplied by the veterinary profession, with their ability to question, look, feel and smell, nerve block, X-ray, digital image, blood test, scan and scope – the latter enabling internal examination of many internal structures, including respiratory and gastric organs, the uterus, and certain joints.

Due to the specialised nature of modern, sophisticated diagnostic apparatus, in-depth examination requires, in many cases, that the horse be examined at a veterinary centre, rather than, as many owners expect, the vet coming to the horse. Haphazard treatment without a diagnosis can be costly in both time and money, and in many cases is ineffective.

Once a diagnosis has been made the vet should decide, from the appropriate forms of therapy on offer, the treatment which is appropriate for the diagnosed condition. There is a large choice of treatments embracing machine therapy, massage, water therapy and exercise therapy. The pertinent choice of each individually named electrotherapy device is not discussed in depth; appropriate selection is best left to the individual therapist. Discussed are the perceived effects achieved by application of varied current wave forms – sound, light and magnetism supplied by therapeutic ultrasound, magnetic fields, low level lasers, TENS (transcutaneous electrical nerve stimulators) and muscle stimulators.

Specialist yards abound, many are attached to veterinary practices and employ chartered physiotherapists or trained masseurs. Contrary to general belief, it is rare to find a member of the veterinary profession who will not cooperate with responsible, knowledgeable, appropriately trained machine owners. On the other hand, and quite reasonably, it is annoying for professionals to be called in to sort out problems caused by irresponsible treatments and unfortunately many people without the benefits of a scientific training have, through no fault of their own, no understanding of the intricate processes involved in situations involving tissue damage, recovery and subsequent repair.

The first parameter to consider is the fact that the body has its own inbuilt repair programme, this programme, activated by commands from the autonomic nervous system (ANS), in response to signals transmitted as a result of the electrical and electrical changes occurring at the site of injury, initiates repair. Repair occurs, as discussed in Chapter 2 (see pp. 31–5), in three well researched, described stages, namely, inflammation, followed by proliferation and finally remodelling.

As previously discussed, cells are the basis of all tissues and it is cellular stimulation that many machines attempt to address. The rationale for cellular stimulation is to optimise the appropriate and functional responses of all components involved in the healing of damaged tissue. Cell physiology, despite being under continual scrutiny in research establishments, is still far from being fully understood in health, let alone in injury or disease.

Living cells spend their time responding to a variety of different stimuli in order to maintain the integrity of their particular tissue and the organ/tissue they represent. Some known requirements include a **stable chemical** and **electrical environment**, pertinent to the specifics of the cell type; **electrolytes in the correct balance** to ensure the correct fluid balance between interior and exterior fluids; **appropriate nutrients** and, always, **oxygen**. If any of these are neither present nor available, the cells' energy systems (mitochondria) cannot function, rendering the cell a non-functional unit.

Groups of like cells form tissues, if damage were confined to a single cell the effects on the tissue would not be apparent, but damage can be likened to the effects of throwing a stone into a pool, the ripples (effects) spread from the point of entry (primary damage) in a multi-directional manner. Tissue damage also causes pain, which is itself an inhibitor of recovery.

Amongst the many hundreds of processes which will occur during recovery a few of the overall processes can be enhanced through careful choice of therapy given at the appropriate stage of healing.

To enable recovery the area of damage must stabilise. This requires exudates to be removed, local circulation to be reinstated, nutrients to be delivered, the appropriate electrical and magnetic states to be restored and the removal of an appropriate amount of pain.

Unfortunately, there are no set 'treatment recipes' for musculoskeletal conditions as there are with 'drug therapy'. Relate the situation to yourself: if you have bronchitis, the doctor gives you a prescription for an antibiotic, and provided you, as the patient, stick to the dosage, you will

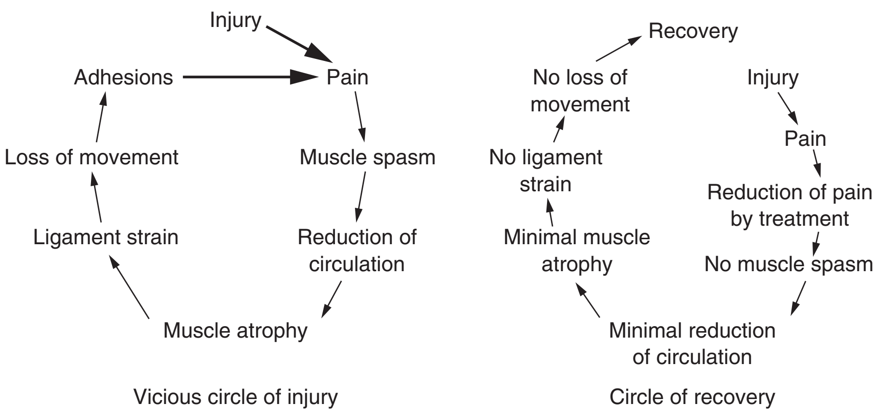


Fig. 5.1 Circles of injury and recovery.

be well within a calculated time. Sprain an ankle, there is no set time; recovery depends on the degree of the injury, the ability to receive the correct treatment at the correct time, and your co-operation to re-educate the movement pattern lost as a result of the pain. Remember, pain inhibits movement. The effects of the pain are best described by the circle of injury (Fig. 5.1).

Bearing in mind the aims of treatment for a diagnosed condition, it is up to individuals to select the appropriate machines, or by understanding the effects of these electrically motivated devices, make the best use of those they already own.

The mechanism of healing has been discussed in Chapter 2, the aims of therapy can be considered as follows:

(1) to control early haemorrhage and associated oedema, thus reducing detrimental side effects;
(2) to alleviate pain in order to reduce muscle spasm;
(3) to enhance the natural physiological mechanisms of tissue repair;
(4) to prevent adhesions and contractures.

Tissue repair follows a predictable timetable, although the time span for recovery will vary, depending on the extent of injury and the number of tissues involved.

(1) Control early haemorrhage and associated oedema

Control of the acute inflammatory phase is typically addressed by the use of cold supplied either by local application of ice, commercial packs, or water immersion.

The effects of the cold achieve:

- *vasoconstriction*: reduction of local blood flow and so reduction of fluid loss from damaged vessels, which in turn reduces oedema.

Oedema in tissue creates pain, due to an increase in local pressure, the pain causes spasm in muscle tissue associated with or adjacent to the area of damage and the spasm further reduces circulatory flow. The effects of ice are temporary and, to a degree, transient. The body's thermal regulating mechanism ensures that the area does not become unacceptably cold for too long and the body responds by directing blood to the area to restore equilibrium of temperature (Hunting Rush).

A reduction in tissue temperature reduces the local oxygen requirement as cellular metabolism slows down. Without adequate oxygen cells die and secondary hypotoxic injury results. The time length advocated for each ice application varies, in human literature times of between ten and thirty minutes for each application, with a similar break period between applications, is suggested.

Cold therapy is considered useful for two to three days after injury, to control the acute inflammatory response. Cold does not enhance the next programmed cellular responses, necessary for progression of repair, namely collagen synthesis and fibroblast proliferation, at this stage of healing heat, or alternate heat and cold application is advocated to improve blood flow within the affected area.

(2) Alleviate pain and muscle spasm

Control of oedema reduces the pain associated with pressure, in turn, control of pain limits muscle spasm. *The guarding response of muscle tissue, secondary to pain, must be carefully considered before removal. In some cases muscle spasm acts as a necessary splinting mechanism.*

(3) Enhance the natural physiological mechanisms of tissue repair

As previously discussed, healing of tissue follows a predetermined pattern. All tissue types possess their own particular 'scaffold' or matrix pattern. The 'clot' formation at the injury site provides a structural framework for the rebuilding process of this matrix. As the acute inflammatory phase subsides, chemicals, released by macrophages, attract fibroblasts to the damaged area, their role is to form collagen, the main supporting protein required by connective tissue. Slowly a matrix forms creating a temporary repair, the series of predetermined events within the repair mechanism continue, and a type of tissue, named granulation tissue, is laid down. *This tissue does not possess the tensile or load-bearing strength of normal tissue*.

In order for the tissue to remodel to its original state a blood supply is required. Very slowly a new vascular network is created, the vessels invading the matrix in order to supply the juvenile tissue with the necessary fuels, building components and oxygen, also to remove any discarded materials and metabolic waste whose presence might cause detrimental side effects. The delivery of cells and cell components to the site of injury is obviously important, adequate circulation, acting as a conveyor belt, delivering via the arterial blood and removing via the venous blood, is one of the keys to recovery, as is stimulation of cellular processes.

A.T. Still, a nineteenth century American physician made two indisputable statements:

> 'The rule of the artery is sovereign': meaning if circulation is impaired the affected area cannot fulfil its function.
>
> 'Structure governs function': meaning the normal function in any living organism is not possible if its supporting structures have lost part of their mobility.

Under normal, uninterrupted circumstances, left alone and given time, most tissue damage remodels to its original. Senior vets have always said 'give it time, leave it to nature'.

The use of inappropriate therapeutic methods may affect repair.

(4) Prevent adhesions and contracture

Disruption, resulting from interruption of the predetermined recovery pattern, lack of required repair material, infection, persistent inflammation, the presence of foreign material and recurrent damage, will all interfere with the recovery process. The end result of poor quality healing may result in contracture or adhesions and interfere with function. While small areas may not be detrimental to overall performance, large areas, such as those resulting from burns will affect tissue mobility.

Mobilisation of tissue by appropriate means will, to some extent, reduce the extent or prevent adhesions.

First aid

(1) Compress the area;
(2) support the area;
(3) keep the patient warm.

In principle, all injuries should be seen by a vet (horse) or doctor (human). In the event of there being no professional help on hand, the owner/trainer must take the responsibility and do the best that he/she can in the circumstances.

A *first aid box* is a must. The box should be kept stocked and always stored in the same place. All too often, the famous 'someone' has moved the kit, and that 'someone' is always missing in a crisis; or the box has been raided, and the necessary items are missing. The minimum contents should comprise:

- cotton wool;
- suitable disinfectant;
- bandages: vet wrap (× 2 minimum): stable, crepe, elastic, triangular;
- gamgee;
- lint;
- Elastoplast™ roll. (Band Aid® in USA);
- a roll of elastic bandage and a box of Elastoplast™ dressings;
- Melolin dressing;
- Jelonet dressing;
- Animalintex®;
- scissors.

Useful additions are:

- wound dressing powder;
- cold bandages;
- purple spray;
- iodine (old fashioned!);
- micropore tape;
- arnica spray;
- aloe vera gel;
- pack of sterile saline solution;
- a 50 cc syringe in a sterile pack, with suitable needles to withdraw the saline solution if needed to irrigate a dirty wound;
- cold bandages in packs.

Animalintex® is carried by most people. It has a place, but for immediate first aid Melolin dressings may be as good if not better.

- C*lean*: always clean an open wound to reduce the risk of infection. It is essential to clean the wound thoroughly, however difficult this may be at the time of injury. The removal of all foreign bodies, such as mud, hair and grit, pays dividends, the risk of secondary infection being reduced to a minimum. The principle of cleaning and sterilising wounds was enforced by Florence Nightingale at the time of the Crimean War; human medicine took a great step forward!

- *Cover*: open wounds need a dressing – preferably the type that will not stick when removed. For this Melolin is ideal.

- *Compress*: compression equals even pressure over and around the injured area, and is aimed at reducing haemorrhage – that is, the loss of blood and fluid from the injured tissues. Cotton wool or a gamgee pad should be placed over the dressing, and an appropriate bandage applied. Bandaging has two functions:
  (a) to hold the dressing in place;
  (b) to provide support.

The injured tissue is unable to fulfil its normal functions; the bandage can assist by taking strain off adjacent tissues which are temporarily having to take over the activity of the injured area. Bandaging is an art in itself.

It should be noted that almost as much damage can be done by bad bandaging as by no bandaging at all (see Appendix II, pp. 187–9).

- *Cold*: cold assists in reducing the risk of continued bleeding (haemorrhage) by causing a temporary constriction of the blood vessels.

  N.B. Cold becomes temporarily ineffective after fifteen to twenty minutes. Break for five to ten minutes, then reapply.

Movement may need to be restricted to a minimum for 24 hours after injury. Seek veterinary advice.

Treatment

Following diagnosis, with the knowledge of the extent and nature of the problem, a programme of treatment and management can be initiated.

Early re-establishment of an adequate circulatory flow is essential for healing. Should the circulation be drastically reduced, tissue death (*ischaemia*) may occur. It is for this reason that bandages must be checked every few hours in the immediate post-injury period.

The human reports pre-ischaemic pain, and observation shows 'blue' fingers or toes. The horse has no method other than removing his bandages with his teeth to show discomfort. All too often bandages are covered with Cribbox® to discourage removal. A horse that is comfortable usually leaves his bandage alone.

Massage

The art of 'rubbing' or *massage* is as old as time. Probably the first recorded account dates back to the Emperor Huang, the Yellow Emperor, who wrote a medical book circa 2000 BC. All descriptions of healing contain instructions in the uses of rubbing (massage) often coupled with the use of aromatic oils. Strapping with a straw wisp was once part of the daily grooming routine. Adams, in his book, *Care and Management of the Horse* (1799) describes how to make a wisp from 'good clean wheat straw' and how to 'wisp the animal dry' after hunting to avoid 'stiffness of the muscles'. Also noteworthy is the fact that in the recent biography of the legendary Vincent O'Brien (O'Brien & Herbert 2005), a wisp features in his list of essential grooming tools.

Electrically powered machines are sold described as massage machines, however, none replicate hand massage, as the resultant sensation and effect upon tissue from these machines is one of vibration.

Hand massage is described as the use of the hands and fingers to aid circulation, remove muscle stiffness and pain, the art (for it is an art) is of more use than many of the sophisticated machines. Good masseurs, with sensitive fingers able to detect differing tensions within the soft tissues of the body, are, like good grooms, worth their weight in gold.

To massage effectively it is essential to be taught, and to practise on a willing friend or relation before expecting an injured animal to play 'guinea pig'. It is also essential to understand the superficial muscle placement and the directional lie of the fibres of individual muscle groups.

The main effect of massage is, following the effects registered in the targeted tissues, to influence circulatory and lymphatic flow. To achieve the most beneficial results the direction of the strokes should, as nearly as is possible, be directed parallel to the course of the underlying muscle fibres, and the directional lie of the venous and lymphatic vessels. The hands should not just slip lightly over the skin, pressure is required as the hands move over the body mass toward the heart. The lie of the coat may make this difficult; if so, the type of stroke used may need to be varied. A secondary effect of massage is the reduction of pain.

Your own instinctive reaction if, for example, you walk into a door in the dark is to 'rub' the painful area; this triggers the release within the body of naturally produced pain-relieving chemicals – endorphins – and the subsequent reduction of pain relieves muscle spasm allowing the normal interchange of fluid and gases within the tissue to recommence.

Hand massage

Effleurage or stroking

The hands are moulded around or over the targeted tissue, and pressure is applied as the hands are moved, using short, slow, repeated strokes moving over the area towards the body centre. The direction of the stroke should be as nearly parallel to the directions of the muscle fibres and venous return as is possible. At the end of the stroke (the length of which is determined by the area being treated, the length of the operator's arms and the size of the animal) the hands are moved rhythmically back towards the starting point, light contact with the skin being maintained. Hand use may be one hand followed by the other, as the first repositions, both hands together, or to obtain greater pressure, one hand superimposed upon the underlying one. The rhythmic sequence of strokes, coupled with greater pressure over muscle masses and less over bony prominences, should be applied for a minimum of ten minutes over any given area. The technique is employed at the beginning of a massage session, to link techniques during a massage session and to end a session.

Effects and uses

- Reduction of muscle spasm secondary to pain (endorphin release);
- to enhance circulatory flow – thermographic imaging has demonstrated a rise in tissue temperature following effleurage; this temperature rise, due to the thermal regulating mechanism, will enhance circulatory flow as the body restores temperature balance;
- reduction of swelling (oedema) after injury (lymphatic);
- to calm a stressed animal (pulling the ears is effleurage);
- before exercise, to stimulate circulation and 'warm' muscles;
- after strenuous exercise; to remove metabolic waste by enhancing circulatory flow.

Kneading or *petrissage*

The hands are placed over the bulk of a muscle; the underlying tissues are pressed firmly inward. The movement of the hands is down, around and up. The technique attempts to recreate the compression and relaxation effected by working muscle on the local circulatory vessels.

Effects and uses

- Enhanced lymph and circulatory flow, due to replication of working muscle effected by compressing and then releasing the underlying tissues;
- reduce muscle tension after exertion;
- mobilisation of scar tissue;
- mobilisation of adhesions following a haematoma.

Wringing

The two hands grasp an underlying fold of tissue, lift it upwards away from the body mass and wring the fold. Then release the fold.

Effects and uses

- Circulatory and lymph vessel compression.

A nearly impossible technique to use on a horse.

Skin rolling

A fold of skin is picked up between the thumb and fingers. The fingers press the fold against the thumb as it rolls away creating a continual roll of the skin. (Visualise the pattern of the movement left by a sidewinder snake in the sand.)

Effects and uses

Below the skin and attaching it to the underlying structures is a tissue named subcutaneous fascia. The fascia is contiguous, as a three-dimensional sheet or membrane, throughout the entire body, wrapping muscles, organs, suspending and supporting. It is presumed that stimulation in one area will result in a flash of signals throughout the full extent of the structure. These signals are variously described, but are considered to stimulate autonomic cutano-visceral reflexes, restoring disturbed autonomic balance, leading, in turn, to recovery from dysfunction.

Giniaux and others have linked cutaneous, segmental discomfort, to dysfunction of varied organs and locomotor patterns.

Friction

Friction is used when very specific local work is required. The forefinger, reinforced by the second finger of one hand is placed over the damaged area, the movement is deep, small and performed in a manner which ensures the skin and underlying tissues move as one.

The direction of pressure can be either circular, the fingers working over and around the damaged or adherent structures, or transverse with the fingers sweeping firmly across the linear direction of the underlying fibres.

If the fingers slip on the skin, or the skin does not move as one with the underlying tissue a blister will form.

The operator's other hand should support the area adjacent to that being treated; tension felt through the non-operational hand will indicate the local and general response of the patient.

Effects and uses

- To create a local inflammatory response;
- to break down scar tissue;
- break down adhesions;
- in tendonitis;
- in synovitis;
- in tendon or ligament rupture.

Many people will adapt and formulate techniques in a manner comfortable for them, once they have learned to use their hands. The essential criterion is to work towards the heart and not cause pain.

Body brush and strapping pad

Grooming with a body brush acts as a type of effleurage, provided a good rhythm is achieved and the use of a strapping pad mirrors petrissage.

For those who find it difficult to get a reasonable pressure through their hands, bath mittens made of a 'cactus' cloth-type material are very effective.

Mechanical massagers

Mechanical massagers reduce/remove pain. In 1959, Wall proposed the gate control pain theory. His work was continued by Melzack (Melzack and Wall 1965, 1982) and showed pain sensation can be filtered out at the synapse, or input point, of ascending messages, located in the dorsal horn of the spinal cord. It appears from subsequent work involving TENS (see p. 128) that if tissue is subjected to a cyclical vibration of a set frequency over a set time period, pain perception can be confused.

Mechanical massagers are now available both as hand-held units and specialised pads. The latter can be adapted to fit almost any area of the horse (or human).

The effect of these machines is one of vibration. Patients tolerate the sensation well, and the machines are of great benefit if used sensibly. Electrically driven, either from the mains or from a rechargeable battery, most have a variable speed of vibration. It is suggested that an animal be allowed to become accustomed to the noise before the machine is used. Many are not audible to the human but hearing in the horse is tuned to a greater frequency range.

The smallest, electrically driven vibrator is the hand-held Pifco™, which is very useful for treating the lower leg or the joints of the legs. The best results are obtained if the area needing treatment is encased in tube-grip, a type of support like an elastic stocking. The compression supplied improves venous and lymphatic movement, the vibration moves and therefore raises the temperature of underlying tissues and this also affects circulatory flow (Fig. 5.2).

Niagara and other massage pads

When first starting to use, hold the pad in position, rather than strap on and leave, in order to allow the animal to become accustomed to the

Fig. 5.2 A massage glove and hand-held massage machines.

sensation, this should be minimal at the start of the first application. It is recommended that the machines be used for approximately thirty minutes at each session.

Effects and uses

- Pain reduction.

N.B. It is essential to decide if the removal of pain is pertinent. Undeniably, pain removal does reduce muscle spasm; this effect in turn restores the normal circulatory flow compromised by the muscle spasm. To mechanically remove pain and then follow up with exercise is not advisable unless the source/cause of pain has been identified. **Pain is present for a reason.**

The effects of massage

Massage, either hand or mechanical, achieves a chain of effects:

(1) promotes relaxation and endorphin release. Rapid if allogrooming areas targeted;
(2) reduces pain perception, endorphin release;
(3) improves circulatory flow, this is secondary to the effects of compression and release, mimicking the effects of working muscle on vessels (venous and lymphatic);
(4) increases tissue temperature in areas massaged. Increased blood flow results due to the thermal regulation mechanism restoring, by circulatory manipulation, the ambient temperature within the heated tissue.

Uses

- Pre- and post-strenuous exercise or competition work;
- all cases of soft-tissue injury;
- filled joints,
- bruises;
- windgalls;
- following falls;
- maintenance.

All types of hand massage are passive techniques, and massage cannot be considered a substitute for muscular contraction.

Massage does not build muscles. It is often used in conjunction with other forms of therapy. Underwater massage is provided in the form of a spa – a water-filled container incorporating jets which are played against the submerged tissues. Also available for horses are 'wellie' boots where the water is agitated by compressed air. See Hydrotherapy, pp. 137–42.

Contraindications to massage

- Dehydration;
- unresolved haemorrhage;
- infection;
- persistent unidentified pain;
- skin infections;
- colic;
- tying up.

Cold and heat

The body, exposed as it is to extreme and constant changes of temperature, responds by adjusting the heat balance to maintain the core temperature (i.e. the temperature of the vital organs – brain, heart etc.) at or near its required ambient level.

The complex thermoregulatory system is informed, via thermoreceptors located throughout the body mass, of the temperature within the control area of each receptor. Adverse signals recording excesses of heat or cold, no matter what the cause, be it exercise, air temperature, or external heat application, trigger an immediate chain of responses designed to return the area to an acceptable normal temperature.

On or near the body surface heat is lost by peripheral vasodilatation, and conserved by peripheral vasoconstriction. This ability to utilise the peripheral (surface) circulatory system is the principal rationale behind the therapeutic use of heat and cold.

The physiological effect of cold therapy

Research has demonstrated the following tissue responses to cold therapy:

(1) vasoconstriction, followed by;
(2) deep tissue vasodilatation;
(3) reduction of muscle spasm;
(4) a limited thermal analgesic (painkiller);
(5) reduction of local tissue activity.

Of these, the first two are useful in the treatment of the limbs of the horse.

Cold and its uses

Cold can be used both for first aid and as a treatment.

Cold for First Aid

Excess haematoma formation at the site of injury is curtailed as the cold causes a temporary vasoconstriction, thus excessive oedema is avoided. There is a mild analgesic (pain killing) effect, as the sensory nerve endings reduce their normal activity; reduction in local tissue activity conserves the oxygen supply within undamaged cells reducing the danger of secondary anoxic destruction.

Commercially produced sachets

These contain non-toxic gels: after refrigeration they remain flexible yet cold for up to three hours. Carrying cases, which ensure the sachets remain cold for approximately five hours after removal from the refrigerator, enable them to be part of a mobile first aid kit when travelling.

Ice massage

For areas where submersion is impractical ice massage can be employed. Ice cubes are messy, hard to hold and numb the fingers. The most useful method is to freeze a paper cup of water with a 'lolly' stick in the centre. Holding the stick, you can use the frozen end without freezing off your own fingers – useful for working over bruised areas on the trunk or around the stifle.

Fig. 5.3 Cold hock appliance.

Commercially produced wraps

These wraps, impregnated with gel, cool rapidly down to approximately 6°C when exposed to air and remain cool for up to three hours. They are re-usable (Figs 5.3 and 5.4).

Bonner bandages

The great advantage of Bonner bandages is their twofold effect: support and cold. The fabric has stretch characteristics and remains cold after refrigeration for fifteen minutes. The ice crystals melt slowly after the bandage is applied. Skin temperature under the bandage reaches the therapeutic range of 6°C. The bandage provides instant cold for first aid when packed in a thermal bag and taken to outside events.

Frozen gamgee or cotton wool

Gamgee or a thick pad of cotton wool can be soaked in water, shaped to the injured area, frozen in a deep freeze, and then bandaged into place. Several made up at one time ensure a constant supply, and the necessity to replace also ensures that the injury is checked at regular intervals. Towels soaked in ice cold water, wrung out and then bandaged into place are also useful.

Fig. 5.4 Cold bandage.

Precautions when using ice

- Do not place frozen substances in direct contact with the skin as this can cause an ice burn.
- Do not reduce local tissue to a 'below freezing' condition and maintain that situation. Cryo (freezing) therapy destroys.

N.B. *Care must be taken to ensure that the commercial products do not contain prohibited substances, the skin is porous, not a barrier.*

In cases of nerve involvement do not use cold: the desensitised tissues will not respond normally after reaching an unacceptable level of chill, and will suffer irreversible damage due to *ischaemia*.

Tissue response to cold water

For years hosing or standing in a running stream has been advocated as a treatment for equine leg injuries. The rationale: cold and compression.

Injured tissue is actively creating excessive heat within the damaged area; this heat (created by 'cell work') would normally be removed via local blood vessels. Following injury this does not happen, so standing in running water, agitated water (wellie boot or tub) or applying water under pressure (hosing with a spray nozzle) creates a compression/relaxation factor (massage) and this reduces the local heat, partly by conductive cooling, partly by influencing the circulatory flow.

Vasoconstriction

During the first four to six minutes of intense cold application (ice), the treated area undergoes a reduction of blood flow and the inflammatory reaction in the area is temporarily curtailed.

Vasodilatation

If the cold application continues for longer than six to ten minutes, there is a deep tissue vasodilatation lasting from six to twelve minutes. Known as 'Hunting Rush', this response is a thermoregulatory response to the unacceptable cold, or thermal insult, to the area. Vasoconstriction then recurs, followed by a vasodilatation in a fifteen- to thirty-minute cycle. By this method, an increased circulatory flow through the area is established. Hosing does not have the same effect, although it undoubtedly causes local vasoconstriction if the water is sufficiently cold.

Methods of employing ice/water therapy

The limb can be immersed in a container, which is then filled with water to which crushed ice is added. A plastic bucket or dustbin will serve, but the purpose-built aqua boots, or 'horse wellies' as they are affectionately known, are the most practical method of application.

The aqua boot has the added advantage of an attached compressor mechanism; the water in the boot can be agitated, producing underwater massage. In some yards, this type of underwater massage has been effected by using a vacuum cleaner hose with the vacuum cleaner mechanism reversed! The boot is more practical. Sea salts, Epsom salts or other additives are sometimes used in place of ice, but there is no proof that their addition is beneficial unless of a sufficient strength to achieve osmosis.

Treatment times

Hosing, aqua boots: up to twenty minutes, two or three times a day.
Iced water: fifteen minutes, two or three times a day. When using ice, make certain the horse is warm itself.

After an application in water, towel dry (working up the limb). A hair dryer is a great help, particularly if bandages are to be re-applied and are not of the Glentona™ type.

Uses

These methods can be safely used for all acute soft tissue injuries – that is, sprains, strains, tears, filled joints.

Iced water in aqua boots is used as a routine by some owners for their competition horses. It is particularly popular with those who own trotters and with some of the show jumpers. The effects can easily be obtained by using a hand massage unit, but it may be that there is warmth in the legs of these types of competition animals due to some deeper structural problem. The immersion in water will reduce the warmth, thus allowing owners to be fooled into thinking that there is no problem. The cold will also have a mild analgesic effect, and therefore any sign of discomfort or lameness could well be suppressed.

N.B. Experience suggests that a horse showing increased lameness, following ice/cold immersion of the suspect limb, should be X-rayed. Bone damage appears to become increasingly painful following cold immersion.

Contraindications to cold

- Impaired nerve supply;
- impaired blood supply.

Heat

The application of heat has been used both for its apparent analgesic and increased circulatory effects. As the level of athletic competition has advanced, so sport-related injury has increased, causing research workers to investigate scientifically previously accepted therapeutic methods. Investigations have shown that, amongst other effects, heat enhances muscle elasticity, by increasing the circulation through, and the temperature within, muscle tissue, thereby assisting in the prevention of muscle injuries. Experiments have suggested that, if the heat is applied immediately pre-competition, tissue collagen (the principal component of tendons) demonstrates an increase in its ability to elongate under load.

N.B. *It does not follow that heat felt in a horse's tendon should be ignored or hailed as useful. Heat in a tendon is a sign of tissue activity, secondary to damage.*

Several manufacturers have designed leg wraps for horses and suggest that the warmth created by the wearing of these wraps, for one or two hours pre-competition, may reduce the risk of tendon injury. This theory is so far unproven.

There are many sources of heat. Those applied to the surface of the body by means of specialist lamps, rugs lined with some form of insulating/reflecting material, or wraps, cause superficial heating. The use of a high frequency alternating current heats the deeper structures, heat achieved by the resistance to current flow, provided by the density and interfaces of the various tissues.

Contrary to most beliefs muscle blood flow is not significantly increased by heat alone: applied heat and exercise increase blood flow within a muscle to a greater degree than heat or exercise alone.

Physiological effects of superficial heat

(1) Local vasodilatation (circulatory increase) at temperatures up to 42°C, the blood flow increasing locally by four or five times that of the resting level; if the application of the external heat source is prolonged for more than thirty minutes the blood flow reaches a plateau and declines.
(2) Reduction of pain via the sedative effect on the sensory nerve endings.
(3) Increased metabolic activity in the skin and superficial underlying tissue.
(4) Relief of joint stiffness following injury.

Deep heat

Short wave diathermy

Short wave diathermy heats by means of a high frequency alternating current passing through the tissues. The resistance provided by the differing densities of the tissues causes the greatest amount of heat to be generated in those tissues with the greatest density, i.e. bone, a very dense tissue, and heats more than fat tissue. This fact must be remembered if using diathermy; unacceptable heating of bone causes severe pain.

The machines are mains operated, and the animal must not be left unattended. Short wave diathermy is not very suitable for use in the animal field, particularly because the distance between the electrodes (which are mounted on adjustable arms) and the skin must remain equal. The distance between skin and electrode must be similar on both sides of the body; dissimilar distance will cause uneven heating, and possibly even a burn, should the electrode–skin gap be too narrow.

Effects of short wave diathermy
The effect of heat on tissue is always similar: increase in the blood supply. Radiant heat increases the blood supply in the superficial tissues; short wave diathermy heats the deep tissues.

Uses
Any injury lying deep – for example, the joints of the vertebral column.
Treatment times: fifteen to twenty minutes on alternate days.

Contraindications to short wave diathermy

- Any form of metal implant (after a fracture, pinning or plating may have been used);
- any suspicion of malignant disease;
- recent haemorrhage in the area of injury;
- grossly oedematous or swollen tissue.

Short wave diathermy is of far more use for the human patient than for the animal, in its present form, but is included as there are still machines available. Short wave diathermy machines should only be used by qualified personnel.

Hot and cold contrast bathing

Contrast bathing is a method of circulatory stimulation. The injured area is wrapped first in a hot compress, left in situ for three to five minutes; then a towel, wrung out in ice cold water, replaces the hot compress and is left in situ for a similar time length. The total treatment time should last for approximately fifteen minutes and be repeated three times daily for up to a week.

Effects
The heat causes a dilation, and the cold a constriction, of the superficial vessels; this artificially increases circulatory flow.
There is some evidence to suggest that the alternate dilation and constriction in the superficial vessels will have a 'knock-on' effect, and cause a similar effect in the deep vessels.

Cellular effects in response to varied stimulation

The first mention of the therapeutic use of a magnet was made in 200 BC by the Greek physician Galen. Throughout the centuries, magnetic influence on living organisms has been a topic for discussion. In the mid 1950s, Dr Andrew Bassett, working at Columbia University, New York, began to investigate the electrical activity of bone. In the 1960s, his research group suggested that it was possible to influence biological systems with electrical command signals, which in their turn might activate cell function. Magnetic fields were the eventual choice for his continued research. Others have progressed in the field of optimising cellular response following tissue breakdown.

In 1985, Becker demonstrated that electrical current is the trigger which stimulates healing, growth and regeneration in living organisms. He considered repair is a closed-loop system, suggesting a specific signal is generated by injury, leading once again to a 'chain' of responses, each delivering specific signals to achieve repair.

In 1995, Mercola and Kirch used the term microcurrent electrical therapy (MET). Experimental work using animal wound models resulted in improved quality of wound healing. The wounds were kept moist and externally applied electrical currents, using less than one milliampere of current delivered in biocompatible wave form, were used to stimulate the area of damage and promote recovery.

Artificial stimulation at cellular level may prove harmful and indiscriminate use in the absence of a diagnosis is very unwise.

A statement made in Italy in 1983, presented at the National Congress of the Italian Society of Physical Medicine and Research, is worthy of note:

> 'There are many who trade on general lack of critique in an uninformed medical community to promote electro-therapeutic devices, unbacked by sound scientific research. While field work with pulsing magnetic fields and even static magnetic fields appear to be producing interesting results, there are as yet no scientific studies to back the claims made by many of the manufacturers.'

Magnetic field therapy, PMF (pulsed magnetic flow) and static magnet fields

Unfortunately, despite the indisputable fact that more than 2000 papers on magnetic devices and their effects are published each year, many are speculative, rather than scientific. Therefore it is impossible to state categorically the effects of the many equine products available.

Effects of magnetic field on tissue

Experiments with thermography (a method of measuring the heat in tissues caused by increased circulation) show that magnetic fields with specific pulses cause an increase in circulation, the improved circulatory flow is also demonstrated thermographically following the application of static magnets. The consequence of an increased circulatory flow and a more efficient oxygen uptake is improved tissue activity. In the case of tissue damage, improved tissue activity leads to the enhancement of repair processes.

Thermography measures superficial temperature changes, deep-tissue heating must be theorised in view of the fact that with electromagnetic pads placed opposite each other, one on either side of the horse, there will be a disturbance of cells caused by the alternating polarity between the magnetic coils. Activity equals heat, thus a rise in tissue temperature, secondary to cellular disturbance is possible.

Cellular effects

The normal electrical charge across the cell membrane is considered to have specific control on cell behaviour, influencing the ionic exchange across the membrane. It is proposed that changes in the local ionic microenvironment caused by electro-stimulation, such as that produced by a pulsating magnetic field, may influence the cell and redirect the energy behavioural pattern. As yet, these hypotheses have been proved only in the case of bone and even then there are conflicting opinions as to the efficacy and effects of the varied devices. The exact effects of magnets have not yet been demonstrated scientifically in the case of soft tissue, but it is undeniable that soft-tissue injuries, when exposed to magnetic field influence, appear to have an improved ability to recover.

As each cell type enjoys its own unique environment, devices with a wide band of electromagnetic fluxes must influence a wider group of interacting molecules.

In theory, magnetic fields, used for therapeutic purposes, always provided their fields are appropriately calculated to interact with those of living tissue, should be able to contribute to restoring tissue stabilisation, by activating atoms, ions and molecules, in order to restore the required membrane polarisation of disturbed cells. (Figs 5.5 and 5.6.)

Pain control

The reduction of pain by transcutaneous nerve stimulation was demonstrated by Melzack and Wall (1965). PMF frequencies subject large nerve fibres to varying wave forms; if these nerve fibres lie within the treated area, pain perception may be significantly reduced. As the reduction of pain and an increase in circulatory flow enhance natural healing, the effects of PMF should be beneficial.

A note of caution: excessive exposure to electromagnetic fields appears to have harmful effects particularly in the case of 'strong' fields of

Fig. 5.5 A rug and neck rug. Magnetic strips can be appropriately adjusted.

Fig. 5.6 The Bemer™ horse mat.

electromagnetism. Cell function is the result of the interaction of chemical, electrical and magnetic influences. If your horse reacts unfavourably to PMF you are using inappropriate frequencies or the diagnosed condition is not suitable for PMF therapy.

Avoid over-exposure to yourself.

All electromagnetic devices are activated by rechargeable batteries incorporated within the unit. One, a boot developed in America, is designed for the treatment of legs; the firm have also developed a shoe for treatment of problems within the foot. The manufacturers of these units make no claim for soft-tissue repair – they state the unit was designed for, and the experimental field work done on, bone tissue.

The rugs on sale are all well designed, the latest, made in Germany, dispenses with a full rug. This device, termed the *horse mat*, is fixed with a roller to the horse's back in the saddle position. The designer, a physiologist specialising in molecular and magnetic fields, considers it unnecessary to stimulate other than a small area to deliver effective therapy.

Treatment times

All electromagnetic machines have specific treatment times laid down by the manufacturers. The settings are changeable and are dependent on the type of injury. In the main, the treatment times are for not less than thirty minutes, daily or on alternate days.

Static field devices also come with instructions. All instructions should be carefully adhered to, over stimulation is not beneficial (Fig. 5.7).

Uses

Field trials, not clinical trials, suggest that magnetic fields influence wound healing, the reduction of post-traumatic oedema, improvement in the function of arthritic joints, reduction of the pain associated with *thoraco-lumbar* problems, tendon injuries, fractures and other bone-assisted conditions.

While all manufacturers lay down specific treatment instructions, a minimum of three weeks' treatment is suggested even if clinical signs have disappeared. This is because working on the hypothesis that the magnetic field has triggered cell activity by external stimuli and that the activity is not just the body's own reactive control, by the end of a 21-day period some form of effective healing should have occurred.

Field work suggests that cessation of treatment with cessation of pain (often the only objective finding), which may occur early in the treatment programme, may lead to recurrence of symptoms – in many cases with increased severity.

Contraindications to magnetic field therapy

- Sepsis;
- kidney disease;

Fig. 5.7 Magnetic field built into a boot.

- in conjunction with a leg wash;
- following major damage to blood vessels;
- laminitis.

Ultrasound

Like laser, ultrasound has more than one use in the medical field. Used for scanning, measurement, diagnosis and treatment, it is the therapeutic range that is applicable after injury. Unlike massage, muscle stimulation and heat, but as with magnetic field and laser therapy, the effects of ultrasound occur at cellular level.

Incorrectly used, it is probably the most dangerous piece of machinery on sale to the general public. Post-treatment fractures, destruction of joint surfaces and deep-tissue *necrosis* (death) have been reported in animals after treatment by unqualified personnel.

What is ultrasound?

Sound waves are pressure waves travelling through a medium such as air. They have a specific wavelength, frequency and velocity. Water is a good conductor of sound; air is comparatively poor. The upper limit of hearing is just over 20 KHz (20 000 cycles per second). The therapeutic frequencies of ultrasound are well above this, being in the region of 0.75 MHz, 1 MHz or 3 MHz.

For a machine of 1 MHz, a medium that will vibrate at one million cycles per second is needed. A quartz or barium titrate crystal is used, fused to the metal plate of the transducer or treatment head. When this crystal is bombarded with a high frequency current, movement occurs in the crystal and is transmitted to the metal front plate, producing an ultrasonic wave. This wave obeys the laws of reflection and refraction.

Air will not transmit ultrasonic waves. They reflect back upon themselves and may shatter the crystal, thus the need to use a coupling medium between the treatment head and the area to be treated. The head should always be perpendicular to the surface to be treated, or refraction will occur. The measurement of ultrasound is calculated in watts/cm^2.

As the beam travels through a medium its intensity is reduced by scattering and absorption. It has been calculated that the intensity of an ultrasonic beam decreases by a constant fraction per centimetre, known as the *half-value thickness*. This depth is calculated to be 7 cm for 0.75 MHz machines, 4 cm for 1 MHz machines and 2.5 cm for 3 MHz machines. This calculable depth is of significance when treating deep structures, as the half-value thickness is again reduced by half when the beam has travelled the same distance from the half-value level.

It is not possible to increase the surface wattage in the hope of an increased treatment level deep down: this would harm the superficial structures. The use of a machine with the three MHz settings, their depths already described above, is the only realistic method of treating tissues of differing depth.

Machines

Ultrasound machines are battery or mains operated. The generator is housed in a metal box, with the control knobs on the upper surface. The controls consist of a timer, often incorporated with the on/off mechanism; a selection knob for pulsed or continuous sound; a dial which will give a readout of the watts to the cm^2, and in those machines with more than one hertz setting, a hertz selection control.

Fig. 5.8 Battery-powered ultrasound machine: (1) A small head suitable for treating tendons; (2) a larger head for treating muscle masses.

Attached to the generator by a lead is the treatment head or transducer (Fig. 5.8).

There is no way of knowing if the machine is emitting a beam other than by testing the machine daily. This is done either by placing the transducer in water, or by inverting the head, covering it with a treatment gel and then turning on the machine. The beam of energy is clearly visible in the water and the gel bubbles in the centre if the machine is working.

Effects of ultrasound

These are thermal and non thermal:

- thermal effects: these include reduction of muscle spasm, a mild inflammatory reaction including increased blood flow, and an increase in the elasticity of such structures as scar tissue;
- non-thermal effects: research has shown that ultrasound stimulates cell behaviour and activity.

Laboratory tests on rat tissue have shown that in treated tissue there are more bundles of collagen fibres, though these bundles are finer than normal tissue, and the tissue is slightly stronger and more elastic than the tissue of the untreated control subjects. A 1978 study in Iraq (Morcos & Aswad) on only five horses, showed significant improvement in tendon repair treated with ultrasound after surgical splitting.

Treatment of bone by ultrasound

Treatment of bone in the first two weeks after fracture has been shown experimentally to minimise the cartilage production phase, and leads to rapid ossification, though repair in the early stages is of a juvenile-type bone. Conversely, treatment in the second stage of repair is contraindicated, ultrasound delaying bone union by stimulating an increased production of cartilage (Pilla 1990).

The optimum time for treatment in the stimulation of bone repair appears to be in weeks one and two after injury. Treatment started after this time is not efficacious and delays or reverses bone union.

Machines

All machines on the market were developed for the human field and have merely been renamed for veterinary use.

Battery powered units are available for ultrasound treatments. The more versatile have the three frequencies – 0.75 MHz, 1 MHz and 3 MHz. These are the most useful, but the 1 MHz machine is the most frequently found in practice.

Treatment

Areas to be treated should he close clipped. Treatment can be given by using a coupling medium and direct contact, or the immersion technique.

Contact method

A liberal supply of coupling medium should be spread over the area requiring treatment. The treatment surface of the transducer should also be lubricated. The transducer is put firmly on to the skin; the machine is timed for the length of treatment and then turned on. The intensity required is then selected. The transducer head must be kept moving throughout the treatment. A slow circular movement or parallel stroke movement of the head should be employed. There is some evidence to suggest that there is a better effect on tissue repair if the parallel stroke method is used, the strokes being aligned in the direction of the underlying normal tissue. Conversely, the use of a circular movement for haematoma re-absorption and the softening of old adherent scar tissue is better (Japanese research; Baker 1975) (Figs 5.9 and 5.10).

Underwater method

The limb (it is only for limbs that this method is suitable) is immersed in a tub of water, e.g. a plastic bucket (Fig. 5.11). The leg must be rubbed

Fig. 5.9 Ultrasound to the subdeltoid bursa.

to ensure that no air is trapped in the hair of the coat, as this air will reflect the beam away from the treatment area. The treatment head should be held parallel to the limb and approximately 1–2 cm away. Water is a good conductor of ultrasound. The head must be kept moving, as in the contact method. Remember, the lower the wattage/cm^2, the better the effect: less heat, more cell stimulation.

Pulsed or continuous

Pulsed ultrasound delivers two or more microseconds of sound, followed by a period of silence. The ratio of sound to rest varies with every machine. It is considered that pulsed ultrasound causes minimal heating. It is necessary to know the ratio of pulse to rest, because this is the only way that the treatment time can be calculated. In general, all

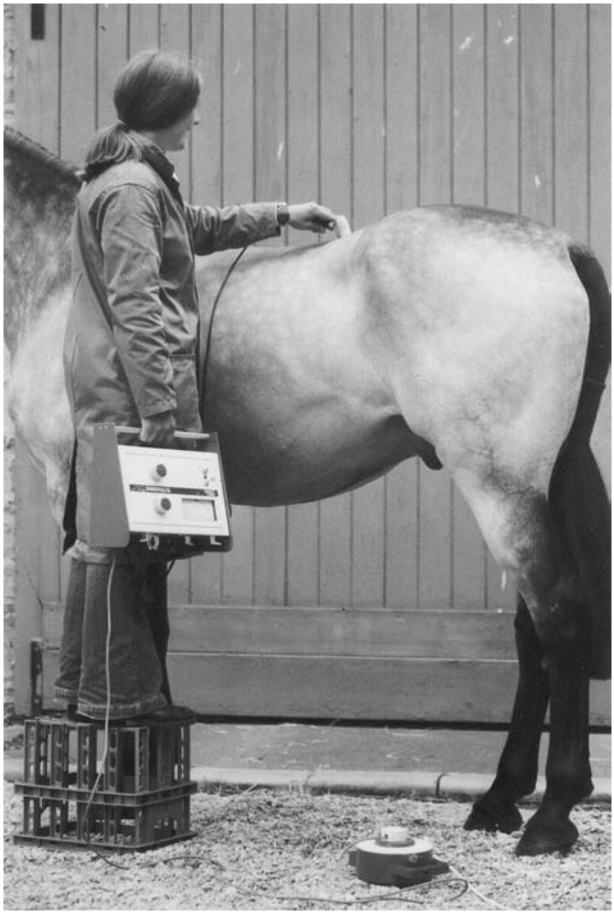


Fig. 5.10 Ultrasound to the lumbar spine.

treatments are given using continuous ultrasound, but the choice as to whether to use pulsed or continuous sound must be that of the operator. Severe haematomas and recent injury with massive oedema are best treated with pulsed ultrasound.

Contraindications

- Avoid the brain, eyes and reproductive organs, tumours, thrombosis, heart disease, circulatory and intestinal disorders. Too high a dosage may produce periosteal pain. Always use a low output dosage.
- Do not treat if there is any suspicion of haemarthrosis or sepsis, other than sinusitis.

Fig. 5.11 Ultrasound in water for a bruised sesamoid.

- The treatment causes no sensation unless the dosage is too high, and is tolerated well by most horses.
- Many animals are being treated over too long a period, i.e. up to three months' daily exposure. This is harmful, and can cause demineralisation of bone.
- A month is suggested as being the maximum for a treatment regime – give at least two weeks' break before recommencing treatment.

Phonophoreses

There are certain gels on the market which contain adrenocortical extracts, usually the equivalent to 20 mg of corticosteroid per gram. These can be used as a coupling medium in ultrasonic therapy. As they contain anti-inflammatory and anti-exudative substances, they are of particular benefit for recent injury; this method is suggested as a non-invasive way of producing a superficial local anti-inflammatory effect.

N.B. It must be remembered that corticosteroids are banned for fourteen days pre-race or competition.

Light therapy

Light therapy has now become widely accepted as a therapy aid, benefits to living organisms and tissues demonstrated by considerable research. Both infrared and visible light have been shown to achieve at least twenty changes at cellular level.

All the diverse tissues in the body are endowed with their own unique light absorption characteristics, that is, they only absorb specific wavelengths of light and appear to ignore those which are not appropriate.

Light is measured in nanometres nm (1 nanometre equals one billionth of a metre). The penetrable depth of light is dependent upon the wavelength or nm of the device.

Radiant heat (superficial)

Infrared lamps are a source of radiant energy. This energy penetrates the skin (*epidermis*) into the underlying tissue (*dermis*) and is experienced as warmth. The wavelength of infrared light is 904 nm with an expected penetrable depth of 30–40 mm. A great number of stables have radiant heat lamps suspended from the roof or ceiling. The air flow through most stables is constantly removing heat (which rises), and the lamps are generally hung too high to have very much effect, particularly if the horse is rugged (Fig. 5.12).

The type of heat source with a series of lamps mounted on a frame and which can be lowered until the heat source is approximately two feet away from, and at right angles to, the tissue to be treated produces

Fig. 5.12 Lights providing both radiant heat and ultraviolet light.

the best results. Obviously, care must be taken when a horse is under the lamps and all heat lamps should be covered by a grille to ensure that there is no possibility of the horse being in contact with the bulbs.

Uses

- To warm a horse after an attack of colic or after tying up;
- to dry off a horse after exercise or swimming;
- to improve the general health – especially useful for early foals and other young stock.

Treatment times

Radiant heat

The times of treatment depend very much upon the condition being treated. A maximum of thirty minutes is usual for radiant heat supplied from a solarium. The lights are usually left on continuously if the radiant heat source is in the box and suspended from the ceiling. Solarium heat can be used at least twice a day.

Ultraviolet or artificial sunlight

It is advisable to start with a three-minute exposure and to increase, over a period of two to three weeks, to a maximum of fifteen minutes' exposure. The time of exposure may also depend upon the make of the machine – most have comprehensive instruction booklets. It is inadvisable to disregard the instructions provided. The dosage times have all been calculated by experts to ensure the best possible benefits, as has the distance from the heat/light source in order to avoid the possibility of the animal being burned through direct contact with the bulbs.

Solarium

The solarium consists of a series of infrared and ultraviolet, or artificial sunlight lamps mounted on a cradle suspended from the ceiling or roof beams. The majority of cradles can be raised and lowered, with the horse standing directly beneath the lights. A set of stocks ensures that the animal cannot move and will derive full benefit of either sunlight or heat. The effects of radiant heat are identical to those produced by the single infrared lamps.

Care should be taken if a horse has stood under a solarium and the infrared employed for a length of time. After three quarters of an hour, the capillary dilatation may be sufficient to cause, albeit minor, a temporary fall in the blood pressure. For this reason an animal should be allowed, after a treatment session, to rest in his box for at least an hour before being worked.

The effects of ultraviolet light

Ultraviolet light is a source of artificial sunlight. All living tissue benefits from *controlled* exposure to the sun's rays. One of the many benefits is the natural production of Vitamin D.

The amount of sunlight available to the boxed horse is reduced to exposure on exercise, and then only if the sun is out. A source of artificial sunlight can be used to improve the general health of animals denied the natural source.

Uses of the infrared lamps and the solarium

To help to reduce stiffness after excessive work, i.e. competition or racing; improve general health.

Laser therapy

As with every new therapeutic tool, extensive and often grossly exaggerated claims are made in respect of the 'miracle' cures the apparatus will effect.

History of lasers

In order to understand the complexities of the wide range of laser application, a short description of the development of lasers is necessary.

Fifty years ago Theodore Maiman designed an apparatus around a ruby crystal. The resultant beam, a LASER (Light Amplification by Stimulated Emission of Radiation) drilled a neat hole through a stack of razor blades in one millisecond! The use of light for healing, actinotherapy, was first described in India's sacred books dating to about 4000 BC. Hippocrates (5 BC) practised heliotherapy in specially constructed buildings designed to angle the rays of the sun to the patients lying on slabs beneath holes in the roof.

Maiman's work encouraged the scientific world to investigate the possible potential of artificially developed light generated in a manner that achieved single, defined wavelengths. The work has resulted in the application of lasers in industry, telecommunications, space travel, surveying and medicine.

Properties of a laser beam

(1) *Monochromatic*: The wavelength is a single defined band. The band or wavelength differs in each category of laser.

(2) *Coherence*: There is no variation in the behaviour of the photons: they arrive at the target in a predetermined format, which never varies.
(3) *Lack of divergence*: The photons travel in parallel, unlike domestic light where the beam becomes broader after leaving its source.
(4) *Intensity*: The power capacity of lasers is immense: 'hot' lasers could create a radiation force producing billions of kilowatts to the square centimetre, powerful enough to destroy life on earth.

Laser energy is measured in joules to the square centimetre, and their power in milliwatts (mW). Lasers are named according to the medium from which they evolve, e.g. helium neon, a gas-based source (HeNe).

Lasers in medicine

There are two general groups, high powered (hot) and low level (cold).

High powered (hot) lasers

High powered lasers cause thermal changes in tissue. One example, the CO_2 (carbon dioxide) laser is used as a scalpel both for cutting tissue and coagulating tissue, i.e. 'welding' a detached retina into position within the eye.

The beam of a Na-Yag Laser, also 'high powered' or 'hot', can be transmitted through fibre optics, thus access to internal areas of the body (e.g. the bladder or intestines) is possible; internal bleeding can be treated, and tumours destroyed without major surgery.

Low level (cold) lasers

These are the therapeutic lasers. No instrument is stronger than another. Those with multiple diode heads cover a larger area of tissue than those with single diodes (Fig. 5.13).

The single diode affects one square centimetre of tissue. The depth of penetration is dependent on the wavelength (10–15 mm). The red light, displayed by some lasers as a small red dot on the target area, is a guide to ensure accurate deliverance from the diode. It is not the 'healing' light.

Low level laser therapy (LLLT)

The following are low level laser models.

- Helium neon, HeNe
  Wavelength 630 nm (620–670 nm)
  Output power varies, 15 mW (15–30 mW)

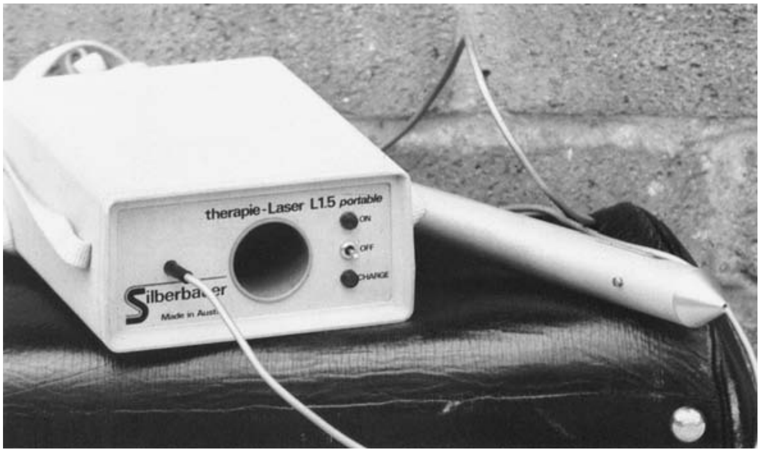


Fig. 5.13 Helium neon portable laser.

- Gallium aluminium arsenide, GaAs
  Wavelength 830 nm (720–904 nm)
  Output power varies, 15 mW (15–100 mW)

Body systems influenced by LLLT

- Lymphatic system;
- circulatory system;
- nervous system.

The exact cell reactions and the mechanisms of healing affected by LLLT are still not clear.

(1) LLLT beams are absorbed in subcellular organelles.
(2) Many components contained within the body required for tissue reconstruction appear to have their natural capabilities enhanced after LLLT irradiation.
(3) The components are carried from the irradiated area to the area where they are required even if this is not within the immediate target area.
(4) LLLT appears to have a beneficial effect on acute conditions. The results in chronic conditions vary.

Lymphatic system
Tissue damage is complex; immediately following trauma, a back up of fluid occurs due to obstruction of normal drainage, this creates pain due to pressure and oedema. If the lymphatic system is unable to clear the excess fluid, toxins build up within the area compounding the problem.

LLLT directed over lymph vessels proximal and distal to the site of injury appears to re-establish lymphatic flow.

Circulatory system

The application of LLLT over or near components of the blood vascular system enhances circulatory flow and influences capillary interchange within the target area. The tissues and components serviced by the blood vessels, within the target area, also benefit.

Nervous system

The 'gate' theory of pain control is well documented. LLLT applied to acupuncture points or over different nerve roots results in localised pain relief.

Regeneration of nerve

Work (1991) has demonstrated regeneration of peripheral and central nervous tissue following both section and compressive injury.

Treatment using LLLT

Treatment times should be closely monitored as over treating appears to inhibit rather than enhance tissue activity. Laboratory work on neural tissue *in vivo* demonstrated activity increased after six seconds of irradiation, was at its highest after fifteen seconds, was inhibited after 60 seconds and retarded strongly after 120 seconds (E.L. Kodah 1990, Department of Anatomy, Tokyo University, Ohta-Ku, Tokyo).

The area to be treated should be mentally divided into 1 cm squares. The beam should be directed to the centre of each imagined square for fifteen to thirty seconds.

Conditions suitable for LLLT

- Nerve compression/bruising;
- open and post-surgical wounds;
- tendon and ligament injuries;
- post-operative myofisciatis (Winks Green, private communication from South Africa 1991);
- gross oedema;
- pain reduction.

Contraindications to LLLT

- The eye;
- pregnancy.

The benefits of using a laser are:

(1) it is non-invasive;
(2) there is no sensation associated with the beam;
(3) there is an obvious reduction in recovery time.

Fig. 5.14 Treatment of an open wound. The horse had trodden on a piece of old, buried corrugated sheeting, removing the entire heel bulb. He won at Cheltenham six months later.

Open wounds
The effect of the cold laser is to enhance wound healing, apparently without the production of proud flesh. The laser depresses the rate of bacterial division and, as such, assists in keeping the wound sterile.

Treatment should be given around the periphery and in the centre of the crater of the wound. Care must be taken that the periphery does not grow in, leaving pockets which may retain fluid and become infected (Fig. 5.14).

Laser acupuncture

In order to practise acupuncture in the traditional Chinese manner with needles, specialist training is required. Acupuncture using the LL laser dispenses with the need to learn to insert needles, the only necessity for laser acupuncture being a knowledge of the location of the acupuncture points and – most important – to which areas and structures the differing points apply. Treatment by acupuncture is completely ineffective unless the correct points are used.

There are a wide variety of machines available for acupuncture, one of the most useful being a machine with a sensor mounted on the tip of the acupuncture probe. This sensor is capable of measuring the electrical skin resistance. As the skin resistance is lower over the acupuncture points, the bleep of the sensor changes significantly, so determining the presence of an acupuncture point.

To stimulate the point, the probe is held over the detected area and the laser beam activated. Some machines require as little as fifteen seconds' exposure to be effective. It may be necessary to treat as many as twenty or thirty acupuncture points in order to give pain relief. The pain relief can last for as long as ten days.

Treatment for pain by acupuncture is normally given once a week.

N.B. The beam of a laser should never be directed towards the naked eye. Some makes of machine require both operator and patient to wear dark glasses.

Helium neon and infrared lasers – operational hints

(1) Apply laser therapy as first treatment.
(2) Direct the laser beam perpendicularly to the area requiring treatment.
(3) Remember that pulsed laser is said to control pain: continuous beams are suggested for healing. You can alternate pulsed–to–continuous irradiation during each session if your machine has this facility. Leave a two- to four-day interval between sessions. (Fig. 5.15)

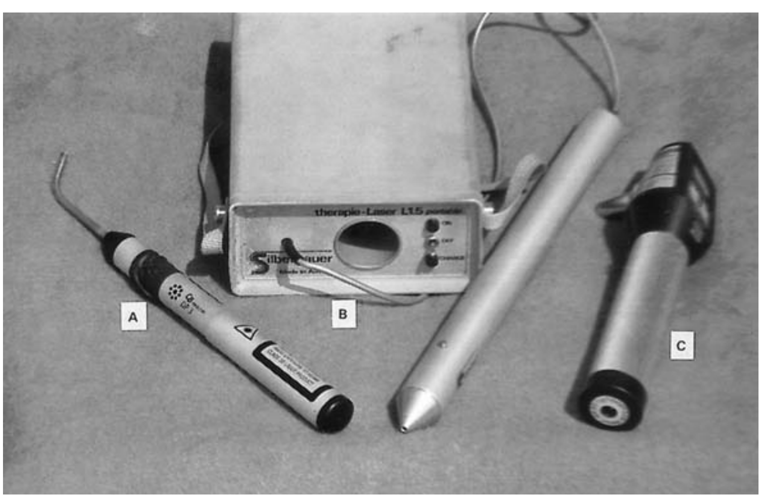


Fig. 5.15 Low level lasers: (a) CB laser (GaAs); (b) Silberaue laser (HeNe); (c) Laserex (GaAs). All these are battery powered and all are suitable for the treatment of animals.

Note:

- Pain aggravation may be observed after early sessions. This is a physiological reaction – but it is better to advise the client.
- Avoid combining laser treatment with anti-inflammatory drugs. Use only antibiotic coverage, if necessary.
- It is advisable to shave the points/areas under treatment.
- The depth within tissues to which a cold laser penetrates and is effective varies with the wavelength of the emitted beam frequency of the machine. For practical purposes, the majority of machines are effective to a depth of 10–15 mm in soft tissue.
- *As with all types of treatment, laser therapy requires skill and knowledge.*
- *Correct targeting is essential.*
- *Incorrect targeting is both counter productive and dangerous.*

Light emitting diodes

Another relatively recent form of light therapy is the light emitting diode or LED. The principle was originally developed for NASA as a result of requirement for a high intensity, solid-state lighting system to achieve plant growth during space flight. A spin-off from plant growth was the fact that NASA was able to demonstrate that LED light absorbed by cells stimulated both bone and muscle metabolism in the human model.

LEDs are not dissimilar to lasers in as much as similar healing results are claimed since their wavelengths fall into what has become known as the 'healing spectrum', though they differ in power output. Their beam is neither collimated nor coherent, and the wavelengths are combined to deliver a broad, rather than a single spectrum, ranging from 830 nm to 930 nm. This is considered to stimulate a broader range of tissue types and effect a wider range of photochemical reactions than the conventional, single wavelength laser.

Electrical stimulation of muscle

Muscle which is weak due to disuse, muscle which has lost power following damage to the joint and/or ligaments which form its working unit; muscle whose tendon has been damaged or muscle subjected to direct trauma: none of these will regain pre-injury ability unless appropriate treatment to maintain at least 50% of original functional ability is given.

General belief supposes that a muscle will recover its pre-injury state immediately after normal activity has resumed. In fact adjacent muscles are forced to take on the work of the weakened structure, often in an imperceptible manner, and by doing so create secondary problems. This change in function often causes the groups involved to work at a mechanical disadvantage. Ligament strain, joint strain, problems in the back, pelvis or in the movements at hip and shoulder are often the results of muscle imbalance.

Neurophysiologists, by isolating the signals normally delivered to a muscle (correlated from all the information continually supplied in the healthy state) have paved the way for effective maintenance of muscle function from the onset of injury. The new stimulators, described as 'life support systems', deliver stimuli that ensure the natural metabolism (feeding) of muscle is maintained. This analysis of the normal healthy firing patterns of the motor neurons has caused a revolution in the field of muscle stimulation.

Faradism causes muscle contraction but the stimulus is very crude, the point of current entry is uncomfortable in contrast to the trophic stimulators whose wave form creates little or no sensation in the skin underlying the electrodes.

To maintain muscle competence, treatment should be started within 24–48 hours of injury, but the stimulators can be used to rebuild muscle at a later date in cases where early treatment was not available. Muscle activity cannot take place without the back up of all other body mechanisms. The body cannot move without muscle activity. Movement influences every system, and it is of prime importance to maintain muscle capability after injury.

Muscle atrophy

Muscle atrophy and weakness occur as a result of direct injury to muscle or tendon, disuse as a result of fracture, injury to a joint, injury to partner muscle groups, and interference with the nerve supply to muscles.

Effects of electrical stimulation of muscle following injury:

(1) maintains muscle metabolism;
(2) improves the venous and lymphatic drainage;
(3) assists in preventing gross muscle atrophy;
(4) prevents the formation of unwanted adhesions;
(5) scar tissue formation is reduced to a minimum due to the maintenance of muscle mobility;
(6) damaged or weakened muscle can be partly rebuilt and re-educated.

Certain muscle groups appear to degenerate or atrophy faster than others, this possibly relates to the proportion of slow twitch (ST) to fast twitch (FT) fibres present. Healthy or undamaged muscle receives a constant supply of electronic signals (information); remove those signals and there is a reduction of circulation with consequent degeneration.

The reduction in bulk of a muscle group, when contrasted with the same (unaffected) group on the opposite side of the body, is startlingly visible within a few days. Palpation will often reveal an apparent 'softness' in one part of a muscle or of a muscle within the group; similarly a tear or a haematoma (bruise) can be detected via the examiner's fingers.

Following any type of injury it is important to rebuild the area to its pre-injury state: contrary to general opinion this does not occur naturally. As work is resumed following recovery from the accident or disease, all muscles will begin to regain function and strength, but the weak muscle will not be singled out by the body as requiring more attention than its surrounding companions, thus imbalance occurs. This factor is the main reason for recurrence of the original problem – the area remains weaker, and is unable to meet the demands as training progresses, thus precluding the restoration of pre-injury performance levels.

Electrical stimulation of the muscle or muscles affected, started immediately after injury, no matter which structure is involved, will reduce muscle loss; treatment using the new stimulators acts as a life-support system for the injured area. This stimulation of muscle should be followed by an active exercise routine designed to re-educate the damaged area, to continue muscle strengthening, and to co-ordinate all the local muscle groups. This is the only way in which to regain pre-injury state and potential. (See Figs 5.16–5.23.)

Faradic stimulation

This type of muscle stimulator has been superseded by machines whose computerised programmes are housed in containers the size of the average cigarette packet.

The Transeva machine developed by the late Sir Charles Strong was endowed with a wave form well tolerated by equine patients. It is used to isolate individual muscles and only one group of muscles can be stimulated at any one time using the Transeva method.

Diagnosis using Faradism

For many years it was considered possible to locate muscle injuries using Faradic stimulators. In view of the increased knowledge of neuromuscular behaviour, firing patterns and the characteristics of equine muscle this hypothesis must be in doubt.

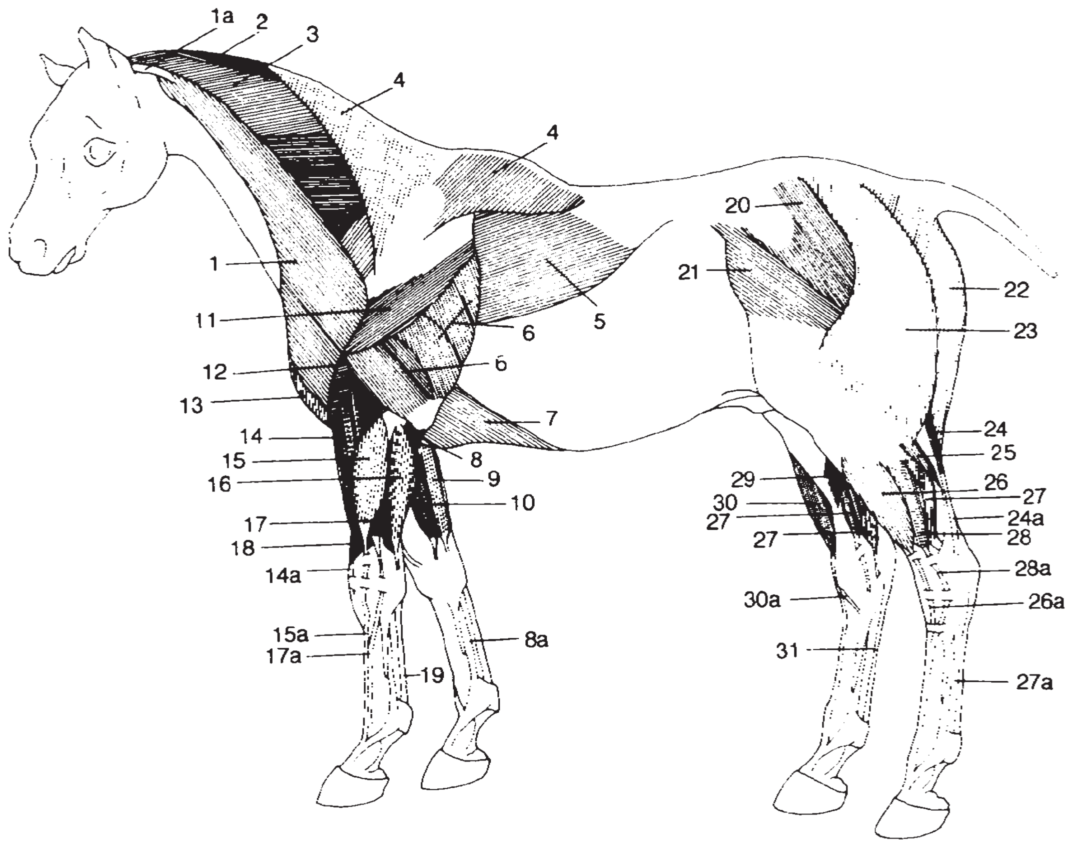


Fig. 5.16 Superficial muscles. For points for stimulation see Figs 5.17–5.21. 1/1a: Brachiocephalic muscle and tendon; 2: Rhomboideus cervicis; 3: Splenius; 4: Trapezius; 5: Latissimus dorsi; 6: Triceps; 7: Deep pectoral; 8/8a: Flexor carpi ulnaris; 9 & 10: Flexor carpi radialis; 11: Deltoid; 12: Brachialis; 13: Pectoral muscle; 14/14a: Extensor carpi radialis; 15: Extensor digitorum; 16: Extensor carpi ulnaris; 17: Extensor digitorum lateralis; 18: Extensor carpi obliquus; 19: Superficial flexor tendon; 20: Superficial gluteal muscle; 21: Tensor fasciae latae; 22: Semitendinosus; 23: Biceps femoris; 24/24a: Gastrocnemius; 25: Soleus; 26/26a: Extensor digitorum longus; 27/27a: Flexor digitorum profundus; 28/28a: Extensor digitorum lateralis; 29: Popliteus; 30/30a: Tibialis anterior; 31: Superficial digital flexor tendon.

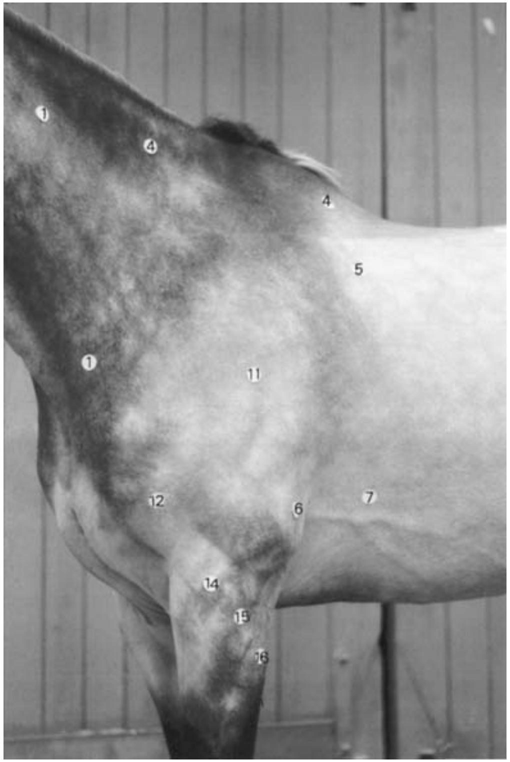


Fig. 5.17 (left) Motor points for muscle stimulation. 1/1a: Brachiocephalic muscle and tendon – stimulate after neck problems; 4: Trapezius – stimulate after shoulder problems; 5: Latissimus dorsi – stimulate after shoulder problems; 11: Deltoid – stimulate after shoulder problems; 12: Brachialis – stimulate after shoulder problems and radial palsy; 13: Pectoral muscle – stimulate after shoulder or leg problems; 14: Extensor carpi radialis – stimulate after radial palsy; 15: Extensor digitorum – stimulate after radial palsy; 16: Extensor carpi ulnaris – stimulate after radial palsy. (right) Motor points for muscle stimulation. 20: Superficial gluteal muscle – stimulate after any back or pelvic problem; 22: Semitendinosus – stimulate after problem in hip or hock, or tear in muscle; 23: Biceps femoris – stimulate after problems in hip or hock, or tear in muscle; 24: Gastrocnemius – stimulate after problems in hip or hock, or tear in muscle; 26/26a: Extensor digitorum longus – stimulate after problem in stifle joint; 28/28a: Extensor digitorum lateralis – stimulate after hip or hock problems.

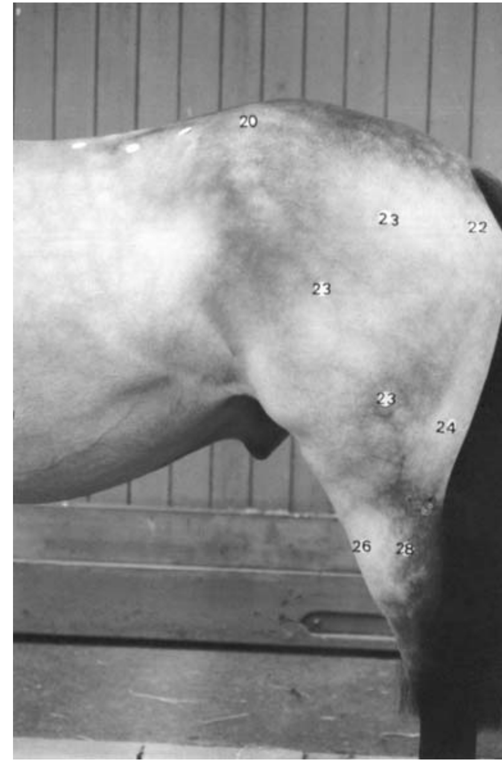
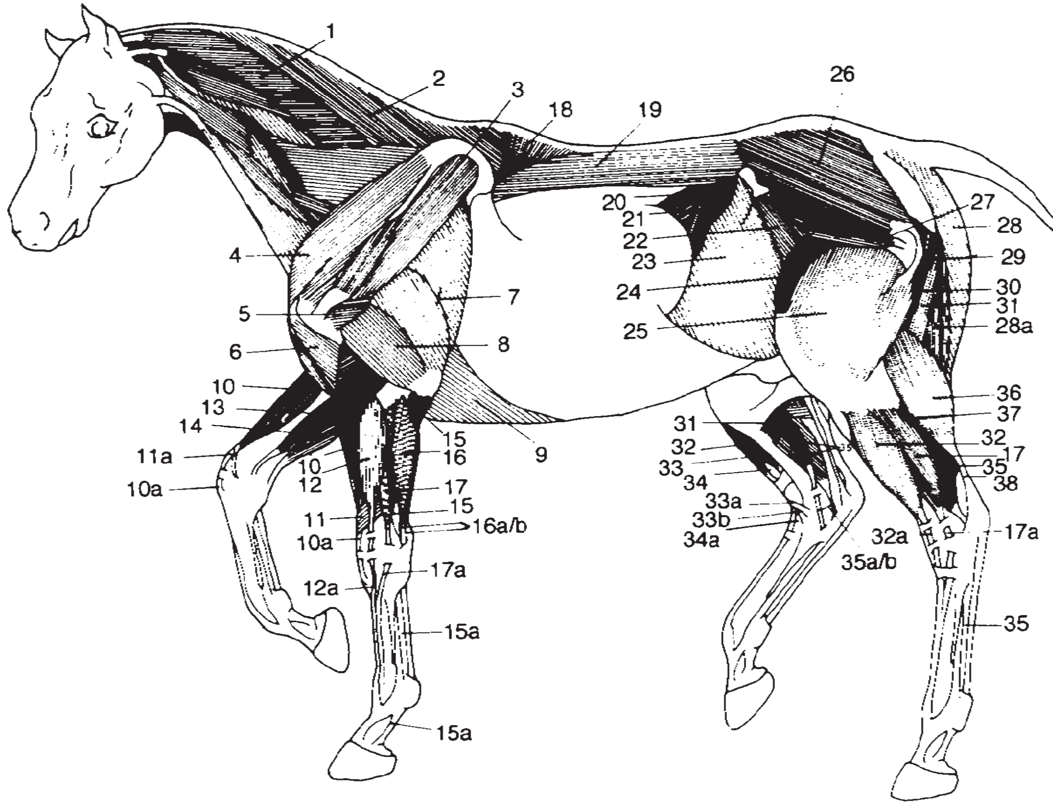


Fig. 5.18 Deep muscles: lateral view. Muscles sited under the superficial layer. For those that can be easily stimulated, see Figs 5.19 (left and right). 1: Part of semispinalis capitis; 2: Rhomboid; 3: Infraspinatus; 4: Supraspinatus; 5: Teres minor; 6: Biceps brachii; 7/8: Long and lateral head of triceps; 9: Posterior part of the deep pectoral; 10/10a: Extensor carpi radialis (see Fig. 5.16 Superficial muscles); 11/11a: Extensor carpi obliquus (see Fig. 5.16 Superficial muscles); 12/12a: Extensor digitorum communis (see Fig. 5.16 Superficial muscles); 13: Flexor carpi radialis; 14: Flexor carpi ulnaris; 15/15a: Flexor digitorum profundus (see Fig. 5.16 Superficial muscles); 16: Ulnaris lateralis; 17/17a: Extensor lateralis; 18: Thoracic part of semispinalis; 19: Longissimus; 20: Retractor costae; 21: External abdominal oblique; 22: Iliacus; 23: Internal abdominal oblique; 24: Rectus femoris; 25: Vastus lateralis; 26: Gluteus medius; 27: Deep gluteal muscle; 28/28a: Semitendinosus (see Fig. 5.16 Superficial muscles); 29: Quadratus femoris; 30: Adductor femoris; 31: Popliteus; 32/32a: Extensor digitorum longus and tendon; 33a/33b: Tibialis anterior and tendon; 34/34a: Peroneus tertius and tendon; 35a/35b: Flexor digitorum profundus; 36: Gastrocnemius (lateral head); 37: Soleus; 38: Achilles tendon.



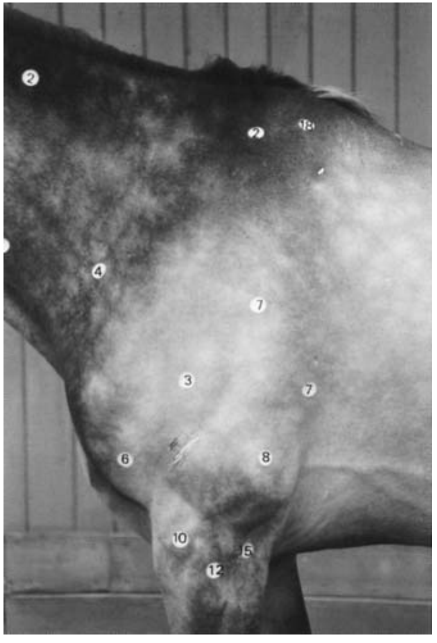
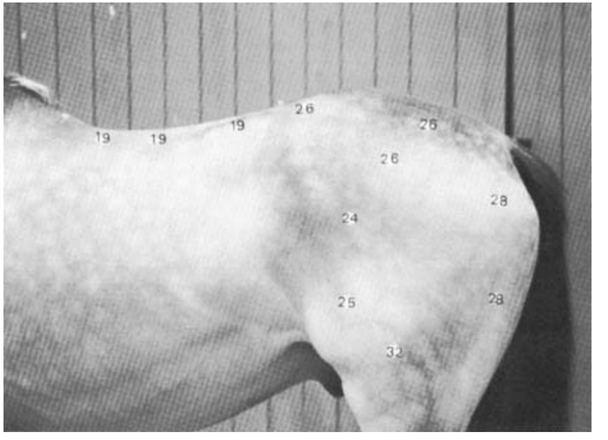


Fig. 5.19 (left) Motor points for muscle stimulation. 2: Rhomboid – stimulate after neck or wither problems; 3: Infraspinatus – stimulate after neck, shoulder and leg problems; 6: Biceps brachii – stimulate after elbow or leg problems; 7/8: Long and lateral head of triceps – stimulate after shoulder and leg problems and after radial palsy; 10: Extensor carpi radialis – stimulate after shoulder and leg problems; 12: Extensor digitorum communis – stimulate after shoulder and knee problems.
(Right) Motor points for muscle stimulation. 15: Flexor digitorum profundus – stimulate after leg problems; 18: Thoracic part of semispinalis – stimulate after wither problems; 19: Longissimus – stimulate after all back and pelvic problems; 24: Rectus femoris – stimulate after hip, hock or stifle problems; 25: Vastus lateralis – stimulate after hip, hock or stifle problems; 26: Gluteus medius – stimulate after all back, pelvic and hip problems; 28: Semitendinosus – stimulate after problems in hip or hock or tear in muscle; 32: Extensor digitorum longus and tendon – stimulate after leg problems.



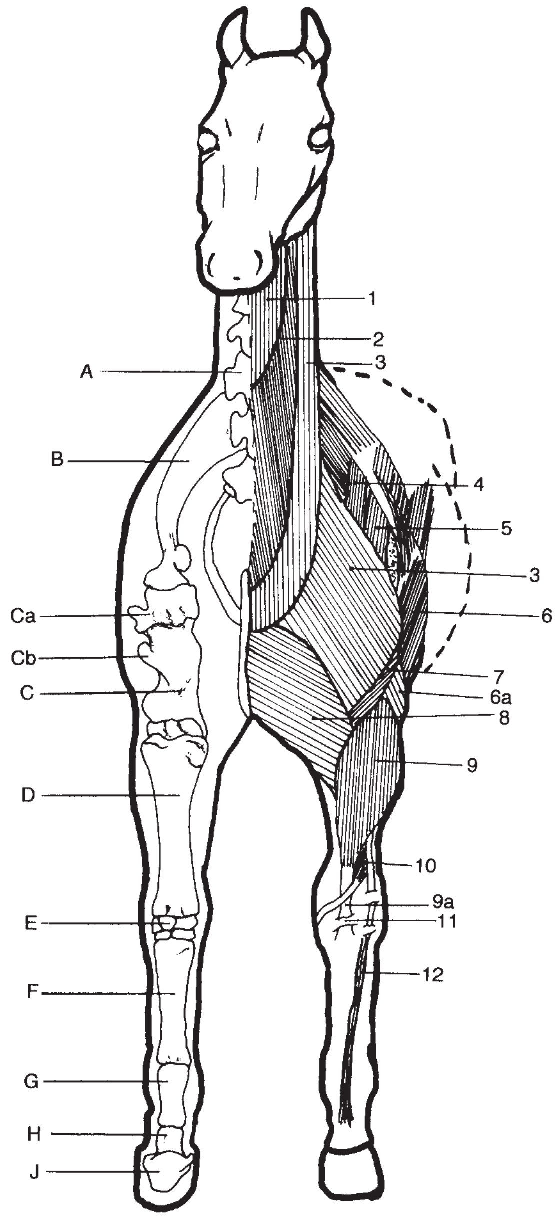


Fig. 5.20 Skeleton and muscles: anterior aspect. For stimulation points see Fig. 5.21. Muscles 1: Sternothryohyoid; 2: Sternocephalic; 3: Brachiocephalic; 4: Deep pectoral muscle; 5: Supraspinatus; 6: Long and lateral head of triceps; 7: Brachialis; 8: Superficial pectoral; 9: Extensor carpi radialis; 10: Extensor carpi obliquus; 11: Annular ligament; 12: Common digital extensor tendon. Skeletal landmarks: A: Cervical vertebrae (neck); B: Scapula (shoulder blade); C(a): Point of shoulder; C(b): Upper end of tuberosity of humerus; D: Radius; E: Carpal joint (knee); F: Cannon bone; G: Long pastern (1st phalanx); H: Short pastern (2nd phalanx); J: Pedal (3rd phalanx).

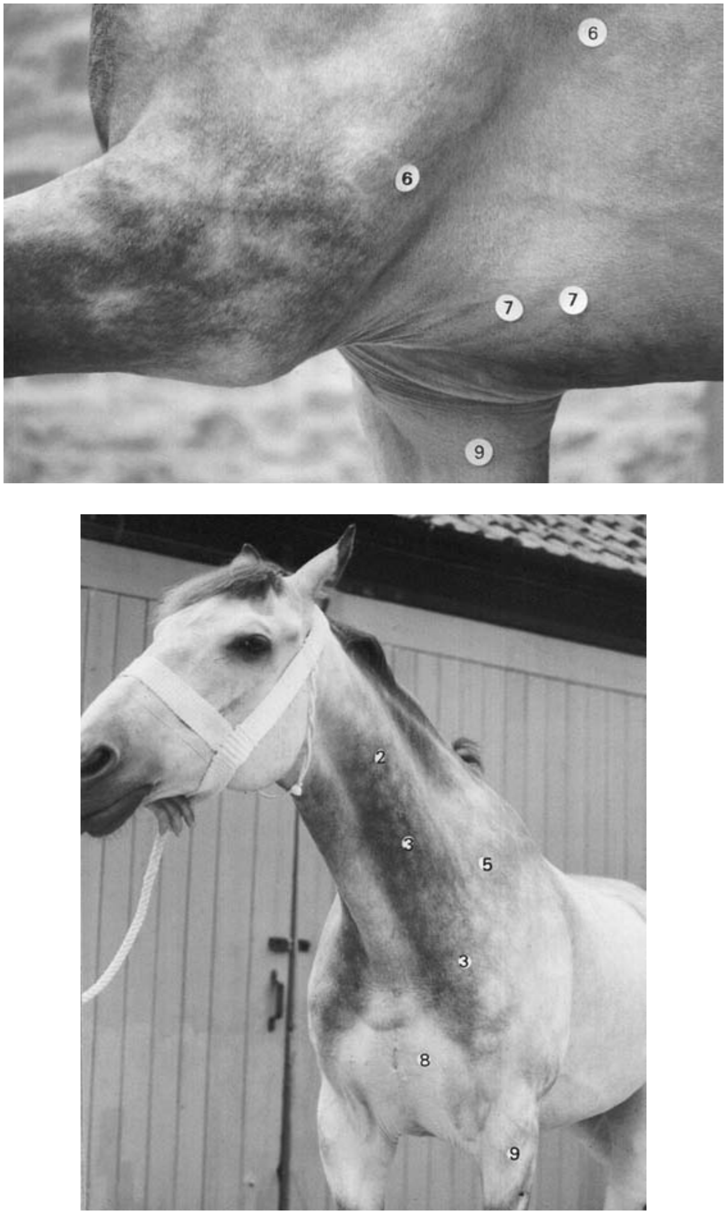


Fig. 5.21 (upper) Motor points for muscle stimulation. 6: Triceps – stimulate after shoulder, elbow or leg problems and after radial palsy; 7: Deep pectoral – stimulate after shoulder, elbow or leg problems; 9: Flexor carpi ulnaris – stimulate after shoulder, elbow or leg problems.
(Lower) Motor points for muscle stimulation. 2: Sternocephalic – stimulate after neck problems; 3: Brachiocephalic – stimulate after neck or shoulder problems; 5: Supraspinatus – stimulate after shoulder or elbow problems; 8: Superficial pectoral – stimulate after any shoulder problem; 9: Extensor carpi radialis – stimulate after shoulder problems or radial palsy.

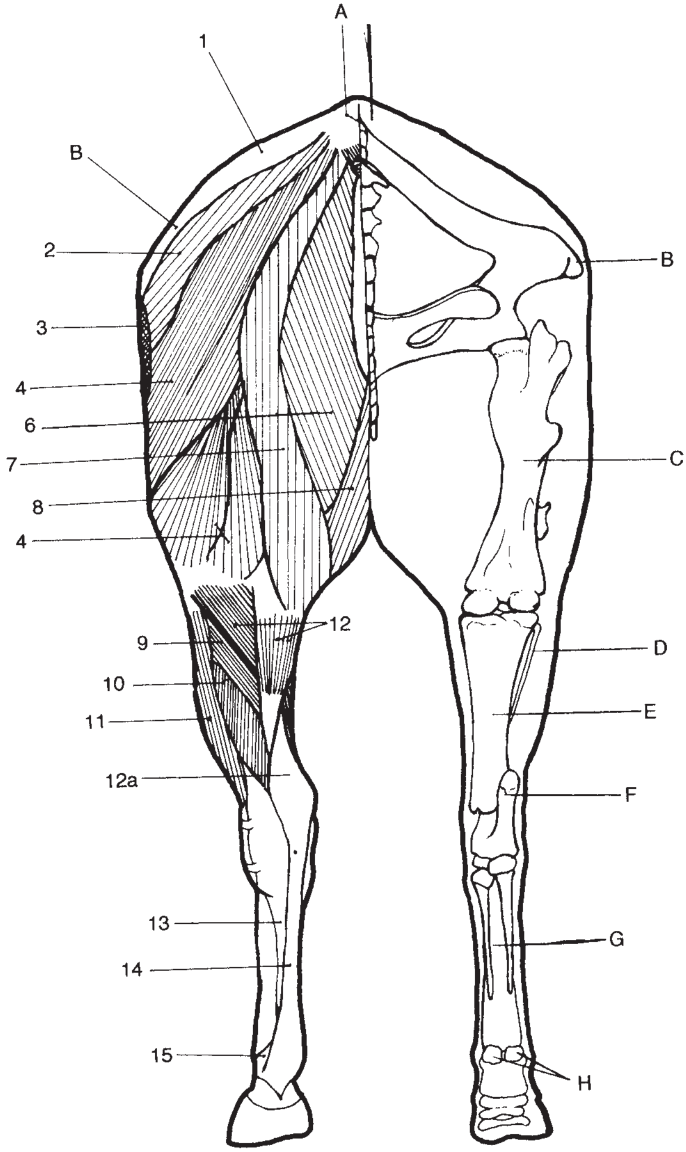


Fig. 5.22 Skeleton and muscles: posterior aspect. For stimulation points, see Fig. 5.23. Muscles: 1: Gluteal fascia; 2: Superficial gluteal muscle; 3: Tensor fascia latae; 4: Biceps femoris; 6: Semitendinosus; 7: Semimembranosus; 8: Gracilis; 9: Soleus; 10: Flexor digitorum profundus; 11: Extensor digitorum lateralis; 12: Gastrocnemius; 13: Part of the deep flexor tendon; 14: Superficial flexor tendon; 15: Lateral part of the suspensory ligament.
Skeletal landmarks: A: Tuber sacrale (jumper's bump); B: Tuber coxae (point of hip: incorrectly named – the hip joint is lower); C: Femur; D: Fibula; E: Tibia; F: Point of hock; G: Cannon bone; H: Sesamoids.

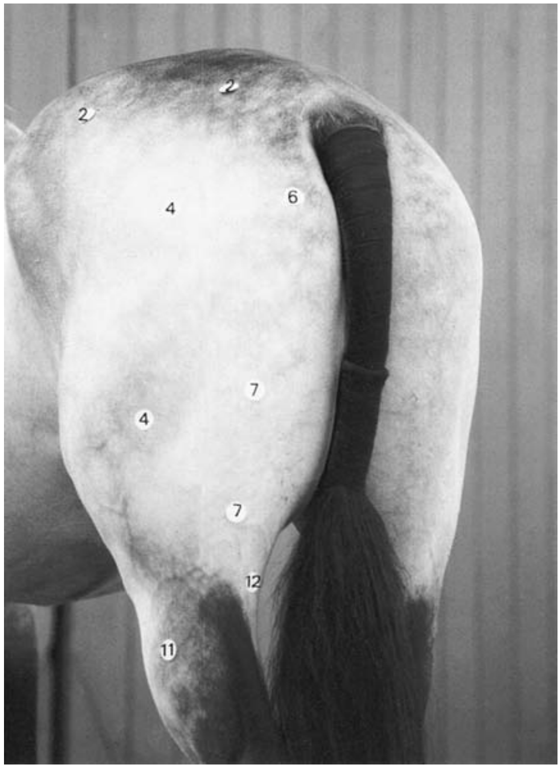


Fig. 5.23 Motor points for muscle stimulation. 2: Superficial gluteal muscle – stimulate after problems in the lumbar spine or pelvis; 4: Biceps femoris – stimulate after problems in hip or hock, or tear in muscle; 6: Semitendinosus – stimulate after problems in hip or hock, or tear in muscle; 7: Semimembranosus – stimulate after problems in hip or hock, or tear in muscle; 11: Extensor digitorum lateralis – stimulate after stifle problems; 12: Gastrocnemius – stimulate after problems in hip or hock.

Muscle stimulation using a Neurotech™ or trophic stimulator

Stimulation using the Neuro 4 ™ stimulator (Figs 5.24 & 5.25) allows for a wide range of effects when the pulse per second (pps) setting is adjusted as below.

Five to fifteen pps	promotes aerobic activity; increases circulatory supply; enhances oxygen supply; increases blood glycogen levels for fast twitch (FT) fibres.
Twenty pps	promotes activity in fibres using both aerobic and anaerobic pathways; affects stamina.

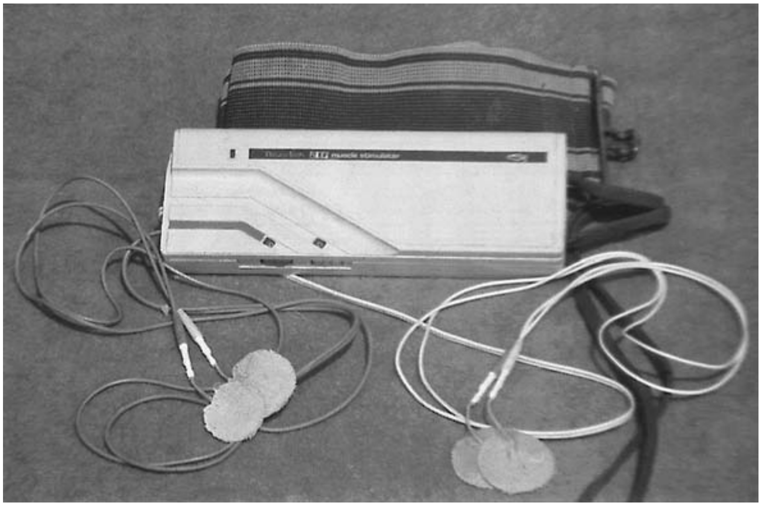


Fig. 5.24 Neurotech muscle stimulator.

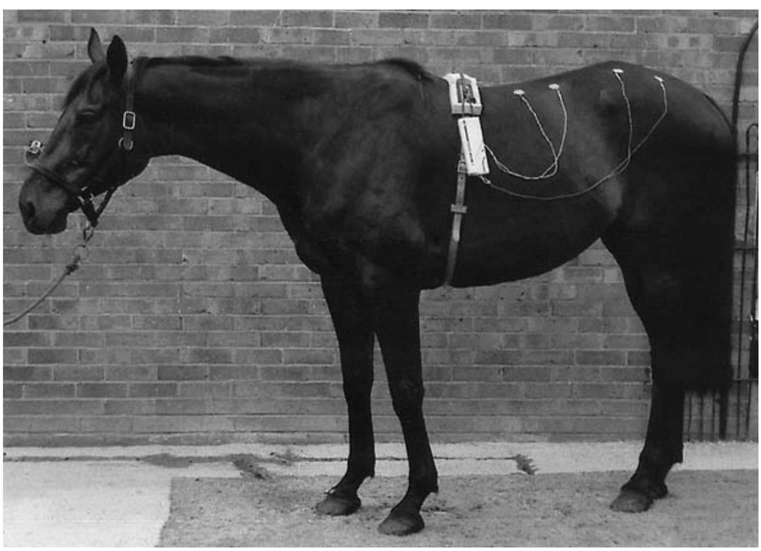


Fig. 5.25 Muscle stimulation to longissimus and gluteus medius.

Thirty to forty pps	enhances large motor units; creates glycogen demands; bypasses central inhibitory system.

Thus the stimulator allows the operator the ability to influence both aerobic and anaerobic activity, also to stimulate glycogen delivery.

Fig. 5.26 Neuro 4 stimulator. This stimulator achieves a wide range of physiological effects when the ppp is appropriately chosen.

The stimulator was designed in conjunction with Diana Farragher FCSP, OBE.

Stimulation should be given daily for a minimum time of thirty minutes. Treatment should start within 24–48 hours of injury.

Method

- Dampen the pad placement areas on the skin (one electrode should be on or near the motor point of the muscle and the second electrode is placed at the distal end of the muscle);
- dampen and gel the electrodes;
- test machine on yourself;
- turn to off or '0';
- place electrodes in position;
- turn on and gradually increase the intensity until a visible 'flick' is apparent.

When using the Neurotech™ muscle stimulator (Fig. 5.26):

- make certain the animal is not distressed;
- attach unit to a surcingle;
- leave animal with a hay net and wearing a bib;
- check at intervals;
- remove electrodes at end of treatment (30–60 minutes) and wash the gel off skin.

The muscle contractions should *not be violent*, the small 'flick' is the result of a phasic pattern and is adequate for both maintenance and the rebuilding of contractile properties.

Several of the stimulators are equipped with two sets of electrodes, each with its own intensity control. This allows both sides of the back to be stimulated simultaneously; as this occurs in natural activity much benefit is gained by mirroring normal contractural expectancy.

Transcutaneous electrical nerve stimulators (TENS)

TENS machines are used as pain suppressors. A pulsed signal is delivered via skin electrodes which blocks pain signals from an area of injury.

Pain is complex and the secondary effects (muscle spasm, reduced circulatory flow, loss of movement and oedema) all create crisis within the architecture of the involved tissue.

Reduction of pain can be of benefit but only if diagnosis has been made. Pain may, in some cases, be the only objective finding and to remove the pain before isolating the cause of injury is a mistake.

Delivery of the pulse per second (pps) can be varied, as can intensity. It is suggested that 60+ pps will suppress the transmission of pain signals. This is based on work in 1965 by Melzak & Wall. Recently their work has attracted some criticism. Reducing the number of pps achieves a signal which causes a muscle 'ripple'. This movement will in turn improve local circulatory flow, reduce local spasm and assist in the absorption of excess tissue exudate (oedema): these factors will reduce pain mechanically.

The machines are useful and are marketed in the veterinary field as the Doctor Pulse™.

Method

- Determine the source of pain;
- dampen electrode placement areas;
- test machine on yourself;
- gel and position electrodes;
- select pps and intensity required by diagnosed condition;
- treat for ten to thirty minutes;
- remove electrodes;
- wash off gel.

Uses

- Acute or chronic pain.

Contraindications

- Sepsis.

Manipulation

There are many who claim it is possible to manipulate the spine of the horse, and there are many who claim it is impossible.

Incorrect alignment of adjacent bone surfaces causes the 'computer' in the joint between those bones to record anatomical malalignment; the area is not balanced as it should be and reflex muscle spasm results. This prevents the surfaces returning to their anatomical normal. Even if the adjacent surfaces are only marginally out of alignment, the imbalance is enough to stretch the supporting ligaments and cause pain. The most reasonable explanation for the effects of manipulation are that, having palpated, examined and discovered the area of greatest tension in the back, the manipulator, working on the side opposite to that of greatest tensions, strikes the muscles with a severe glancing blow. Given with adequate severity, this will cause the muscles at the point of impact to contract sharply, and a reflex relaxation will occur simultaneously in their opposing group.

In case of a minor movement of one vertebral component part on another, the sudden relaxation of a muscle, previously in severe spasm, could be sufficient to allow anatomical re-alignment of the vertebral complex. Unless, however, the sets of muscles supporting the back are in balance and of equal strength, the problem, temporarily 'cured', will always recur.

Corrective muscle stimulation must be started immediately after manipulation, but if there is severe muscle wasting it is more sensible to build the weak muscle before attempting manipulation, lest the muscle incompetence be so great that there is no hope of retaining the correct joint alignment.

The choice of therapy requires appropriate selection following diagnosis. The length of time the injury has been present also requires consideration, acute injury is easy, you are working alongside the stages of healing; you can optimise appropriate cell activity and monitor progress or regression.

Chronic injury is much harder to deal with, particularly if irreversible changes have taken place. Increasing circulatory flow, in chronic situations, is often the best and most realistic approach.

Remember, the body is a pretty efficient self healer, so 'if in doubt do nowt'.

6 Rehabilitation

The term rehabilitation has recently been adopted to describe yards that take in ex-racing TBs and re-educate these animals in order to re-home them within the equine industry. From a therapy viewpoint, the term indicates the restoration of pre-injury function. In order to achieve this, appropriate electrotherapy, massage and graduated exercise are employed.

When designing a suitable programme of activity to re-educate movement it is important to realise that equine movement is largely governed by reflex responses.

Reflex action

A reflex is an automatic response which does not require conscious thought. All actions governed by reflex are very complex. One of the very first patterns established is that of a foal rising to its feet and balancing. This coincides with the sucking reflex combining smell and touch, the necessity to suck having triggered the effort to stand and move. Thus it can be appreciated that a 'chain' response occurs – the first reflex triggering the next in line, this continuing until the required result is obtained.

Reflex responses in the ridden or driven animal are established following a long period of learning as riders require their animals to perform tasks never contemplated in the unbroken, natural or wild state. Two facts rarely considered are as follows: first, the horse has the ability to change muscle recruitment in order to avoid giving itself pain, yet still comply with rider requirement; second, the incorrect, uneconomic movement patterns adopted to avoid discomfort, rapidly become imprinted in the movement centre of the brain, replacing the original and becoming the accepted normal. The chain reaction of neural messages required for movement is very complex, once changed, even if the discomfort which caused the change in the first place is no longer present, there is no automatic return to the original programme, the new chain is retained becoming the accepted normal.

Obviously, injury disturbs this 'chain', pain, swelling, muscle tension, the inability to move a body part, all contribute to a different set of signals from the area of damage, and confusion is followed by the establishment of a new reflex. The horse retains the evolutionary need to survive; survival requires movement at any cost. All athletes sustain minor trauma, the horse is no exception; unfortunately even minor incidents give rise to sub-clinical discomfort.

Subtle changes in muscle recruitment are very difficult to spot, the sensitive rider will usually feel 'something is wrong', but the horse is not clinically lame or in obvious discomfort, making life difficult for the vet. As discussed, rider observation can be invaluable, as can help from an observant therapist working with both rider and vet.

The late Dominique Giniaux DVM (1986) wrote in his book *Les chevaux m'ont dit* ('What the horses have told me') about the need to observe gait, link this to muscle contour and development, and read what the muscles are doing.

It is important to try to identify incorrect muscle recruitment and movement abnormalities always taking into account that during a movement it is not only muscle that is involved, included are the bones to which the muscle/muscles are anchored, their fascial anchorage, the ligaments supporting the joints involved, each joint and its components. Any one of a number of tissues may be causing the discomfort. Unfortunately, the secondary effects of incorrect movement are often more tiresome than the primary cause, not only are they uneconomic, and will cause stresses to other skeletal components, but also, because once adopted, as previously stated, the patterns remain programmed in the movement centre of the brain, and are then regarded as normal even after discomfort has been addressed or has subsided naturally. When involved in rehabilitation the fact that a new reflex has become established must be always be considered.

Following injury in the human it is possible through communication, by voice and/or example, to discuss and demonstrate the incorrect movement patterns which persist following recovery. For example, an accident resulting in a fracture of the lower limb changes the person's approach to mobility. A new pattern of moving is explored, adopted and rapidly becomes the accepted 'norm'. This pattern will persist after recovery and it takes approximately six weeks of therapy to get rid of the 'limp' (lameness) and re-establish the correct 'reflex pattern'. If relearning is disregarded, unacceptable, incorrect mechanical stress to previously uninjured tissue occurs, causing secondary injury. As discussion is not possible with the horse the problem is more complicated.

Rehabilitation is a specialist subject requiring knowledge, a great deal of patience, sympathy and the ability to gauge just when to 'ask for more'.

Active rehabilitation is given, when possible, in conjunction with machine therapy but will probably still be required when the machine phase is no longer applicable, for machines alone are unlikely to achieve the desired end result.

In equine rehabilitation available 'aids' are swimming pools, walkers, treadmills, wading, water treadmills, long reins, an arena and finally riding.

Rest versus activity is a very controversial subject. Laboratory work on injured bone, muscle and tendon tissue in the rat, has shown that early, controlled activity of the injured area stimulates and assists repair; the formation of adhesions is reduced to a minimum, joint mobility is retained and full function is restored at an earlier date than in similarly injured, control subjects, for whom immobilisation and rest were employed.

Most horses are still turned away following injury, possibly after a period of box rest; even in a box they will have changed their weight bearing and movements to avoid discomfort. Remember, the horse will retain the incorrect biomechanical pattern, and not move correctly when turned away 'to rest'. Effective rehabilitation before the horse is turned away will ensure that, when brought up to start back in work, the horse will progress, having been re-taught to move correctly before resting.

N.B. Tendon findings in the rat should not be automatically accepted as occurring in the horse. Recent research into equine tendon injury and repair by the Global Alliance identifies the lack of a particular protein instrumental in tendon formation. This protein, apparently necessary for and present during the original tendon modelling is absent in mature tissue.

Injury of an acute and sudden onset is easily recognised. It is the small problems, which often pass undetected for long periods which result in an imbalance of movement, a reluctance to lead on a certain leg, stiffness to one side, shortening of stride length, and so on. Dr Erickson, of Kansas State University, using a heart rate computer found that musculoskeletal injuries were detected, and therefore present, between 8 and 30 days prior to the appearance of obvious clinical symptoms.

Muscle re-education

Care must be taken to select the correct 'aid' pertinent both to the injury, the degree of recovery, and the task to which the horse may return. A number of questions must be considered:

Fig. 6.1 Passive stretching of the left forelimb.

(1) What task must the injured muscle accomplish?
(2) Will that task require isometric work?
(3) Will the task require concentric work?
(4) Will the task require eccentric work?
(5) Is the muscle a prime mover?
(6) Is the muscle a fixator?
(7) Will the movement require work in the inner, mid or outer range, or all three?

Great care must be exercised to avoid 'overbuilding' a single muscle or muscle group. All muscle work is a balanced, combined effort; as one set of muscles contracts so the opposing group must work in a manner that ensures a smooth, controlled action. Neighbouring joints may need to be fixed, requiring even more interaction between associated groups.

It is essential to study the normal biomechanics of equine movement before attempting rehabilitation; always remembering imbalance of muscles will cause either re-injury or a new injury. Just as with human rehabilitation, there should be a 'warm up' before serious work. This can be achieved by massage, walking round the yard, working on the walker – muscles need to be supple before re-education, if they are 'stiff' the fibres may tear. Passive movements, following pre-exercise massage, will also help to improve flexibility (Fig. 6.1).

Passive movements

A passive movement is performed by the handler and requires no active participation by the subject. The limb is held in a manner which ensures comfortable support and a joint or joints are moved by the action of the handler through their normal range. This stretches the muscles whose action would actively move the joint. In some situations muscle fibres lose elasticity post injury and gentle passive stretching improves their contractile properties.

Once the site, type of injury and structures involved have been determined, a plan of rehabilitation can be formulated and the appropriate 'aids' selected.

It is wise to also:

- have the horse's mouth checked for sharp teeth/wolf teeth;
- make certain the foot-to-pastern angle is correct for the horse.

Rehabilitation aids

The walker

Mechanical walkers can be used to maintain fitness in the injured animal. Work in Holland has demonstrated that a horse begins to lose 'condition' after ten days of box rest, but if walked for an hour a day the pre-injury fitness level, other than cardiovascular, is maintained and in some cases improved. Undoubtedly, the work is on a circle but considered from a muscle recruitment angle it mirrors the type of exercise the wild or pastured horse achieves as it moves while grazing. Pastured horses, provided they do not become gross, are often in considerably better shape than their stabled compatriots.

The original 'hot' walkers supported a number of arms attached centrally to a hub with an electric motor pivoting the apparatus at varying speeds with the horses attached, one to each arm, by a lead chain.

Some models were designed with the arm above the animal's head, often creating extraordinary torque positions of the head and neck. Others moved a large rubber wheel with the animal attached to the framework at shoulder level. These avoided the head–neck stresses, but excitable animals tended to get a leg over the frame if they reared or bucked.

The most satisfactory walkers are the cage type; paddles divide the walkway and create separate pens so the animals walk loose.

The walker improves general muscle tone and can be used in conjunction with any or all other 'aids'. Walking has also been shown to improve nutritional uptake, the horse's digestive processes are designed for optimum uptake in association with movement (Figs 6.2 and 6.3).

Fig. 6.2 Cage-type walker.

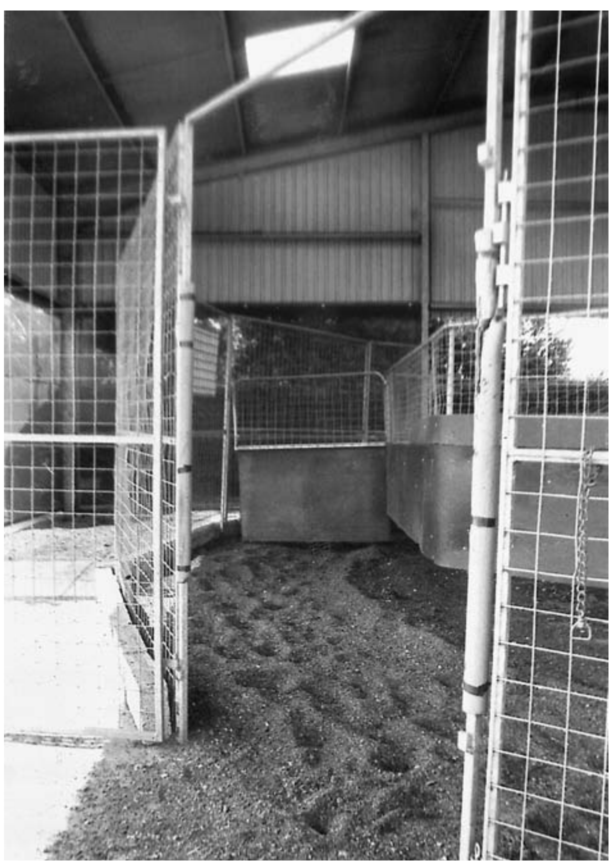


Fig. 6.3 The Claydon horse walker, looking into one of the four pens.

Fig. 6.4 A simple treadmill invaluable for gait re-education and improving the musculature over the loins.

The treadmill

The treadmill provides the ability to exercise a horse on a non-slip surface with minimum concussion, at speeds that vary from the walk to full gallop. Some designs allow an adjustment of angle of the track from flat to a reasonably steep incline (Fig. 6.4).

It has been suggested that too severe an incline may cause hock problems and that work on a flat surface is of most benefit. Due to the movement of the belt the horse must use the loin muscles to help bring the hind leg under the body. The ability to exercise these muscles, in a horse weak over the loins, by allowing them to work unhindered by either saddle or rider weight, is of the greatest value.

The majority of horses appear to take to the treadmill without a problem, but it is necessary to introduce the exercise very cautiously. The main disadvantage of most types is that the horse has to back off the apparatus at the end of the session. This is sometimes difficult to achieve with a young animal which has never learned to back to command. Make certain you can persuade the horse to go backwards before loading him on to the apparatus.

Besides exercising the back muscles, a second important use of a treadmill in rehabilitation is to re-educate gait. The horse cannot move out of cadence as the moving belt demands even stride lengths from each of the four limbs. Putting in a short, single limb stride adopted during an injury phase throws the horse off balance due to the fact it is standing on a moving 'floor'. It has never been claimed that work on the treadmill can replace active exercise because of the backward movement of the belt, and there is some loss of recruitment of the muscles of thrust, but the horse is forced to learn to 'balance' and uses stabilisation muscle groups.

As with all aids, appreciation of the muscle groups predominately being used must be considered before incorporating a treadmill.

The cardiovascular exertion achieved during work influences both respiratory and heart function, but recent research from the USA suggests that as the belt takes the limb backwards artificially the animal is working at half capacity.

Hydrotherapy

As with all adjuncts to training each device has a specific use, the effects, benefits and disadvantages of each need to be considered and the one which is selected should be chosen only if appropriate to requirement.

In order to improve muscle efficiency, work effort needs to be increased and the even resistance supplied by water immersion is an ideal method. In the past, following early conditioning, an increase in the demands of ridden work was the norm, due to staff shortages and increased road hazard this is often no longer possible and the last decade has seen the emergence of water-based devices designed for the equine industry.

For maximum benefit the 'aids' should, in so far as is possible, mirror the complex, over ground limb activity used by the horse.

The swimming pool, hydro spa, water treadmill, and more recently, a water walker, all make use of water either as a training adjunct or an aid to recovery. Prior to the invention/marketing of the above devices, rivers, lakes and the sea were incorporated by some into their training programmes. Unfortunately, little or no scientific research concerning these aids, coupled to double-blind trials, has evaluated their usefulness, field observation to date has been the only guide, but as with all training accessories, consideration of the end result should be the first priority.

Evolution adapted the musculature of the horse in a manner designed to achieve efficient, economic activity, by making use of a highly efficient elastic stretch and recoil. This property is present in all equine soft tissues, particularly in the distal limb tendons. Power is supplied by the massive hindquarter muscles which are designed to create a force enabling the entire body mass to be moved as one over the planted, balancing front leg.

Unfortunately, this natural endowment of efficient energy conservation can be compromised if muscles are forced to work in a manner which radically differs from normal.

Michael Dickinson famously said, 'When there are swimming races for horses I will teach my horses to swim.'

Equine pools

The shape of equine pools vary, some are round, some straight with a ramp for entry and exit at each end; some are oval but with a straight that can be used either as a straight, or incorporated into the oval (Figs 6.5 and 6.8).

Ray Hutchinson MRCVS who was one of the first to build a pool in the UK in the 1980s, and, as a vet, to observe and monitor respiration and heart rate, decided after in-depth international research, that a straight pool was preferable for rehabilitation cases, and it was his preferred method for horses in training. The short time of extreme exertion required for horses to swim through his straight pool at Epsom often raised the heart rate to over 200 bpm, after only one length. Hutchinson felt from the cardiorespiratory stress he observed that continuous laps in a circular pool might be harmful and suggested a lack of oxygen might even cause horses to bleed.

With straight pools, if the horse becomes distressed this will be apparent as it leaves the pool. Should this occur, the horse can be walked before entering the water again along the side of the pool until the heart rate has reduced to an acceptable level (Fig. 6.6).

An oval pool, incorporating a straight, is useful because the straight can be used for teaching new or apprehensive swimmers and also for assessing the swimming potential of individuals, because in the water limb activity varies from horse to horse.

Horses which adopt a '1, 2, 3, 4' limb pattern similar to the walk, keeping their back just out of the water with head and neck comfortably

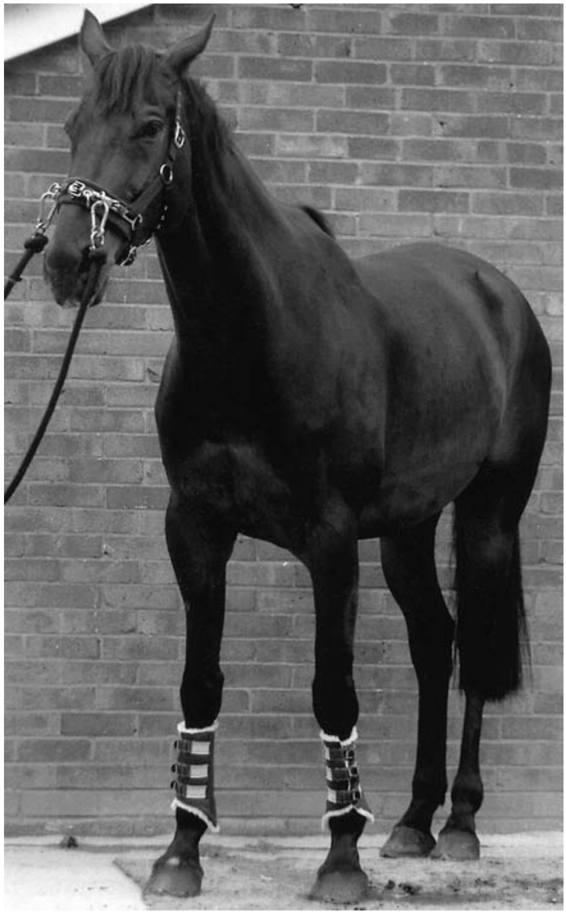


Fig. 6.5 Ideal swimming gear: a cavesson, yacht ropes and shackles, together with Clarendon boots.

positioned, rarely hurt themselves. Unfortunately, not all horses follow this pattern, some climb, using front legs only, others just kick from behind, trailing their front legs, or screw the hindquarters to one side and then kick both hinds simultaneously to one side (Fig. 6.7).

Professor Denoix (France) and Dr Myhre DVM (USA) consider that vertebral over extension, stress to the cervico-thoracic and lumbo-sacral junctions can occur, particularly in bad or poor swimmers. It is also postulated that possible damage to the back may result as secondary to the loss of proprioceptive input since the horse is in a weightless situation.

Observation shows that experienced swimmers take in a deep breath as they enter the water. It is possible that two lungs full of air enhance buoyancy, acting as 'water wings', then, as they begin to swim most

Fig. 6.6 A straight pool.

Fig. 6.7 A horse swimming correctly adopting a '1, 2, 3, 4' limb pattern.

Fig. 6.8 Neoprene bandages, ideal for swimming or water walking.

horses close the outer nostril. Water in the lungs is fatal; the horse is unable to eject inhaled water by coughing. Horses cannot exhale efficiently while swimming, but, as their oxygen requirement rises, they open the outer nostril and try to inhale. A tired horse usually begins to drop its back and becomes noisy as it gasps for air. Experienced swimming personnel should never allow a horse to reach this stage of exhaustion.

The resistance supplied by the water is even, therefore the swimmer adopting a four-limb sequence will correctly use, and therefore exercise, the muscle masses of the shoulders and hindquarters, and to a degree those of the back.

Pools obviously have their place in re-education and rehabilitation, but it should be accepted that swimming does not activate all over ground muscles, the prime benefit of swimming must be considered to be as a non weight-bearing, cardiovascular activity.

In the human model the movement of joints in a non weight-bearing situation is considered to be of value. In the equine, the knee and hock, which are subjected to considerable stress in all competition animals, may well benefit.

Swimming should not mistakenly be considered to involve or strengthen the tendons. Movement of the distal limbs is entirely reliant on tendon stretch and recoil, effected only by weight bearing and weight transference.

Nothing can replicate over ground work, particularly bearing in mind Wolff's law which holds 'that adaptive changes in the structure and biomechanical properties of bone occur in accordance with functional demands' (Raney and Brashear 1971). Excessive swimming is not beneficial in cases where bone development might be compromised. Muscle building should also be considered. In order to conserve energy the horse depends upon elastic stretch and recoil in all muscle groups.

Care must be taken not to overuse swimming lest, as the muscles used in the pool strengthen, they become out of balance with the remainder of the body musculature. It can be detrimental to overall performance if power in some muscle groups incorrectly overtakes that of other groups whose role is to act as essential, skeletal stabilisers.

Excessive chilling, although this is a rare and not a proven cause, has been suggested as a possible reason for the few reported cases of post-swimming colic. In an ideal situation, in cold weather, a horse should be put on a walker or stood under heat lamps to be dried off after swimming.

Swimming should not replace normal exercise; rather it should be used as an adjunct to training. In circular pools, just as when using a walker, it is advisable to swim both to the left and to the right.

Swimming in the sea or in thermal pools such as that in Il Pallazzetto (Italy) requires much less effort to stay afloat due to the density of the water and horses have been known to swim long distances in the sea, if not as a man-controlled activity, i.e. between islands in search of better grazing, without showing exhaustion. The mineral-dense water of the thermal spas of Europe is warm so there is no danger of muscle damage due to chilling even in mid winter.

Advantages/usage

- Excellent cardiovascular exercise;
- joint movement in a non weight-bearing situation;
- useful in cases when over ground work is not possible, e.g. foot bruising;
- muscle work/improvement is dependant on the way the horse chooses to swim.

N.B. It is inadvisable to swim known bleeders.

Thalassotherapy

Remembering the interlinkage of all the body systems and that recovery is dependant on total health, the French have recently begun to explore the benefits, following successes in the human model, of thalassotherapy.

The horse stands in a cabinet similar to that used for spa treatment and warm, natural seawater, is sprayed over the back. Skin is porous, warmth dilates, and it is considered that the minerals naturally present in seawater (calcium, magnesium, zinc, iron, etc.) can be absorbed into the body through the porous skin, this absorption enhanced by the massage effect from the sprays.

Advantages/usage

- Promotion of general health;
- increased circulatory flow.

The sea and sea walkers

Osmosis (dictionary definition) is the passage of a solvent from a less concentrated solution to a more concentrated solution through a semi-permeable membrane.

To improve muscular competence, as already stated, it is necessary to increase the workload, that is, improvise, in order to create resistance and so increase muscle effort, whenever possible using normal limb biomechanics.

Walking in water, for example a stream, provides resistance, walking in the sea is harder work due to the density of the water. There are other benefits; sea wading is beneficial in cases of recovering tendon and varied distal limb problems with associated, unwanted filling. Not only are the tendons subjected to normal stretch and recoil, but also osmosis occurs. The pump action of the frog, vital for the return of fluids from distal limbs, is induced by pressure contact supplied by the sand.

A horse with distal limb filling wades in the sea and ‘it’s a miracle’, the animal emerges after twenty to thirty minutes with clean limbs. The apparent recovery will not last if the underlying reason/inflammation is still present, but even temporary reduction of unwanted fluid is of benefit.

The depth of the water needs consideration, fetlock deep is usually adequate for muscle build and does not change limb action. Work in deeper water, mid cannon for example, does change the action. Imagine yourself running in the sea calf deep, do you run normally? Curiously, observation of horses wading shoulder deep suggests they utilise normal limb activity, albeit with a shortened stride.

For those who are near the sea other benefits are there for the asking; sand stimulates the proprioceptors in the soles of the foot, improving balance perception and co-ordination, controlled work in soft sand, in conjunction with sea wading produced Pharlap and Red Rum. Flagship Uberalles, a very lazy horse, came back to form after shoulder deep sea wading was included in his general exercise programme, the resistance of the salt water forcing him to do some work.

The sea walker

The sea walker brings the benefits of the sea to the yard. Rather than walk on rubber or mats, as on the normal horse walker, the horses walk in a trough filled with a filtered, chilled, saline solution (Fig. 6.9 (a) & (b)).

Depth and speed can be adjusted in order to create varied recruitment of muscle. For example, fetlock deep does not radically change normal limb action, but a depth of 50 cm does, the limb movement adopted at this depth increasing activation of back and abdominal musculature. Thus, if the point of the exercise is to strengthen the back, then increase water depth.

Advantages/results

- Osmosis, removing any excess fluid from the distal limb;
- improved circulatory flow, resulting from the cold stimulating the thermal regulating mechanism;
- resistance, like sea wading, increases muscle loading;
- the frog pump is activated, as over ground, with improved venous return;
- the tendons are subjected to their normal stretch and recoil.

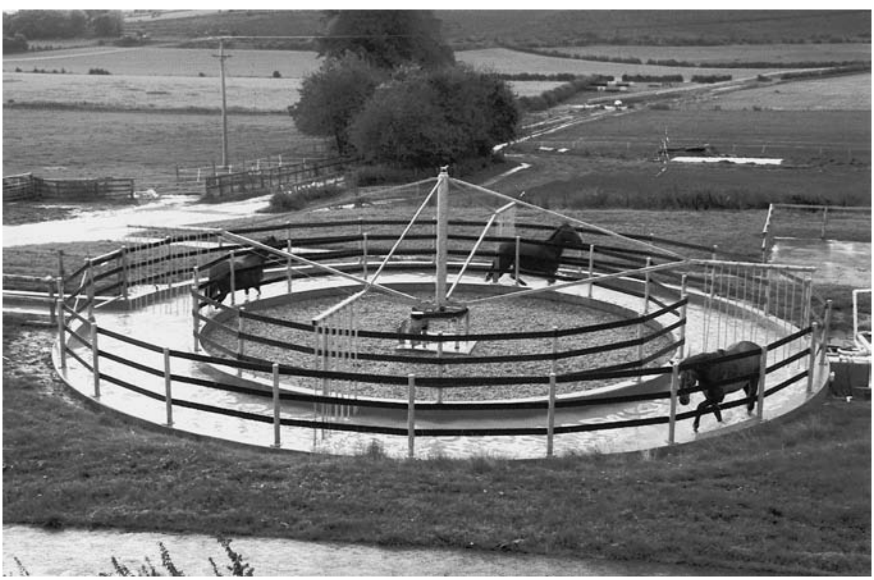
A further advantage of saline emersion is the enhanced healing of superficial wounds.

Water spas

The principle of osmosis is adopted in the saline water spas designed by Prof. Evan Hunt (Sydney). In these, horses stand in a strong saline solution with a water temperature of between 2–4 °C. The water is agitated, providing compression, osmosis occurs and filling reduces.

The maintenance of an ambient temperature in all body tissues is essential for survival. Thermal-regulating receptors, present in all tissues, monitor local temperature. Cold conditions first result in a reduction of circulating blood within the affected area, particularly in

(a)



(b)

Fig. 6.9 The sea walker, bringing the benefits of the ocean to the yard.

the extremities as the body attempts to retain heat. However as over a period of time an area becomes unacceptably cold, the sensors ensure a 'rush' of arterial blood to restore the required temperature level (the 'hunting rush').

In the coldwater spas it is physiological principles which reduce filling and increase circulation, since the horse is not moving.

The suggestion that underwater massage improves circulation requires investigation, as the circulatory return from the foot and lower leg in the horse is dependant upon the pump action of the frog.

A note of caution, it should be remembered that salt is an important electrolyte, removal of fluid from the body will result in an electrolytic imbalance. In order to lose weight, when still race riding, Charlie Brooks employed the principle of osmosis by lying in a saline bath, other jockeys use a sauna. The physical/mental prowess of all dehydrated species is below par until electrolytic balance has been restored.

Advantages/usage

- Improved circulatory flow (hunting rush);
- osmosis;
- filled legs/joints;
- tendon breakdown (reduction of fluid, osmosis);
- sore shins;
- superficial wounds;
- lymphangitis.

Water wellies

The principle behind water 'wellies' is identical to that provided by the coldwater saline spas. The horse's front legs are immersed in giant 'wellies' filled with a cold saline solution and a small compressor agitates the water. Other than the fact the wellies are designed for the front legs, the advantage of portable apparatus, only requiring an electrical output sufficient to drive a small compressor, cannot be ignored. Consideration must also be given to the fact that with less of the body mass submerged the danger of possible dehydration is considerably reduced.

Advantages/usage

- Effects, as for the spa, depend on the temperature of the water, and solution incorporated, i.e. salt;
- portable, so of use at competition.

Tendon recovery?

Scans taken of tendons following use of the osmotic principle appear to show a reduced diameter in a core lesion, with, in some cases, the echo lucent area no longer apparent. This does **not** necessarily mean that the tendon has rebuilt/repaired rapidly. Fluid trapped within the area of damage, also between adjacent fibres, has migrated from the tissues, reducing the diameter of the echo lucent area and allowing local undamaged fibres to recover normal alignment.

The author is not aware of any research which has investigated tendon damage in order to assess, should normal fibre alignment be restored and the painful inflammatory process which naturally follows breakdown be removed, whether the remaining, undamaged fibres are able to bear loads adequately allowing an early resumption of training.

Instances of 'miracle cures' are seemingly impossible from a physiological aspect and require further in-depth, scientific evaluation. This is particularly pertinent in light of recent findings on tendon healing following collaborative research undertaken by the Global Research Alliance Group.

The water treadmill

Treadmills were originally designed for respiratory research, water resistance was not incorporated; a perceived ability to increase the workload, resulted in a treadmill submerged in water. As already stated, the horse on a treadmill does not recruit its musculature in an exact over ground manner because the moving belt to a degree repositions the weight bearing limb/limbs. The front limb is taken by the moving belt back under the body with little muscular effort other than the need to balance, and the hind limb, the limb of power and thrust, is carried behind the horse immediately the foot has been placed under the body mass, prior to, when compared to an over ground situation, straightening in order to catapult the body mass forward. The tank is usually filled to mid chest, so in order to move individual limbs each limb is required to be lifted due to the resistance of the water rather than being swung as in normal conditions.

To achieve this in the forelimb, the horse recruits a muscle, the trapezius, which is sited at the upper border of the shoulder blade (scapula) and normally acts in a pivotal rather than lifting manner. The different usage eventually makes the horse appear thick through the withers due to muscle over build; privately measured on video, this has demonstrated an apparent reduction in stride length.

The hind limb also requires to be lifted, to come forward under the body, since the horse is unable to swing it easily through the water. Muscle recruitment occurs primarily in the loins, the horse reversing normal function of a part of the main muscle of the back, the longissimus; it follows that this activity improves the musculature of the loins. It is difficult to build the muscles of the back when the horse is being ridden, for in order to carry rider weight the back muscles need to achieve considerable tension, functioning in a holding or static, rather than an active manner, the static hold is needed to resist a weight-induced downward curve. Static work does not build muscle, so for a horse with a weak back, active recruitment of the back musculature in the water treadmill is very beneficial.

Water depth also needs consideration. When in deep water the horse adopts a method of moving which requires it to lift the hindquarter of the advancing hind limb, then use the hip flexors, not normally required as a strong muscle group, to bring the leg forward under the body. Over ground, this leg under positioning occurs just before the hindquarter musculature creates the tremendous backward thrust, delivered as the limb straightens to push the body mass over the planted forelimb. On the treadmill there is no need for this thrust, the leg being taken backwards by the moving belt. Care must be taken to avoid only building the muscles employed to bring the leg under the body mass – it is the muscles of thrust that are of the greatest importance.

The water treadmill, like the swimming pool can also be considered as a cardiorespiratory activity, with the advantage that in the water treadmill a horse can inhale and exhale relatively normally.

Advantages/usage

- Demanding, active exercise;
- cardiovascular activity;
- creates resistance to certain muscle groups but does not mirror over ground muscle demand due to belt movement;
- useful when back muscles are weak.

With the device and programme carefully chosen, the use of water to increase resistance can be of great benefit within a balanced training regime, however, the words ‘accelerate recovery’, the claims of so many devices, need to be considered rationally, and in view of the indisputable fact that the body follows a predetermined programme of recovery, should possibly be replaced by ‘enhancement of recovery’ or ‘optimising the body’s natural recovery abilities’.

When using any ‘aid’ the handlers should watch carefully for signs of fatigue, as stumbling in water on a moving floor requires a muscular effort to rebalance far in excess of that required when wading in a stream or in the sea.

The partial weight bearing that is achieved by varying the water depth, allows an animal with a joint or tendon injury to exercise safely.

The principle of human hydrotherapy is based on the assumption that to improve muscle tone the resistance of the water ensures equal impediment to all muscle groups as joints are moved through their available range, thus an even ‘push–pull’ occurs. Regrettably, as stated, this does not occur on the treadmill or in the water treadmill as the belt is artificially moving the limbs backwards.

Long reining

The natural progression, from one or a combination of the previously described aids, is long reining. The use of a single rein or lunge does not allow the handler sufficient control of the hind legs of the animal.

Working horses from the ground using two reins was included in the training programmes of all the various European schools of equitation, and the methods of the Neapolitan School in the sixteenth century and those of Antoine de Pluvinel in the seventeenth century form the basis of today's methods.

The arrangement of the reins to roller or driving pad varies, and four are normally described: Danish, English, French and Viennese.

The English is probably the most appropriate for general rehabilitation but the choice obviously rests with the handler and is to a certain extent determined by the job to which the horse will eventually return.

Basic exercises

In order to move and to carry a rider, the frame, or axial skeleton, must be stable for it is to the axial skeleton that the limbs attach.

The deep muscles which stabilise the frame are influenced by varied over ground activities, just as all pupils of dance train or prepare their muscles using a series of exercises derived from the foundation movements of the schools of classical ballet, so horses should be prepared or, following injury, repaired using the very basic exercises of the equine classical school.

Today, the training which in the past was described as Academic Equitation tends to be lumped as 'flat work'. The term covers a multitude of sins, horses often being lunged in endless circles to prepare for ridden work, then, before they have ever been given the correct basic exercises, to prepare their body musculature in order to enable them to manage, for example, a perfectly executed circle, they are asked the impossible, to carry a rider and perform a perfect circle.

There are continual rider complaints, 'he drops his shoulder on the X rein', 'falls in on the corner', 'lacks suppleness', 'fixes the neck'; hardly surprising if the muscles have not been prepared to withstand the difficulty of balancing three quarters of a tonne often in postures totally unnatural to the horse. Have you ever seen a horse cantering a 10 m circle in a field, for fun, or out of some perverse inclination? *A perfect circle is one of the most difficult exercises for the horse to perform in perfect balance*.

The inbuilt response of the horse (survival reflex) is to ensure it remains upright, with the animal doing everything to avoid falling. Countless books describe school activities, illustrations depict horses performing these activities and the illustrations all have captions. For example, a diagram shows the path to be taken by the horse to perform a shallow loop down the long side of the school, the caption reads, 'Shallow loops straighten the canter, in canter many horses fall out through the shoulder while their hindquarters swing inward'. Why does this happen?

The caption should read: **Horses that fall out through the shoulder and inward with their hindquarter are trying to retain their balance. Their preparation, to enable them to execute the required movement has been inadequate. Their musculature is unable to allow the horse to retain its balance and carry the rider other than by adopting an incorrect body position**. None of the books explain clearly, if at all, that stability of frame and limb leverage is dependant upon muscle capability; that each school activity recruits and prepares different muscle groups in order to achieve a stable frame, and/or varies the interaction of muscles to achieve balance. The author has yet to find a clear explanation suggesting that when the horse feels stable and in balance it will relax and suppleness will follow. Sadly none of the training manuals name the muscles utilised in the varied movements or suggest the most suitable exercises to prepare the horse for a specific task. It is up to the therapist to choose an appropriate regime.

Of course the exercises will do what the captions say; this is because each exercise is loading/building muscle power/strength in the groups doing the most work during the activity.

Example, a picture of a horse working over a fan, caption, 'Use this exercise to stop the horse falling in or escaping through the shoulders'. Why should this exercise achieve the described result? The exercise is making the active muscles of the inside limb work in their middle range, the strengthening range, the fan also demands stability of the inside limb, it must weight bear fractionally longer while the outside limbs make longer strides. The requirement for stability necessitates extra work for the ab- and adductor groups of the inside limb, thereby loading these groups, a method of increasing strength. The inside hind and inside shoulder are improving their muscle capability. If you have a horse with a weakness of the near fore (front L) create a fan and work on the left rein.

It is only by deciding which muscles require attention and then choosing the appropriate exercises that you will succeed.

Work for short periods, that is, use the fan or other gymnastic exercise four to five times, then let the horse go large and relax before asking for the activity again. Never over demand; try performing press ups yourself for five minutes without stopping! In some cases the application of a weighted shoe is required, or the use of a weight boot worn when on the walker. (Figs 6.10 and 6.11.)

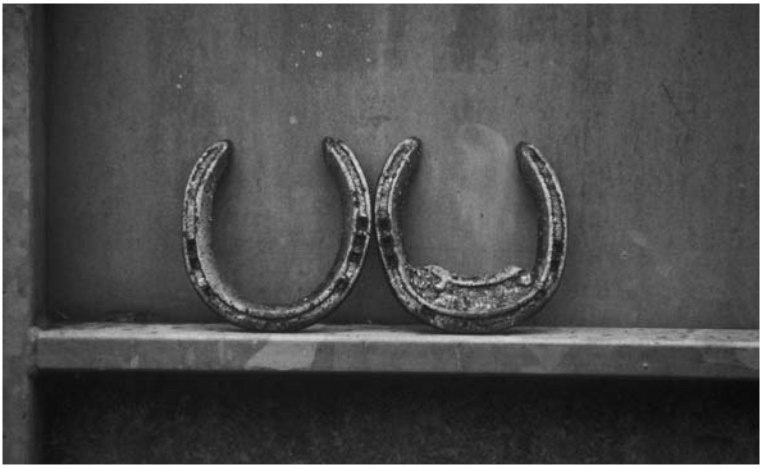


Fig. 6.10 A weighted shoe (L).

Fig. 6.11 A weighted boot. Weight lateral aspect, to influence the pectoral muscles front (R).

To repeat the maxim, stability of the main frame (axial skeleton) is required before the horse dares to relax, loosen and become supple. If this is hard to comprehend remember the frame is made up of individual bones, the limbs also consist of a series of individual bones balanced one upon another, not locked into each other like a piece of a jigsaw. A complex soft tissue arrangement known as the **stay system** maintains the positions of the bones of the limbs, it also assists in the conversion of the limbs into a series of levers, a differing lever arrangement is required for each gait. Small wonder the muscles and associated soft tissues require adequate preparation to achieve harmonious movement sequences.

Academic education should be, and always was, classified as 'Low School' and 'High School'. 'High School' work follows 'Low School' education and the mastery is not required for rehabilitation, following injury.

Final rehabilitation should utilise Low School exercises, and progression is asked for, once muscles are in balance (it usually requires up to six weeks of gradually increased demand), following the use of specific tasks, before the full range of Low School work can be introduced. This involves the horse working first on one track, then on two, at all the animal's natural paces. First down the side of the school in a straight line, loops from the straight can be followed by serpentines. The loops and serpentine begin to balance the ad- and abductor muscles, these are the groups that stabilise individual limbs, preventing them from falling in or outward during flight, and ensuring stability during weight bearing. These muscles are further strengthened when working on two tracks. Only when stability of limbs has been achieved should circles be introduced. With practice, and as the muscles condition, the gaits are eventually perfected, performed as the musculature responds, to the highest degree of possibility and regularity for that horse, always taking into account conformation. As the horse masters regularity or cadence at canter, changes of lead and then flying changes are added. Changes of direction at all paces are incorporated throughout the carefully designed programme. Some work should be given collected, some at extended paces. Only by following such a course can muscles be suitably prepared/repaired enabling the horse to return to economic correct movement.

The art of rehabilitation from the ground, in long reins, is to 'read' the horse's muscles, then to choose suitable 'exercises' to influence the groups to be targeted.

Muscles, as already stated, need to be 'loaded' to improve or strengthen. The arena should be considered, with the use of poles and blocks as a 'gym'. Fields are invaluable not only to alleviate boredom, but slopes can be incorporated, worked across, up or down, and also a

Fig. 6.12 Fields and slopes are invaluable for improving balance.

horse can be made to back up, going up, down or across a slope for two or three strides. Each movement recruits different muscle interaction, as does being forced to balance on uneven ground (Fig. 6.12).

Muscles designed to stabilise the frame require slow, steady, controlled paces in order to build. Horses often try to avoid this type of work breaking from trot to canter or 'running', this is not engaging.

The neck musculature requires consideration, for the neck has a direct influence on the back. A group called the scalene muscles bridge the gap between the lower neck and the front of the thoracic cage. They are difficult to influence as it is necessary to position the head and neck in such a manner that activity in nearly all the other groups that advance the forelimb is blocked. The positioning adopted for the exercise rollkur undoubtedly influences this group but, as it is very easy to achieve incorrect positioning leading to damage, the exercise is best left to skilled écuyer. The neck musculature is best built with the horse working low, the weight of the head, provided the neck is allowed a natural rise and fall, providing substantial loading. Side reins or schooling aids allow the horse to lean, reducing muscle activity in the neck (Fig. 6.13).

One of the reasons that no one task should be continued for long periods is the fact that recovering muscle lacks fuel and requires periods of rest to cleanse and refuel. Rest does not mean the horse stopping and standing still, it means a change of movement, perhaps from collected work to working long and low with changes of gait.

It is the re-establishment of the fuel supply network that is crucial to recovery.

Fig. 6.13 A horse in tack learning to work in long reins. The horse is relying on the side reins.

Aims of long reining

(1) To produce a flexible horse which is working in balance;
(2) to rebuild the muscles and restore co-ordination for the required task.

Descriptions are easy but it is not until the horse is accustomed to the long reins that gymnastic exercises can be introduced. Work over poles is of enormous benefit, both to young animals and to older animals whose paces need correction. Remember, in the early stages of rehabilitating movement, the effects depend on the arrangement of the poles, and the arrangement of the poles must be linked to the muscle groups targeted.

When used properly, light, supple, even paces with a good outline are achieved. In the case of an animal which has been injured, the pole arrangement should be adjusted, first to load the muscles at fault selected Low School exercises, then to achieve even cadence use the full range of Low School exercises. Due to the even striding required to work the limbs with the appropriate layout of the poles, a correct reflex pattern of movement can be re-established. (Figs 6.14–6.20.)

Fig. 6.14 A horse working incorrectly. The situation created by the handler who has failed to move and is therefore pulling the horse off balance.

Fig. 6.15 A horse working correctly down a line of poles. There is no tension on either rein or on the side reins. The horse is working in its own natural outline in balance appropriate for conformation.

Fig. 6.16 The front rein is too tight causing the horse to flex the neck inward.

Fig. 6.17 Poles with blocks arranged for a short stride, achieving middle range or ‘building’ work for the musculature.

Fig. 6.18 Poles arranged to increase stride length. The limb muscles are working in their outer 'elastic' range.

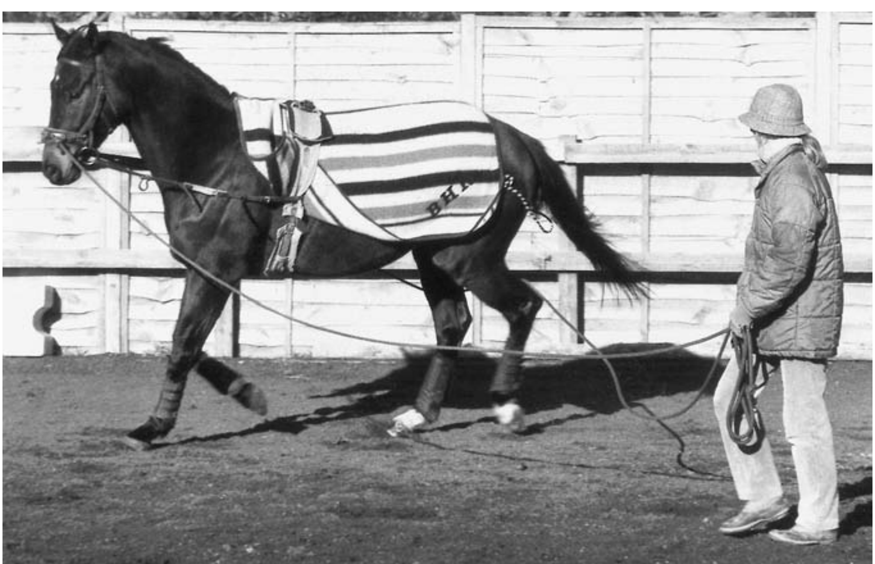


Fig. 6.19 A horse in long reins, but not working in balance and leaning on the side reins.

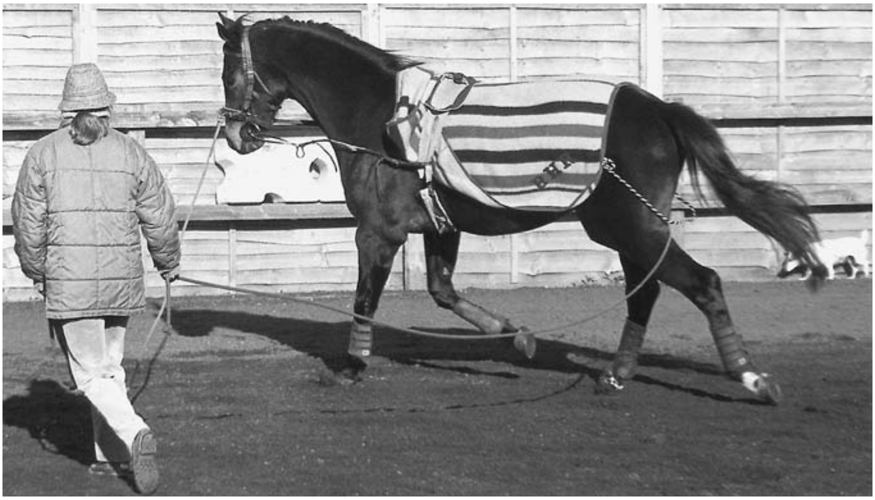


Fig. 6.20 A horse in long reins, working in a good outline. Note the reins are attached to the cavesson, *not* the bit.

Ridden work

Ridden work is the final step in the long road to full recovery. It is the most difficult stage for the horse – the pain has gone, muscles are rebuilt, suppleness and the ability to go forward at walk, trot and canter in the school in long reins have been achieved. The horse now has to relearn the carrying of the rider, at all paces, and probably negotiating obstacles. This phase, if hurried, can undo all the good so far achieved, for remember, if the injury was caused not by an accident but by incorrect action, or unbalanced movement sequences, the incorrect reflexes must be replaced by advantageous patterns. Go slowly!

When starting ridden work:

- check bridle fit – is the brow band/headpiece too tight?
- check position of the bit, its size and type. Is it too narrow/wide, severe/high?
- check the saddle fit. Is there even distribution of weight?
- check the girth for comfort and safety;
- slowly increase the time the horse must carry weight, thus allowing muscles to accommodate;
- hack out for two to three weeks before starting work in the school;
- be certain the horse is capable of, understands, and is confident in the simple movements before you ask for the more difficult ones;
- if possible, loose school over fences before riding at fences.
- do not demand concentration for long periods.

Finally, achieving an 'outline' depends on many factors, not least the conformation of each individual animal.

The Chambon, de Gogue, Abbot-Davies and draw reins are all variously employed to try to achieve a rapid and artificial change of head and neck position. Flexing of the head and neck does assist the horse to raise his back and thereby improve hock engagement, *but* if the rider still 'sits deep' with their weight localised, creating pressure over the pertinent reflex areas of the animal's back, then the horse's brain will force the back to hollow and head to lift (flight/fright reflex). At the same time, due to the effects of a gadget, through the bit, sensors in the mouth will be commanding the horse to lower his head and round his back. Small wonder that if these devices are not used with sympathy and intelligence they rarely work – in fact they often create more problems than they solve.

There is no substitute for time, patience, sympathy and good hands to re-educate following accident or injury.

Summary

- Remove pain and aid tissue healing by using the appropriate machines;
- maintain activity by utilising the aids available and appropriate to the condition;
- re-educate in long reins selecting exercises suitable for the defective muscle groups;
- re-educate ridden.

No set programme can be laid down in black and white; each case is different, each demands a fresh approach. This in itself ensures continuing fascination, for each recovery is a new achievement.

7 The Back – Horse and Human

The discussions relating to back problems, what causes them, what cures them, and whether manipulation really works, must be the most controversial subject in the fields of veterinary and medical science.

In order to achieve any sort of understanding of the back, a mental picture of its construction and functional ability must be achieved.

The horse

The backbone of the horse, the main scaffold rod of the axial skeleton, consists on average of 54 interlocking bones or vertebrae, divided into five sections: the neck, *cervical spine* containing seven bones, the *thoracic spine* or mid-back eighteen (from whose bodies spring the ribs), the *lumbar spine* or loin area usually consisting of six bones, but the Arab commonly only has five, and a long-backed horse may have seven. The *sacrum* is five bones fused together to form one block, and the tail contains between 15 and 21 individual vertebrae.

The construction of the vertebrae is such that movement occurs not only between the adjacent bodies of the bones, but also in small joints called *facets* or *zygapophyseal* articulations. These are joints formed by small bony extensions which project upward and outward at either side of the spine of the vertebrae, lying above the bony ring of the spinal column and connecting with the projections from the adjacent vertebrae.

The amount of movement between adjacent vertebrae diminishes, from that available in the cervical spine, throughout the thoracic and lumbar spine, movement range in these areas is achieved by the addition of small movement at each intervertebral junction.

The bodies of the vertebrae are cushioned one from another by intravertebral discs; these act, as in the human spine, in axial shock absorption. Horses can suffer from disc degeneration but disc herniation is a rarity, disc construction is not identical to that of man, and their relative

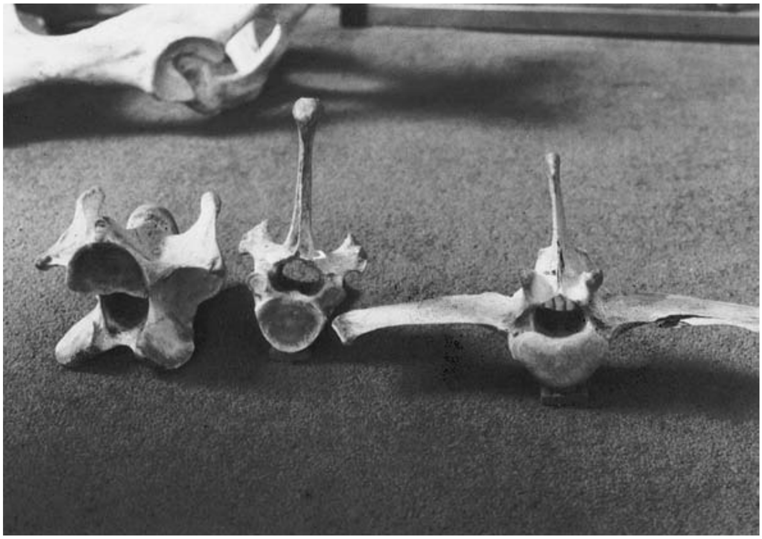


Fig. 7.1 The vertebral shapes in the horse (*left to right*): cervical neck vertebra, thoracic or mid-back vertebra and lumbar vertebra.

thinness in certain areas contributes to reduced mobility of the vertebral column as a whole; for example, at the lumbo-sacral junction which is an area of considerable mobility, the disc is wider. The extent of movement in the various areas of the spine of the horse is also determined, as is the mobility of all joints, by the shape and angle of the surfaces between opposing bone ends (Fig. 7.1).

The neck and tail of the horse possess considerable mobility, and also muscles with a functional design to produce a considerable degree of movement. Thus the horse can raise and lower his head, and turn to bite his flanks; the tail can move up and down, and swish from side to side. The spine from withers to croup is remarkably inflexible. The shape and angle of the facet joints of the thoracic spine allow some up and down movement, *dorsi- and ventroflexion*, but their design allows for a small amount of lateral or side bending, while the facet joints of the lumbar spine are constructed to allow a greater degree of dorsi- and ventroflexion, than is possible in the thoracic area and little or no side flexion.

Movements of the thoraco-lumbar spine are undeniably present, and in response to pressure in specific areas the horse can respond by performing the movements of *dorsi-* or *ventroflexion* and of *side flexion*. These movements are not part of the horse's day-to-day activities: have you ever seen a horse stand in a field and hump and hollow his back?

The muscle groups above, below and on each side of the spine are designed to support the spine, in partnership with the abdominal muscles, and three very important ligaments. The combination of the

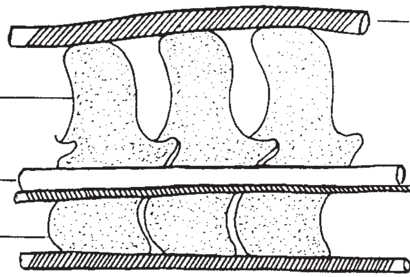


Fig. 7.2 The ventral, dorsal and supraspinous ligaments.

spine, ribcage and pelvis forms a tube or axial skeleton, to which are attached the limbs.

Movement of the body mass occurs as a result of, first, the forelimb being extended and fixed on the ground; and second, the force created by the massive thrust force as the hind limb extends, this thrust, delivered via the sacro-iliac articulations effectively catapulting the entire body mass over the planted forelimb. Simultaneous contraction of the muscles behind the shoulder blade, allow the body mass to swing forward between the pivot created at the upper area of the shoulder blades or scapulae.

The ligaments involved (Fig. 7.2) work rather as do the cables of a suspension bridge. Three in number, they are attached to consecutive vertebrae along the length of the spine.

The *ventral* ligament lies on the underside of the vertebral bodies, the *dorsal* ligament floors the tunnel of the spinal canal, and the *supraspinous* ligament – known as the nuchal ligament in the cervical area – jumps from poll to withers, sending a fan-like set of extension cables forward and down to attach to the cervical vertebrae, continuing its course attached to the spines of the thoraco-lumbar and ending at the sacrum (Fig. 7.3).

The interspinous ligament spanning the gap between each pair of vertebral spines derives its origin from the supraspinous ligament and functions to maintain the relative position of the vertebral spines as well as increasing stability. The weighty head is extremely important in assisting in the maintenance of the normal contours of the back. The ligamentum nuchae acts as a bow string between poll and withers, thus the lower the head, the tighter the bow string and the greater the traction force along the length of the spine. Raise the head, the bow string loses tension, and there is less supporting traction for the thoraco-lumbar area (Fig. 7.4).

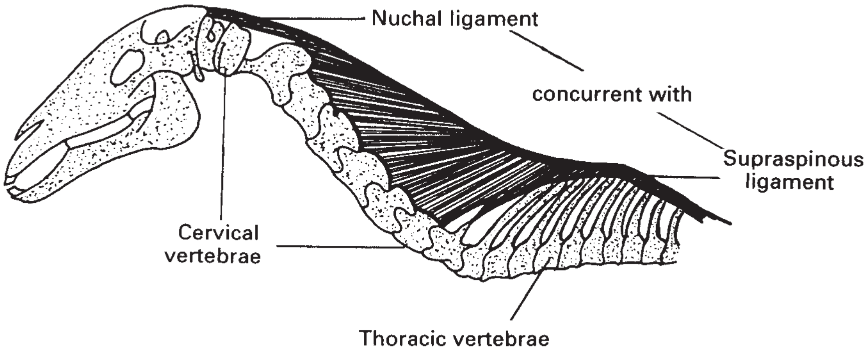


Fig. 7.3 Diagram of nuchal ligament, showing fan-like attachments to cervical vertebrae.

Many horses with 'sore' backs have been 'cured' by repositioning their head at exercise.

Back problems

Severe problems are very incapacitating and give rise to obvious clinical and X-ray findings. Amongst these comes the 'wobbler syndrome': the animal loses the ability to co-ordinate his movements, crossing the hind legs and 'wobbling' from side to side. The cause is pressure on the spinal cord within the canal. Other than spinal decompression – an operation to remove the pressure – little can be done.

Vertebral and pelvic fractures manifest with reluctance on the animal's part to move, and every indication of severe crippling pain associated with gross muscle wasting. Any form of treatment calls for close veterinary supervision; all cases eventually require muscle stimulation and rehabilitation.

The 'problem back' is the one producing some signs of discomfort and reduction in performance ability, but without obvious clinical findings. These types of back are almost certainly a result of ligament strain and associated muscle problems.

A disturbing feature of the aching back is the fact that the great majority of so-called 'backs' are not backs at all. Soreness and discomfort in the back have occurred as a result of a problem in a limb causing the horse to work out of balance, the uneven stresses falling on the back. The uneven stresses cause pain and the 'back experts' have a field day. The answer is to find and cure the limb problem, and then the back will recover. A recent case, seen for recurrent problems in the withers and many times manipulated, was found on examination to have a fracture of a pastern bone.

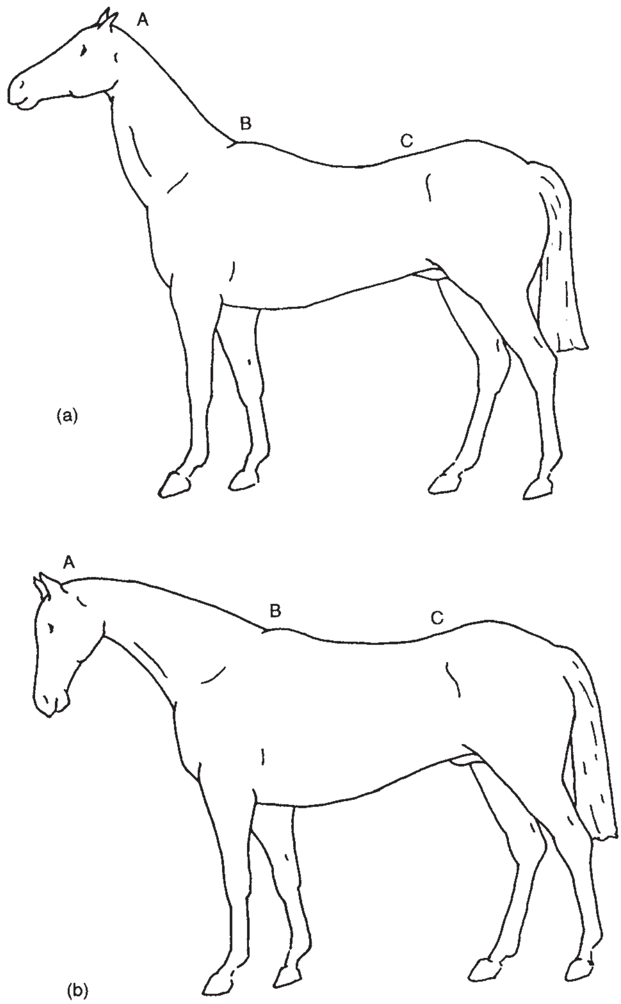


Fig. 7.4 (a) Head raised – distance between A and B shortens; traction on nuchal ligament reduced, strain on back at C; (b) head lowered – distance between A and B correct; traction on nuchal and supraspinous ligament normal, back supported.

That the horse of today is subjected to stresses and strains for which it was not designed, and has not yet adapted, is well illustrated by examining the collection of spines in the Anatomy Department of the Natural History Museum in London. All the thoroughbred spines show some form of bone damage or abnormality in the lumbar spine or lumbo-sacral area; the Hackneys show spinal abnormalities at the thoraco-lumbar junction; the spine of the Mongolian wild pony is perfect, as are the spines of the specimens of mules and donkeys. Examples of spinal abnormalities are illustrated in Figs 7.5 and 7.6.

Fig. 7.5 Bone abnormality between the last lumbar vertebra and the sacrum. Note fusion on right of picture.

Fig. 7.6 Reduction of diameter of aperture for the emergence of the nerve, on the opposite side to the fusion.

The problems in the lumbo-sacral area may well be explained by considering both the pivot areas of limb movement and the dissipation of the G force stresses experienced when a single limb hits the ground at fast paces. As already discussed, the G force is in the region of *350* times the horse's own body weight. At walk and trot, the front legs pivot around the upper part of the shoulder blade and the hind legs around the hip joint (during the gallop phase, the pivot point for the hind legs moves to the lumbo-sacral junction).

The shock waves generated as individual feet hit the ground travel up the limb involved, not as one smooth wave motion but as a series of intermittent stresses; those from the forelimbs angle backwards and terminate at the thoraco-lumbar or lumbo-sacral junction – the length of the back and muscle mass of the animal determining the final location (the longer the back, the further forward the impact). The hind limb forces travel upwards through the gluteal mass, then angle forward and terminate at the fourth or sixth cervical vertebrae. The two impact energies cross in the thoraco-lumbar or lumbo-sacral area; thus at fast speeds and when jumping, all the major stresses arrive at the point of hind limb pivot in the loins (Fig. 7.7).

The sacroiliac joint provides a second problem area. The 'joint' is not a true joint; no movement occurs between the two bone surfaces. It is a meeting place of two bones. Injury to the ligaments supporting the joint causes instability, with subsequent pain and loss of efficient movements of the hind limb of the side affected.

Amongst the reasons for muscle atrophy, discussed in an earlier chapter, was the absence of an adequate nerve supply. Damage to soft tissue causes local swelling. Superficial swelling causes the skin – endowed with elastic properties – to stretch, the skin stretch relieving the pressure on the deeper structures. In areas close to the vertebral column, the swelling has no escape route.

The muscles of the back are supplied by nerves lying in and around the tissues which are damaged by excessive strain to the loins and pelvic area. The resultant swelling, in some cases, presses on the motor nerves supplying the back muscles, with subsequent temporary loss of communication to the muscle supplied by that nerve. There is immediate atrophy of muscle, with all the associated problems: loss of support for that sector of the back, loss of stability in the joints, excess strain on the ligaments which partner the muscle involved, uneven muscle balance in the area – all factors that, without treatment, will lead to continuing malfunction of the area.

To summarise, first seek the cause: it may not be in the back, especially if recurrent episodes are reported. If there is a genuine back problem, reduce the pain, stimulate the appropriate muscle groups, re-educate the movement pattern, check the saddle fit and find the cause.

Or could it be your back problem causing the horse's? An interesting case history is worth relating.

A heavy hunter, aged eight years, was admitted with back problems. On arrival, the history was of a progressive reluctance to jump, the

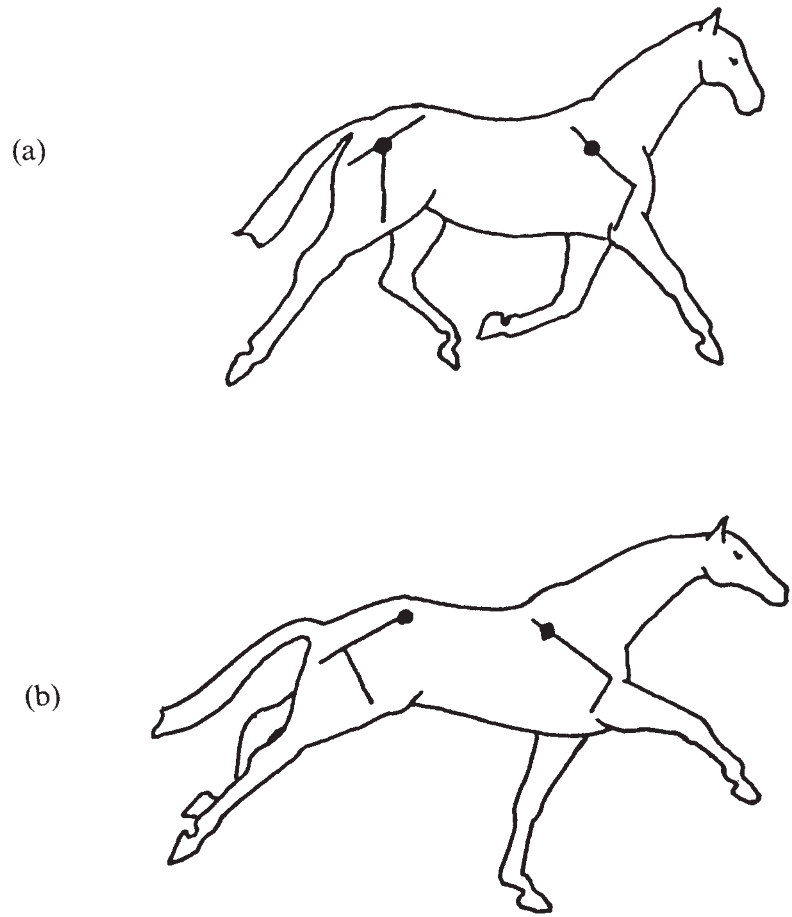


Fig. 7.7 (a) Pivot points of the horse at trot – hip and upper scapular areas; (b) pivot points of the horse at gallop – lumbo-sacral junction and upper scapular area.

problem becoming worse over a three year period and culminating in lameness in the near hind. Discussion provided the information that the horse always rolled excessively after exercise and was cast at least once a week, always with the near side uppermost. Examination revealed gross wasting of the back muscles over the loins on the near-side and some loss of the middle gluteal muscle of the near hindquarter. Back movements were grossly restricted and painful. The horse was sent for scanning; this revealed osteoarthritis of the near-side hip and inflammatory changes at the lumbo-sacral junction.

Treatment consisted of magnetic field therapy, ultrasound, muscle stimulation and eventually re-schooling. At the end of three months, the horse was back in work, happy and pain free but reluctant to jump.

The owner came to ride out before removing his horse and used his own saddle: immediately after being unsaddled the horse, in obvious pain, got down in his box to roll – something he had ceased to do. Examination of the saddle by a saddler disclosed a warped, crooked tree.

Three years of pain, ending with an irreversible change in the hip due to the stress associated with getting cast because the pain in his back caused him to roll, all for saddle fit. Discussion with the owner revealed he had always had back pain after riding that particular horse!

The human back

The feet are designed to absorb and dissipate the compaction forces generated at the moment of ground contact during motion; to propel the body forward, also record, process and act upon quantities of vital information, delivered via a mass of 'computers' sited on the soles. The feet are of a superb design and construction. Only if the feet are allowed to function naturally can the body mass balance effortlessly. Unfortunately, shoes often interfere badly with foot function, and a great deal of natural inbuilt perception is lost.

Some years ago a South African athlete, Zola Budd, who had not worn shoes during training or competition, arrived in the UK to compete, persuaded to wear shoes she collected injuries that eventually curtailed her career. Some of the current top Kenyan runners went barefoot in their formative years; is this the key to their success?

The ankle and knee are hinge joints, their construction and the angle of muscle pull is designed to allow no rotation or turning movements.

The hip joint is a ball and socket, or universal joint; movement is possible in all directions, i.e. movement both of the body on the legs and the legs on the body.

The pelvis rests on the top or 'head' of the upper bone of the leg, the femur, their meeting place forming the hip joint. The pelvis consists of three bones joined in such a manner that there is no movement between them, unlike other joints, but which just 'give' where they meet. The sacrum, the centralised bone, forms the base for the spine, or vertebral column consisting as it does of five lumbar (low back) vertebrae, twelve thoracic (chest) vertebrae, and seven cervical (neck) vertebrae. The vertebrae are divided one from the other by discs.

The structural angles of the pairs of small joints at the back of each vertebral body determine the movement possible in each area. The low back, or lumbar, area allows forwards and backwards movement as well as side bending. Rotation, or twisting, occurs mainly in the chest or thoracic area, while the neck is capable of a wide range of movement in all directions. The amount of movement between each pair of vertebrae is small. Spinal movement is achieved by the accumulation of the small movements throughout the entire vertebral column.

John Gorman, a chartered engineer, made an analysis of the human back in 1983 which has not yet been challenged or superseded.

His findings, based on engineering principles, show that the back when used correctly is well designed. Gorman suggested it was not the design of our backs that causes problems. Most problems in fact occur as a result of stresses to which the back is subjected – put any joint through a movement range greater than it is designed to perform and you cause damage.

He rightly pointed out that the hip joint is capable of a very large range of movement – approximately 180° – and is also the strongest joint in the body. In the western world, the way of life is such that rarely do we use more than half the available range (Fig. 7.8) present at birth. The wide range reduces as we fail to retain the full elastic stretch of the muscles controlling the hip joint. Because of the inter-relationship between hip and back, if the available movement at the hip is reduced the back must immediately endeavour to increase its movement range to comply with the action required. Damage results.

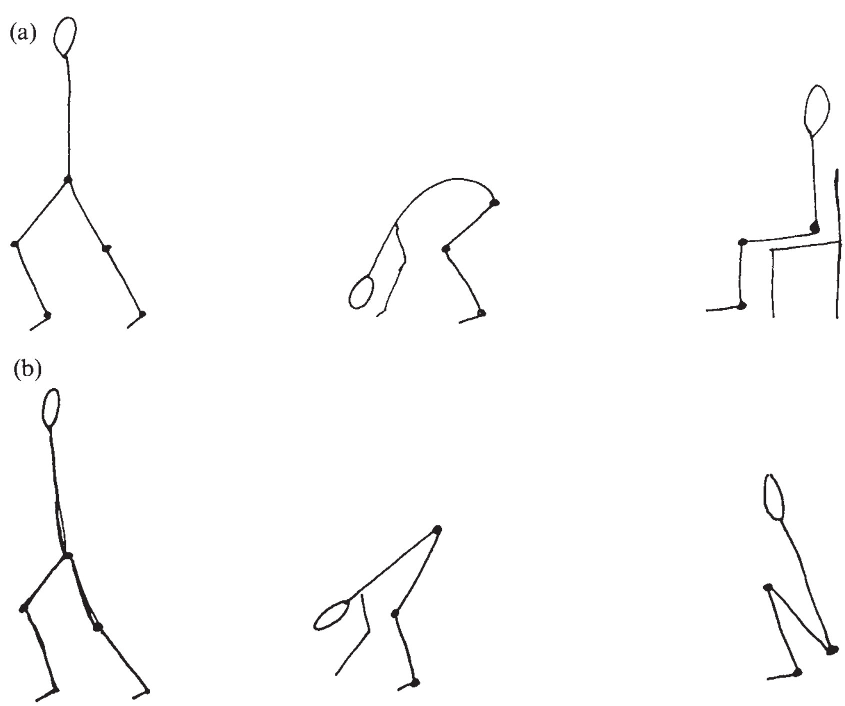


Fig. 7.8 The use of the hip: (a) Western man; (b) natural man.

Obviously, disease causes back pain; but disease is not the subject of this text. Nevertheless, accurate diagnosis is, as always, the main requirement in any condition. Because pain in the back can be caused by a number of problems, X-ray, even scanning, is always advisable to determine the state of the discs and bones. Falls can cause fractures of any part of a vertebra leaving a temporarily unstable area. Because of the proximity of the spinal cord and nerves to the vertebral bodies, permanent damage to this vital system can occur if serious conditions are ignored.

Unless caused by disease or bony abnormalities, back pain is a soft tissue problem involving either the disc, the small joints at the back of the spine (the facet joints), the ligaments and/or muscles supporting the spine.

The discs

The discs are washers cushioned between two vertebrae – the outer wall built rather like a 'Radial X' car tyre, strongly constructed to avoid the possibility of a 'blow out' when under normal stress. The material contained within this outer wall is rather like the material of the horse's frog. Centrally placed is the nucleus acting as a central pivot point, the effect being similar to placing a marble between two flat surfaces; one surface balances above the other and movement is possible (Figs 7.9 and 7.10).

The discs can be damaged when movement stress for which they were not designed occurs – for example, bending forward and twisting, overloading when bending forward and twisting, overloading when bending forward and lifting a weight that is too heavy. Under these types of stresses, some of the fibres of the outer wall of the disc break down and a bulge appears in the area of the breakdown. Due to the

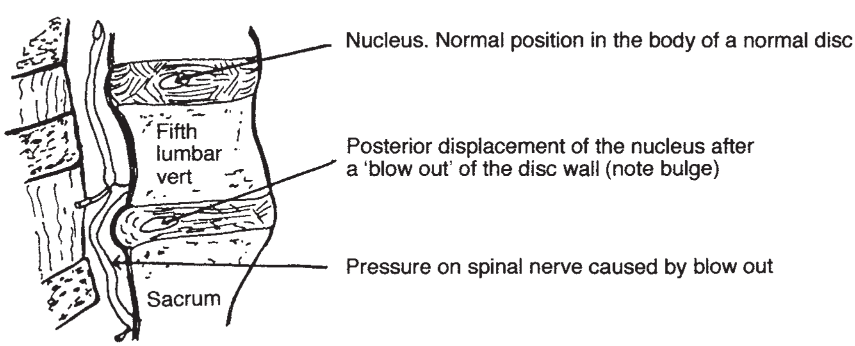


Fig. 7.9 Diagram of a vertical section of the fifth lumbar vertebra and sacrum.

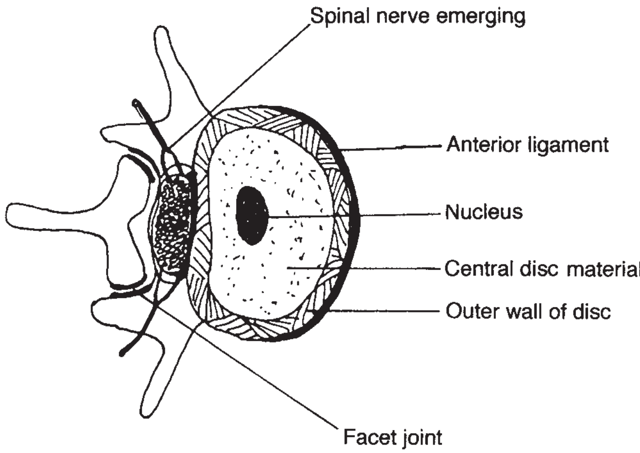


Fig. 7.10 Diagram of a cross-section of a disc.

position of the ligaments which hold the vertebrae together, these bulges can only occur in certain areas. Unfortunately, these areas always involve a highly sensitive nerve complex – result = pain.

Disc pain is rarely felt at the site of the problem. Nerve tissue is highly complex. An easy way to visualise the problem of pain is to appreciate that all nerve impulses travel electrically and that the reaction of nerve tissue to any unusual circumstances is to record pain. This pain is recorded in a number of ways: it may be an ache, like toothache; a continuous soreness; sudden, sharp electric shocks or twinges. Overstimulation of a nerve creates so much electricity that the impulses discharge down the entire course of the nerve involved, their destination being determined by the path of that particular nerve. In this way a severe disturbance in the low back may well cause pain to be felt down to the toes, in the neck the pain may radiate down an arm to the fingers, and in the chest the pain may be felt at the front of the chest and may make breathing uncomfortable.

Sacroiliac joint pain

The two sacroiliac joints (Fig. 7.11) are sited at the back of the pelvis, lying just below the two dimples at the top of the buttocks. They are not true joints, just as in the horse, but a meeting of bone to bone. Held together by immensely strong bands of ligaments, they have no muscles to move or support them, but as one bone can 'give', spring-like, against its fellow, the ligaments are subjected to overstretch forces in certain movement conditions. Pain results, this pain usually radiating into the buttock and/or down the leg of the side affected.

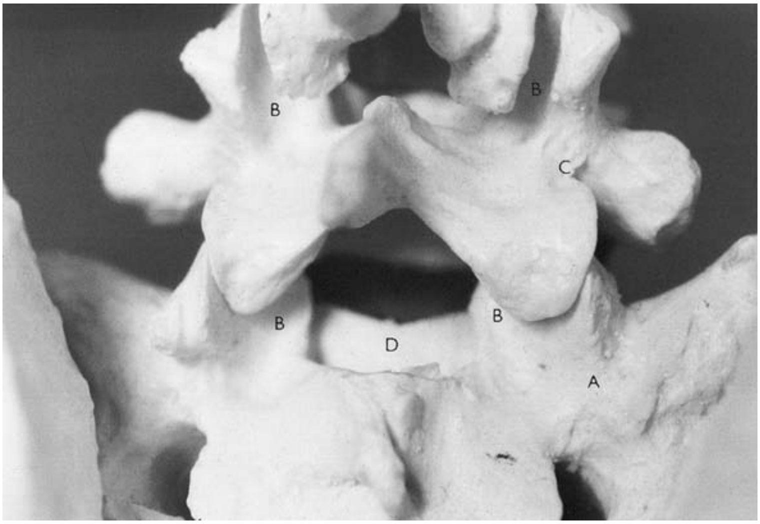


Fig. 7.11 The human spine viewed from the back lumbar 5 on the sacrum: (A) sacroiliac joint; (B) facet joints; (C) aperture for emergence of spinal nerve; (D) canal for spinal cord.

Facet joint sprain

Movements occurring when the muscles and ligaments are over strained or caught 'off guard' may sprain a facet joint (see Fig. 7.11). The joint is forced through a movement range greater than it was designed to perform, and sprained. The immediate response is local muscle spasm, loss of movement, and pain. This pain may radiate from the site of injury, just as with disc problems.

Back muscles

Support of the back is achieved by the layers of muscles lying behind the spine working in balance with the muscles which run from the bottom of the chest to the pelvis, called the abdominal muscles, and also certain of the muscles around the hip joint. The deepest layer of muscle is the first to be subjected to damage, this resulting in instability between adjacent vertebrae.

When all the muscles are in balance, the back works well. Injury always involves muscles, and after injury the back rapidly becomes out of balance. Unless this situation is corrected, the problems will always recur.

Which comes first? Do you give the horse a bad back, or does he give you one?

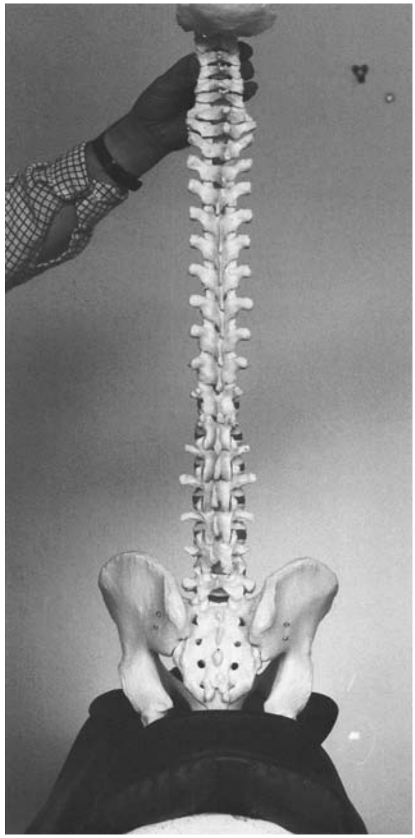


Fig. 7.12 Spine in balance on the saddle.

Once again, we speak of balance. The rider in perfect balance distributes weight evenly, via the saddle, to the back of the horse (see Fig. 7.12). The horse going in balance causes an even pattern of upward thrusts to be experienced by the rider through buttocks, sacroiliac joints and back.

The moment balance is lost, things go wrong. Uneven, unequal stresses are created and damage occurs. This damage may be minimal at first, but if the situation is not corrected, endless discomfort for both horse and rider results (see Figs 7.13 and 7.14).

In order to achieve a comfortable, secure position in the saddle, with minimal stress to the back, there must be adequate movement at the hip joints. If the adductor muscles (Fig. 7.15) are too tight, the correct leg position is nearly impossible to achieve, balance is lost and once again there is the potential for injury.

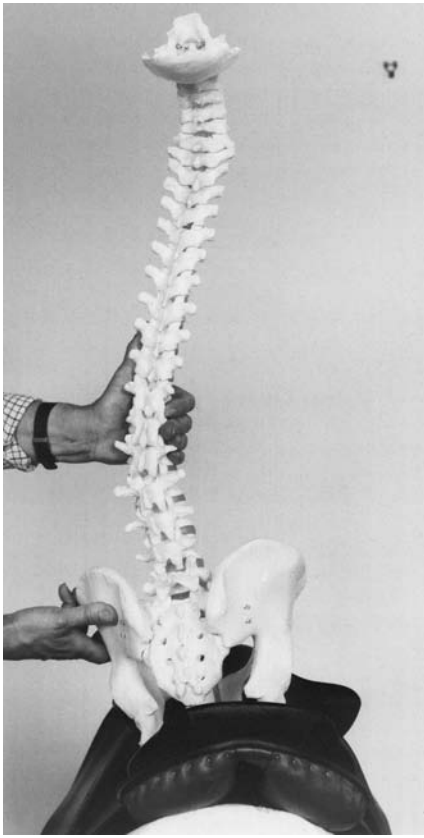


Fig. 7.13 Left hip dropped. Note stress areas: a rotation has occurred – rider pain will be felt in low back.

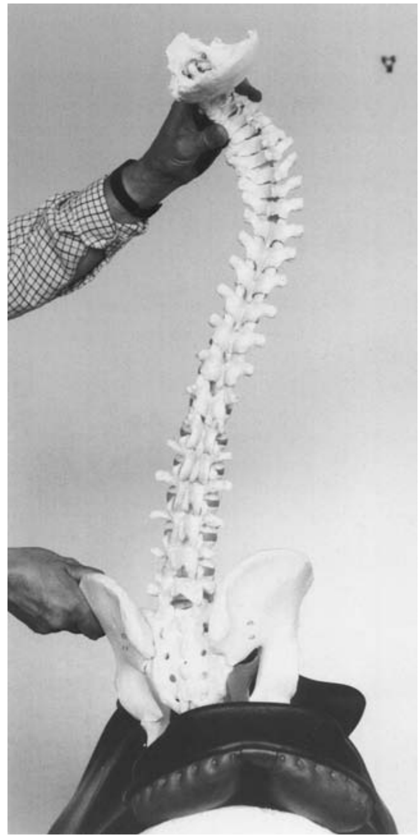


Fig. 7.14 Left hip dropped. Note stress areas of spine: rider pain will be felt at 'bra line' and bottom of neck.

Fig. 7.15 The human pelvis and hip joint viewed from the front: (A–B) position of adductor muscle; (C) sacroiliac joints; (D) ischial tuberosities – the bones you sit on.

8 Common Rider Injuries

Rider injuries

Rider injuries in the main occur as a result of an involuntary dismount, fall of horse and rider, contact with an immobile object such as a gate post or fixed cross-country jump, being thrown, or being kicked, bitten or trodden upon when not actually riding but working with/caring for a horse, or horses.

Recent health and safety requirements have led to ultimate protection being necessary for the person taking part in any form of activity perceived as dangerous. Riding is considered a high risk sport, and recently, considerable attention has been directed towards the design of riding head gear and upper body protection.

Body protectors

Body protectors in the UK are required to be manufactured to a specific standard, this standard was originally a two-tier level of shock absorbency, but in 1995 the standards were revised resulting in a three-class system in order to comply with the legal requirements of PPE, the European Personal Protective Equipment Directive, this Directive becoming law on July 1st 1995.

The variety of body protectors on offer is overwhelming; however there are some valid points worth consideration, the first is flexibility. Those protectors which allow the upper body the ability to move as one with the protector, (multi-pocketed designs) do not, in the main, restrict respiration or interfere with balance, and allow the rider to move as one with the horse rather that being forced to sit in a stiff, pre-determined position. A 'pogo-stick' rider increases horse fatigue, all balance adjustment being loaded onto the horse.

Most importantly flexibility enables the rider to curl and roll if they do have a fall. No protector can prevent damage resulting from 'splat' type fall or if the rider is fired into the ground as stiff as a rod. If a double fall occurs, you and the horse, there is the frightening possibility that if you cannot move your upper body easily, you may not be able to roll to safety. No body protector can withstand the weight of a horse.

All parachute jumpers are taught to fall by curling/collapsing their bodies, and all crash research shows curling and rolling dissipates impact forces.

It is interesting that those wearing full body armour rapidly realised chain mail was preferable, wearing the former the knight fell splat and had his head chopped off as he lay cast unable to move, by wearing chain mail he was able to bounce, get up and run away, living on to fight another day.

The material incorporated into the protector should not provide a level of insulation that causes you to sweat, dehydration is as bad for the rider, as for the horse.

Make certain you can breathe – riders need to employ chest expansion; the diaphragm, the great muscle of respiration, is not able to work efficiently when the body is bent forward as in so many riding positions. If your protector limits your respiratory ability, early muscle fatigue is a certainty. Think of the breathless interviews following an exacting cross-country round or a hard-ridden racing finish.

When considering fit, the length should allow normal, uninterrupted neck movement, and should not impede forward flexion of the upper body by digging into the thigh muscles or groin area.

Riding without a protector establishes in the rider a chain of recorded responses or reflexes, the body learning, over time, a total new balance formula.

If the protector inhibits these balance responses the rider may feel they are not sitting as they should, positions naturally adopted are not possible; many riders request treatment saying, ‘there must be something wrong with me I feel so odd in the saddle’. They have to relearn to ride in their protector.

Head injuries

No head injury should ever be ignored, however trivial it may seem at the time. The brain is suspended, for self protection, in a water bed inside the skull. Despite this natural protection a severe blow to any part of the head even though a protective helmet is being worn can result in bruising within the skull affecting brain tissue. The material of the brain, as already described, is highly specialised and very sensitive to compression or bruising. All head injuries should be examined by a doctor, and, however inconvenient, with regard to curtailment of activity, the advice given should be adhered to.

To ignore medical advice is just plain stupid; your brain is the central computer, it controls balance, co-ordination, sight, speech, conscious thought, as well as every bodily function, reflex or otherwise. You only have one brain; look after it.

Tiresome though it may be to find a cap that fits and is comfortable, go on looking. The cap should stay in place when the wearer bends forward head down and shakes the head. See that the chin strap fits and is comfortable. Caps with fixed peaks should be avoided. Should a fall occur in such a manner that the fixed peak hits the ground first, the neck will be snapped backwards in an extension movement and a severe whiplash injury will result. Fixed peaks on motorbike helmets were banned years ago because of the problems that they caused.

The effects of a head injury do not always manifest at the time of the accident. Severe headache, any form of blurred vision or other unnatural signs occurring within five days of a fall should be reported to your doctor immediately. There is no possible therapy for a head injury other than rest.

Always replace a cap after a fall involving the head, impact forces can change protection levels.

The temporomandibular joint

The temporomandibular joints are the joints just in front of the ears where the lower jaw is attached to the skull. Falls sometimes sprain and marginally dislodge one or other of the joints, often secondary to helmet chin-strap pressure. The common symptom is headache, often of a migraine type, unexplained without reason. Test for a problem in the temporomandibular joints by putting your fingers just forward of the middle of the ear, opening the jaw several times and closing it until you can feel the jaw bone move under your fingers. Then apply deep pressure, first on one side of the face and then on the other, over the joint.

If either side is painful, the best advice is to go to see your dentist. Dentists have far more success with problems in this joint than any other therapists.

The low back

Most riders suffer low back pain; sadly in a large number of cases this is unnecessary. Just as the horse's back should be prepared to take rider weight so the rider's back should be prepared for riding.

The architectural design of the low back in man is for stability **not** movement, all movement of the upper body, on the legs, and the legs, on the upper body, should take place at the hips. There should be no or only **minimal movement** in the low back. Riders who have weak low back muscles, will not only hurt their backs, but will find it very difficult to sit into their horse.

The low back (lumbar spine) is held together by small, dense muscles lying at the back of the vertebral bodies, the *multifidi*. They work in partnership with an internal muscle lying within the body cavity in front of the low back vertebrae, the *iliopsoas*.

While the abdominal muscles aid the upright posture they are only marginally responsible for this, their prime function is to create an abdominal tunic in order to retain the abdominal contents within the body mass.

Experimental work demonstrates one useful exercise to improve low back stability. The exercise is very simple, called the 'hip hike', it requires the subject to lock the ankle and knee in order to stiffen the leg, then to lift one foot, keeping the leg stiff, 2–3 inches off the ground, then lower the leg and do exactly the same with the other leg.

When discussing equine rehabilitation the necessity to try to localise muscle activity, by suitable positioning, was considered. The 'hip hike' recruits iliopsoas and the multifidi provided the leg is stiff; normally they do not work in an active manner, their function being, if strong enough, to stabilise the lumbar spine. The exercise forces the muscles first on one side, then on the other, to work actively. Active contractions plus loading builds muscle.

Loading is achieved by the weight of the foot and gravity. Low back sufferers are asked to lift each alternate leg six times on the hour, through out the day for a minimum of six weeks, at the end of that time 90% have a stable low back.

When trying to 'sit deep', consider that the translation probably went wrong, 'sit close' would have been more appropriate.

The shoulder

The shoulder unit consists of the shoulder blade (*scapula*), the collar bone (*clavicle*) and the upper bone of the arm (*humerus*).

The shoulder blade and the collar bone join each other at the *acromio-clavicular* joint, a small joint lying just above and in front of the shallow saucer, *acetabulum*, on the scapula, which forms the surface for arm movement. Apart from a tiny joint between the breast bone (*sternum*) and the collar bone, the whole shoulder unit is attached to the body by muscles.

The collar bone

Fractures of the collar bone are common. A figure-of-eight bandage applied to pull both shoulders back will help, and should be used when riding for at least six to eight weeks after the injury.

The acromioclavicular joint
This joint is usually stressed when the point of the shoulder hits the ground first in a fall. The involvement of the joint is often missed on examination, as the only movement which really stresses the structure is when the arm is taken across the front of the chest, and over pressure is applied.

The shoulder joint
The joint dislocates when severe traction with rotation occurs – the capsule of the joint, the ligaments and the muscles are all stretched and torn. Occasionally, the large plexus of nerves lying in the armpit, just below the joint, may also be involved. Immobilisation is essential in the early stages after the injury, the most comfortable form being strapping the upper arm to the body.

A frozen shoulder is the term used when the capsule of the joint becomes grossly inflamed; the arm gets stuck and full movement of the shoulder joint is lost. It is a very painful condition and it takes approximately two years to recover untreated. Pain and loss of movement are the predominant features. The condition always does recover, even untreated, but with skilled treatment the pain can be reduced at an early stage and muscle loss minimised.

The elbow

A hinge joint allowing bending and stretching movements, the most usual problems in the elbow are a simple sprain of the joint and tennis or golfer's elbow. Tennis elbow is a tear in the tendon of the muscles that extend the wrist; golfer's elbow is a tear in the tendon of the muscles that flex the wrist.

If the elbow joint is sprained and will not straighten immediately after an accident, avoid forced straightening. Forcing nearly always results in excess bone formation within the biceps tendon, and the joint becomes 'fixed'. Should this happen, full movement is lost for good.

The important thing in any elbow injury is to achieve full flexion (bending), and this is worth working at. Normally, full extension or straightening will occur over a period of time. It is the forcing of this movement which causes trouble.

Wrist and hand

Sprains of the wrist and finger joints are common. Movement always returns. Occasionally, small bony lumps grow at the site of injury in the joints of the fingers; the periosteum has torn at the time of accident and new bone growth results. These lumps rarely, if ever, affect function.

The hip

Fractures of the head of the femur, the upper bone of the leg, the socket of the joint (the acetabulum) and the shaft of the femur itself are all serious problems requiring medical aid.

The most common rider injury is a tear of the adductor muscle causing severe pain in the groin (see Fig. 7.15, p. 174). Much of other hip and buttock pain experienced is referred from the back.

The knee

The knee is a very complicated joint consisting of the femur above, the tibia below and the third bone, the patella (a sesamoid bone), contained in the tendon of the quadriceps which is a large group of muscles which straighten or extend the knee.

The knee has an intricate ligament and muscle arrangement. Most usually torn are the ligaments lying on the inner aspect of the knee or the ligament running around the joint. Tears of the latter may involve cartilage.

Knee cartilages do not heal and bad tears usually require surgical intervention. Modern techniques allow the insertion of a small camera into the knee joint to assess the interior damage. Small pieces of cartilage which are torn can be removed by this technique, known as *arthroscopy*.

Rotational stress of the knee often causes severe bleeds into the joint, with associated swelling and pain.

The ankle

The outer side of the ankle takes the strain on rough ground when the ankle 'turns over'. Swelling, pain and loss of movement are the immediate results.

The foot

Severe bruising and even bone damage occur when the full weight of a horse's foot falls on any part of the human. The foot is particularly vulnerable but fortunately, given time, mends well.

Types of injury

Fracture equals broken bone. Fractures are caused by direct trauma such as being kicked, as a result of a fall when the bone is stressed unacceptably or as the result of a rotational strain.

Bone mends well, provided the broken pieces are held in correct alignment. Manipulative reduction under anaesthetic is usually required in cases of major breaks, followed by immobilisation in a plaster or fibreglass cast.

Simple breaks in fingers do well strapped with adhesive tape; severe, unstable breaks may require pinning or plating. Recovery takes four to six weeks in the case of a simple break, but more severe problems can take several months.

Immobilisation of the collar bone, shoulder blade or ribs is very difficult and these bones are usually left to heal as best they can. The ribs can cause problems if when they fracture the pieces bend inward, piercing the outer coverings of the lung or the lung itself. If rib fracture is suspected, X-rays should always be taken.

Dislocation

Dislocation occurs when the bones comprising a joint are pulled apart and fail to return to their normal anatomical position. The capsule is stretched and torn, as are the ligaments and the muscles of the joint. Immediately dislocation occurs, the supporting muscles go into strong spasm and it is usually impossible to re-align the bones of the joint without anaesthesia.

Strains and sprains

The term used for overstretch of ligamentous tissue is *strain*. Overstretched ligaments, when associated with a joint, reduce the stability of the joint.

The term for an overstretched joint which is not dislocated is *sprain*. Joints are sprained when they are put through a movement range greater than they are designed to perform.

Muscle

Muscle fibres being highly elastic are fairly resilient to stress. Problems occur at the point where the muscle is attached to bone: sudden exertion rips the attachment. Muscles in 'peak condition' sometimes rupture spontaneously, tears in the muscle belly occurring due to a sudden, unexpected change of function. For example, a person leading a horse, elbow bent; the horse suddenly rears and pulls back, the handler's elbow is straightened sharply; the sudden and unexpected force tears the biceps muscle, the main elbow flexor, because at the time of the unexpected movement the muscle fibres were in a state of contraction – they were not relaxed.

Bruises

Bruises are caused by the seepage of blood from tiny vessels injured at the time of an accident. The blood cells, free in the tissue, cause chemical reactions and discoloration. The colour of the bruise changes as the body responds to the unusual situation and begins to break down and re-absorb the effects of the damage. The greater the bleed, the larger and more painful the bruise.

Self-help

It is nearly impossible to be involved in any sport without the odd injury occurring, and association with the horse is no exception. Sportsmen in all other disciplines seek qualified professional help from their doctor, physiotherapist or trainer after injury, and return to their sport fully fit and pain free. Not so members of the equestrian fraternity, who must constitute the largest group of DIY healers within the world of sport.

This short section is not an attempt to teach 'DIY healing', but rather to suggest which methods to choose if you, the injured, prefer to 'chance it' rather than be treated professionally. Guidelines are difficult. Each case differs in so many ways and no injury affects only one tissue, injury is multifactorial – in the main, if the machine causes pain when you use it, you have either chosen the wrong machine or the setting is incorrect. The line of thought 'it's hurting me, it must be doing good' is nonsense and is a dangerous attitude, particularly when using ultrasound. Pain means you are burning, damaging or destroying tissue, the very reverse of what is required. So what can be used safely from the horse repair kit?

Fractures

Recent work indicates that repair of bone is enhanced by the use of magnetic fields. It is safe to use the machines unless the break has necessitated the use of pins or plates. Treatment should not cause pain.

There is always deterioration of muscle after a fracture and it is of the utmost importance to maintain muscle strength. Unfortunately, muscles lose their 'tone' very rapidly and are slow to rebuild. Move the joints above and below the cast as much as is possible. If fingers or toes are exposed, move them. Try to tighten and relax the muscles inside the cast – this helps to maintain muscle but also, even more important, aids circulatory flow. Remember, no healing can take place without an adequate circulation.

When the cast is removed, keep the area bandaged for several days to prevent swelling. The tissues have been compressed since the cast was first applied; removal always results in temporary swelling. The weaker muscles will never catch up with their stronger brothers unless exercised separately. Groups of muscles, weaker than they should be, create the situation of imbalance with consequent uneven stress on the joints involved leading to problems years after the injury occurred.

Dislocation

Following reduction (replacement of the joint to its normal position), pain, swelling and loss of movement are all present. Cold and massage will help the swelling and ease the pain. If the joint is immobilised, tighten and relax all the muscles around the joint. Just as with a fracture, this will retain muscle strength, aid circulatory flow and aid healing.

The maintenance of muscle strength after dislocation is of the utmost importance, for the stretched ligaments will never completely recover their original size and strength; therefore the joint will depend on muscle strength for stability. The magnetic field machine, ultrasound, massage and muscle stimulation will all be of use post dislocation.

Unfortunately, the shoulder joint is subject to re-dislocation if used too early after reduction. Given time, the supporting structures will allow a stable joint, but if stretched too early the joint will slip out of place. If this happens too often, surgical repair is the only option.

Sprains and strains

The usual pattern of pain, swelling and loss of movement is present. Reduce the swelling with cold and massage. Cold bandages, especially the Bonner types with their inbuilt elastic support, are very useful.

Muscle tears

The earlier gentle movement is started, the less scarring in the tissues and the better the end result. Reduce the swelling and relieve the pain with cold as immediate first aid.

Bruises

Cold, massage and magnetic field therapy are the most useful in the early stages.

Ensuring muscle recovery

A useful method of 'loading muscle' to ensure recovery, necessary after all types of injury, is to purchase an aerobic weight, 4–6 oz (110–170 g) upper limb, 6–8 oz (170–225 g) lower limb, and put it on the wrist or ankle of the limb previously injured. By wearing the weight daily, half the day at first, working up to the whole day, during normal daily activities, muscle strength has usually recovered in six weeks.

General rehabilitation

Contrary to the ideas of many people, riding a horse does not make you fit. Mr Thelwell produced a brilliant drawing, titled 'The Body Beautiful – What Three Months' Riding Can Do', depicting a very fat lady bumping along on a very fat horse. On the next page, titled 'After', the picture showed the very fat lady now on a very thin horse! Fit horse, still-fat lady.

All winning riders are immensely conscious of the need to be fit, working out in gyms and swimming pools, jogging and riding bikes (the latter best without the saddle).

Getting fit is, to many, a bore. Regaining fitness after injury is even worse; but remember that injury, although confined in many cases to a small area, affects the working of the entire body. Injuries recover quicker given treatment and specific work for tissues in the area involved, followed by a programme of general activity.

The principles of the repair programme are the same for rider and horse: aid the repair after damage, regain full movement and muscle strength and re-educate the whole to regain confidence.

Appendix I

The Veterinary Act

As with all professional bodies, veterinary surgeons (UK based) are governed by codes of professional conduct, their governing body being the Royal College of Veterinary Surgeons (website: www.rcvs.org .uk).

The Veterinary Surgeons Act 1966 (section 19) provides, subject to a number of exceptions, that only members of the Royal College of Veterinary Surgeons may practise veterinary surgery.

Veterinary surgeons, guide to professional conduct (As provided by RCVS London, 28 March 2006)

'Veterinary surgery' is widely defined in the Act. Section 27 provides that it:

> 'means the art and science of veterinary surgery and medicine and, without prejudice to the generality of the foregoing, shall be taken to include:
>
> (a) the diagnosis of diseases in, and injuries to, animals including tests performed on animals for diagnostic purposes;
> (b) the giving of advice based upon such diagnosis;
> (c) the medical and surgical treatment of animals; and
> (d) the performance of surgical operations on animals.'

Treatment of animals by non veterinary surgeons

The following are the main relevant exceptions:

- Anyone may give an animal first aid in an emergency, to save life or relieve pain or suffering.

- The owner of an animal, or a member of the owner's household, or an employee of the owner, may give it minor medical treatment.
- The owner of an animal used in agriculture, or a person engaged or employed in caring for such animals, may give medical treatment or carry out minor surgery not involving entry into the body cavity, but not for reward.
- Veterinary students may carry out tests under veterinary direction and give treatment under veterinary supervision.
- A veterinary nurse may give medical treatment and carry out minor surgery (not involving the body cavity) at the direction of a veterinary surgeon who employs the nurse or acts on behalf of the nurse's employer. A student veterinary nurse can only give treatment under the supervision of a veterinary surgeon or a qualified veterinary nurse.
- Treatment by physiotherapy can be given by a person acting under the direction of a veterinary surgeon who has examined the animal and prescribed the treatment by physiotherapy.
- There are no special exceptions for farriers, complementary or alternative therapists or animal behaviourists. If not a qualified veterinary surgeon, no person can lawfully practise any element of veterinary surgery, even under veterinary referral, unless the circumstances fall within one of the various exceptions.

It is a legal requirement that persons undertaking any form of animal treatment comply with the Veterinary Surgeons Act.

Appendix II

Bandaging

Whatever the reason for bandaging – be it for support while working, support after injury, to apply pressure, either for control of inflammation or to reduce filling – the basic problem is to apply the bandage in such a way that it is functionally useful, does not slip and does not interfere with circulatory flow.

There are many types of material on the market, and only common sense can dictate the tension required for each type to enable the bandage to fulfil an adequate function. The emphasis when bandaging must be on evenness of tension: however soft the body of the material, an over-tight edge or over-tight turn can cause major damage to the underlying tissues. The tendons and joints of the distal limbs are particularly vulnerable to damage from over-tight bandages, underlying bumps or creases caused by old, lumpy wraps or poorly applied gamgee, also from bandages left in situ for too long.

Horses travelling long distances with their tail bandage applied too tight may lose their tail hair.

Gamgee or some other suitable padding material wrapped carefully around the leg, under the bandage, gives a better distribution of pressure, but care must be taken not to overrun the edge of the padding. The longer the bandage, the more gradual the spiral and the less likely it is to cause damage from creases.

A well-rolled bandage is a must for starters; it is far easier during application, to get even pressure with a carefully rolled bandage. If the bandage ties with tapes, these should be kept flat and must not be pulled tight; they should be at the same tension as the bandage. If crepe or tape-less bandages which do not have Velcro fastenings are used, the best way to secure them is with a strip of adhesive tape, Micropore or Elastoplast™.

Extra care must be taken when bandaging the knee joint. The accessory carpal bone (*pisiform*) is the bone which protrudes at the back of the knee; it is immediately adjacent to the overlying skin and is especially susceptible to pressure. A figure-of-eight type bandage should therefore be used when bandaging a knee, so giving minimal pressure over the accessory carpal bone.

Types of bandage

Tube gauze: an elasticated stocking sleeve useful for supporting underlying dressings. Available in various widths from all the larger pharmacies.

Glentona™ bandages: made of a thermo-lactic material whose properties include the ability for moisture to pass from the inner to the outer surface of the bandage.

Coldwraps and commercial cold bandages: most are fashioned from an impregnated gauze, the chemical used providing a source of cold for varying time periods when exposed to air. Some are single use, others can be re-rolled and placed in an airtight plastic container, stored in the refrigerator and re-used.

N.B. It is essential to follow the instructions on the pack when using commercial cold packs. A recent report documented the history of an athlete who sustained a moderate muscle strain of the gastrocnemius muscle. A shop-purchased cold pack was applied, instructions advised a fifteen-minute application. The pack was in situ for more than thirty minutes. On removal it was noted the skin area had become purple and the surrounding area had blanched. Removal was followed by an acute pain onset and the formation of a large blister, this required attendance at a burns clinic where a burn, described as superficial and deep partial thickness, was treated.

Crepe bandages: most satisfactory for support and pressure. If rinsed in warm water after use, they will regain their elasticity. Without their elasticity, they are of no benefit and can be dangerous.

Wet bandages: some bandages shrink as they dry; this can cause a severe reduction in blood flow, and damage to the skin and underlying structures. Use with great care.

Protector bandages: persistent filling in a leg, knee or fetlock joint can be both controlled and reduced using a neoprene bandage, trade name

Protector™. Designed in Australia, the material is similar to that used for wet suits, the four-way stretch ensures even pressure and the material can safely be soaked in iced water before being used, enabling the application of cold and pressure with no danger of shrinkage.

Bandages, whatever their function (unless ordered to be left in place by the veterinary surgeon), should be removed at least every twelve hours. When removed, a quick hand massage will stimulate the skin circulation. Allow the area to breathe. When the bandages are re-applied, care should be taken to ensure the folds lie in such a way that the edges of the bandage cover a different area.

Appendix III

Cupping

Adherent scar is often very difficult to free from the underlying tissues, particularly after injuries to the front of the knee, the scar tending to split on the resumption of activity requiring full knee flexion.

Cupping was the old-fashioned method of raising the skin from the underlying tissues. Used with bloodletting or the application of leeches(!), the apparatus consisted of a small, short, glass or bone funnel with a rubber ball fixed over the narrow end. The open end was placed firmly on a patch of dampened skin. By squeezing the rubber ball, air was evacuated; the ball was released slowly and the vacuum created pulled the underlying skin into the funnel aperture, thus stretching the tissue.

Exactly the same effect can be obtained by cutting the end off a 5 cc syringe; the open end is placed on the scar, which must be damp or oiled, and the plunger is then withdrawn. The tissue lying beneath the syringe is drawn up the barrel. Underlying adhesions can be stretched and the scar, if adherent, freed.

It must be remembered that scar tissue has virtually no blood supply, and care must be taken to ensure that there is no damage to the few blood vessels which are present.

Appendix IV

Points for Those Treating Horses

Carry a clipboard with pad and pen for recording case histories. Your case histories must be accurate. Digital photographs provide a useful visual record.

Insurance cover is essential for all offering treatments professionally.

Retain a professional approach and appearance. The animal may not be fussy – but animals have owners!

Wear clothes which do not restrict movement. You may have to kneel for long periods or move suddenly at speed.

A kennel/stockman's coat is useful; the pockets are invaluable. Unless you have a purpose-built unit in a veterinary yard, you will be working in a grooming or loose box. It is sometimes possible to use a straw-bale table; if not, there is just the floor. Vital leads have a habit of getting lost in bedding, so use pockets.

Boots are more useful than shoes. Make certain they have good, non-slip soles. Some are designed with steel toecaps – very useful, as toes break easily if stamped on. Boots do not fill with bedding, and you do not make a neatly swept yard messy by trailing bedding or shavings as you leave the box.

Avoid wearing jewellery. Rings have a habit of catching and many people have broken fingers by getting rings caught.

Use a good-sized watch which can be read easily and is waterproof.

Perfume upsets some animals – their smell appreciation differs from ours. (A notice on a monkey cage stated, 'We can smell you too, you know!')

If having worked in a yard where some form of infection is present, disinfect clothes, boots, hands, therapy apparatus.

Transmission of infection is not appreciated by clients; hygiene has become generally very poorly addressed/considered.

Machines

If possible, have a strong box/container. Ultrasound machines do not like being kicked or trodden on. A compartment within the box for leads, gels, etc. is a great advantage.

General points

Make certain all machines are turned back to zero before switching on. A patient will tell you if something has happened; a horse will kick you if all is not well. Test on yourself before using – once you have frightened an animal, it takes a long time for him to regain confidence.

Stables are sparsely provided with plugs, so take at least two long extension leads with you, 5 metres in length. Battery-operated machines are preferable.

Keep all lotions, solvents and gels in plastic containers: broken glass is a disaster.

A bucket is a good carrier for pads, electrodes, spare leads, sponges, salt, towels and other necessities. A spare bucket/plastic container, for soaking pads, holding a sponge, soaking towels or containing ice is also useful.

Have an adjustable halter and tie rope with you in case you arrive and find the tack room locked or all halters in use.

A plastic bib can be useful: if you have a patient which bites at one end and kicks at the other, you can eliminate one danger! Machines with leads attached to specialised pads are a hazard: it is amazing how quickly leads can be chewed through, and bandages or boots removed. The bib prevents this.

Hand-sized towels folded in half and then sown/machined to create a bag make a good ice container.

Carry a tape measure and a pair of carpenter's dividers. These allow you to record accurate measurement of swelling in the limb or the muscle bulk of the forelimb or hind limb.

The length from the bulb of the heel to the heel of the shoe is also worth measuring. There is very often great disparity between the inner and the outer side of the heel, and this can be a cause of breakdown.

Owners accept measurement, not guess work.

A plastic milk crate makes a useful platform if a horse is taller than you. It can also be used as a table or stool. Most dairies will sell you one. (Bear in mind that some makes are stronger than others.)

The owner

Owners are often very emotionally involved with their animals. The mere fact that the animal is ill or injured, and that they might themselves have contributed to the injury may make them feel helpless, frustrated and even angry. This may result in their being quite unable to help and irrational about suggestions made.

Explain what is going to be done and why, and also the possible reaction of the animal, including the effects of and reaction to the treatments: some treatments make the situation worse before it gets better.

Discuss aftercare; write down what the owner or groom is to do between visits. If called to a big yard, find out the yard routine – in hospitals, all treatments fit in with ward routine, and so should your visits.

In a racing yard, the head lad is very important. Make yourself known to him; without his help and backing, you may just as well go home, whatever the owner or trainer says. The head lad will respect you for your knowledge if you respect him for his, and will ensure that any requests for specialist exercise or grooming are carried out.

The lad who does and rides the horse will be a mine of useful information so talk to him.

Appendix V

Use of Anti-Concussion Pads

Shock and vibration and the associated musculoskeletal problems which they promote in the human have long been studied, are accepted and well documented. The ability to measure by means of 'force plates' the impact shock or 'G' force created when the foot meets the ground has led to the development of new types of material designed to dissipate the G force by as much as 78%.

The musculoskeletal structure of the horse is subjected to forces ranging from 30 G at the walk to as much as 360 G galloping and jumping – that is, the limb first touching the ground after the suspension phase at gallop, or landing after a jump, sustains a load equivalent to 360 times the normal body weight of the animal. Small wonder that such force creates problems in the foot and lower leg.

While it may be argued that the majority of the impact is absorbed by the digital cushion and also by the natural expansion, internal design and flexibility of the hoof, not all is accounted for and shock waves proceed up the leg until, finally, they terminate in the spine. The amount of shock dissipated in the foot also depends on the foot being correctly trimmed, the balance between the toe and heel, the angle medial to lateral and the fit of the shoe – in short, good foot care.

Polyurethane and viscoelastic polymer are first cousins, designed with a molecular structure able to absorb and dissipate shock laterally (sideways), thus reducing the G force sustained by the landing foot by as much as 78%. Riders using anti-concussion pads have reported that their horses felt more comfortable and moved more freely. While this is a subjective observation, the level of rider questioned would indicate honest appraisal.

The pads are available in different degrees of thickness, the choice depending upon the disciplines of the horse. Available as rims or full pads, they are fitted under the shoe. As the materials used are able to breathe, no problems associated with the sole being covered have yet been encountered. There is a recent tendency, based on work by Rick Redden DVM and others, to adopt a bare foot approach, due to the dangers of traffic reducing riding on roads, and the explosion of all-weather surfaces, reducing as they do concussive impact. Provided the foot is healthy and given time to adapt, adopting the bare foot must appeal to many. The feet need to be correctly trimmed and balanced by a farrier trained to work with un-shod horses.

Appendix VI

Suppliers of Machines Suitable for Animal Physiotherapy

General suppliers UK

Horse and Rider Medics
All units/equipment re-designed for equine use.
www.hrmedics.co.uk

SKF Services Ltd.
Major supplier for the therapist working in human therapy and rehabilitation.
www.skfservices.com

Bonner Bandages
Vetsearch Equine Supplies
Tel: 01588 638252

Wellie boots
See Horse and Rider Medics.

Jacuzzi Tubs/ Spas
ECB Equine Ltd.
www.equinespa.com

Panama Equine Hydrotherapy Ltd.
www.panamaspa.com

Low level laser (cold)
SKF Services: www.skfservices.com
See Horse and Rider Medics.

Sunlight
Solarium:
Newmarket Requisites, Black Bear Lane, Newmarket, Suffolk CB8 OJT.
Hippolarium:
Alvescot International Ltd, 2 Bollin Tower, Alderley Edge, Cheshire SK9 7BY.

Horse walkers
John Funell, Ash Tree Farm, Staverton, Daventry, Northants, NNII 4NN.

Sea walkers
Equine Health Centre Walkers
www.equinehealthcentre.com

Magnetic field therapy
Armadillo: www.armadillo-products.co.uk (static magnets)
Bemer 3000: www.bemeruk.co.uk (electro magnets)
Centurion Systems UK & Ireland Ltd: www.centurion-systems.co.uk (electro magnets)

Muscle stimulators
See Horse and Rider Medics; SKF Services Ltd

Massage machines
Niagara Equissage
www.equissage.co.uk
Pifco: Any branch of Boots the Chemists
John Bell and Croydon, Wigmore Street, London, W1M 7DE.

Surfaces
Martin Collins Enterprises
www.mceltd.com

Treadmill
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Glossary

Abdomen: the part of the body which lies between the chest and the pelvis.

Abduction: a drawing away from the median plane of the body.

Absorption: the uptake of substances into or across tissues.

Acute: having a short and relatively severe course.

Adduction: a drawing towards the median plane of the body.

Adhesion: a fibrous band abnormally joining tissues together.

Adrenaline: an important hormone secreted by the medulla of the adrenal gland.

Aerobic: growing in the presence of oxygen.

Anaemia: an abnormally low amount of haemoglobin in the blood.

Anaerobic: molecular oxygen is not a necessity for function.

Analgesic: relieves pain.

Anterior: situated in front of, or in the forward part of an organ.

Antiseptic: an agent which prevents the decay or decomposition of tissue by inhibiting the growth and development of micro-organisms.

Anus: the external opening of the rectum.

Aorta: the main vessel of the arterial system which carries blood away from the heart.

Arteriole: a minute arterial branch, especially one near a capillary.

Artery: vessel in which arterial blood is carried, the blood inside passes away from the heart and is delivered throughout the body.

Arthritis: (*arthro* = joint; *itis* = inflammation) inflammation of a joint or joints.

Articular surface: the internal opposing surfaces of a joint.

Articulation: movement occurring at a joint.

Ataxia: an inability to co-ordinate voluntary muscular movements.

Atrophy: wasting away of a normally developed organ or tissue due to degeneration of cells.

Avascular: not supplied with blood vessels.

Avulsion: the tearing away of part of a structure.

Bifurcation: the site where a single structure divides into two branches.

Bilateral: having two sides or pertaining to both sides.

Blistering: applying an agent to the skin to produce blistering and inflammation of the skin; was used to treat chronic or sub-acute inflammation of joints, tendons, and bones.

Blood pressure: the pressure of blood on the walls of the arteries, dependent on the energy of the heart action, the elasticity of the walls of the arteries, and the volume and viscosity of the blood.

Bog spavin: a chronic distension of the joint capsule of the hock with synovial fluid.

Bone spavin: a lameness, originating in the hock, which is characterised by either exostosis or bone destruction on the inner surface of the hock.

Bowed tendon: damage to the tendon which results in inflammation.

Bronchial: pertaining to either or both of the two main branches of the trachea, one going to each lung.

Bronchus, bronchi: either or both of the two main branches of the trachea, one going to each lung.

Bucked shins: a periostitis of the front side of the cannon bone, usually occurring on the forelegs of young horses which are strenuously exercised.

Bursa: a sac or sac-like cavity filled with fluid and situated at places in the tissues at which friction would otherwise develop.

Bursitis: an inflammation of the bursa, occasionally accompanied by the formation of a calcified deposit.

Calcification: the process of tissue becoming hardened by a deposit of calcium salts.

Callus: localised hyperplasia of the epidermis due to friction or pressure; an unorganised woven meshwork of bone which forms at the site of a fracture and is eventually replaced by hard adult bone.

Capped olecranon: a soft, fluctuant swelling over the point of the elbow due to trauma.

Capped hock: an inflammation of the bursa over the point of the hock caused by trauma.

Cardiac: pertaining to the heart.

Cardiac cycle: the actions of the heart during one complete heart beat.

Carpal: pertaining to the knee.

Chronic: long term, continued, not acute.

Clot: a semi-solidified mass of blood.

Collagen: a main fibrous protein of skin, bone, tendon, cartilage and connective tissue.

Collateral: secondary or accessory; a small side branch, as of a blood vessel or nerve.

Concussion: a violent jar or shock.

Conformation: the shape or contour of the body or body structures.

Congenital: existing at and usually before birth; referring to conditions which may or may not be inherited.

Connective tissue: the tissue which binds together and is the support of the various structures of the body.

Contusion: a bruise or injury incurred without breaking the skin.

Cow hocks: a conformation fault in which the hocks are pointed inward when viewed from behind.

Curb: a thickening of the plantar tarsal ligament, resulting in an enlargement below the point of the hock, and marked by inflammation and lameness.

Dehydration: condition resulting from excessive loss of body fluids.

Diagnosis: distinguishing one disease from another, or identifying a disease from its characteristics and/or causative agent.

Diaphragm: the muscular membrane separating the abdominal and chest cavities.

Digital: pertaining to the long and short pastern bones and the coffin bone.

Dilatation: the condition of being dilated or stretched beyond normal dimensions.

Dilation: a stretching or expansion.

Dislocation: the displacement of any part, usually referring to a bone.

Distal: a point further from the centre of the body.

Distension: the state of being swollen or enlarged from internal pressure.

Dorsal: pertaining to the top of the back, or denoting a position more towards the upper body than some other point of reference.

Dysfunction: disturbance or impairment of function.

Electrolyte: a substance which dissolves in water to yield a solution capable of conducting an electrical current, when dissolved electrolytes become either negatively or positively charged.

Endorphin: a pain-relieving chemical derived from a substance found in the pituitary gland.

Epidermis: the outermost layer of skin.

Epiphysis: a part of a bone, especially at the end of a long bone, which develops separately from the shaft of the bone during the growth period – during this time it is separated from the main portion of the bone by cartilage.

Epiphysitis: inflammation of the epiphysial plate present in immature/developing bone.

Epithelium: the covering of internal and external surfaces of the body, including the lining of vessels and other small cavities; it consists of cells joined together by small amounts of cementing substances.

Extension: a movement that brings a limb into a straight line.

Extensor: any muscle which extends a joint.

Facet: a small plane or surface on a hard body, as on a bone.

Fascia: a sheet or band of fibrous tissue lying below the skin, subcutaneous fascia, or surrounding muscles and various organs of the body.

Fasciculation: an involuntary muscle tremor.

Fetlock: the area or joint of the lower leg between the distal cannon and proximal pastern P1.

Fibrosis: the formation of fibrous tissue.

Fibrous adhesion: a fibrous band or structure usually formed as a result of repair by scar tissue.

Filing: the act of filing down the teeth to remove sharp edges; also referred to as floating.

Flexion: the act of bending.

Fossa: a hollow or depressed area.

Fracture: the breaking of a part.

Frog: wedge-shaped mass of (in the healthy foot) relatively soft elastic horn lying between the bars of the foot.

Gaskin: the thigh of a horse usually referred to as the second thigh.

Gastric: pertaining to the stomach.

Haematoma: an accumulation of blood within the tissues which in time clots to form a solid swelling.

Haemoglobin: the oxygen-carrying protein pigment of the red blood cells, erythrocytes.

Haemorrhage: the escape of blood from the vessels; bleeding.

Hoof tester: Used to help diagnose foot problems, a pincer-like instrument is used to gently squeeze the structures of the foot. Applied over an area of underlying damage causes the horse to flinch.

Hyperextend: extreme or excessive extension.

Hyperflexion: extreme or excessive flexion.

Hypersensitivity: a state of altered activity in which the body reacts with an exaggerated response to a foreign agent.

Insertion: the point of attachment of a muscle, ligament, tendon or other structure.

Inspiration: the act of inhaling or drawing air into the lungs.

Intravenous: within a vein.

Involuntary: performed independently of the will.

Ischaemia: inadequate blood supply to an organ or tissue.

Joint: an articulation, the place of union or junction between two or more bones of the skeleton.

Laceration: tissue damage, resulting in a torn, ragged wound.

Laminitis: inflammation of a lamina within the foot.

Larynx: the area of muscle and cartilage located at the origin of the trachea and below the root of the tongue; 'voice box'.

Lateral: pertaining to a side or outer surface; a position further from the midline of the body or of a structure.

Lesion: an abnormal change in the structure of a part due to injury or disease.

Ligament: a band of fibrous tissue which connects bones or cartilages.

Lumbar: pertaining to the loins, the lumbar area or part of the back between the thorax and pelvis.

Luxation: dislocation.

Lymph: a transparent yellowish liquid containing mostly white blood cells and derived from tissue fluids.

Medial: pertaining to the middle or inner surface; a position closer to the midline of the body or of a structure.

Metatarsal: cannon; the area between the hock and fetlock joint.

Mobility: the ability to move.

Muscle tremor: an involuntary trembling or quivering of a muscle; fasciculation.

Navicular: a small bone in the foot of a horse; a term commonly used to designate pathology of the navicular bone.

Necrosis: death of a cell or group of cells.

Nerves: cord-like structures, mostly invisible to the naked eye, comprising a number of fibres which convey impulses between the central nervous system and the body mass.

Nervous system: the principal control system, receiving, interpreting and conveying information in order to co-ordinate all bodily activities.

Non-vascular: not supplied with blood vessels.

Oedema: excessive accumulation of fluid in the body tissues.

Olecranon: the point of the elbow formed by the bony projection of the ulna.

Optic: pertaining to the eye.

Origin: the point of attachment of a muscle which remains relatively fixed during contraction of the muscle.

Ossify: the formation of bone.

Palpation: the act of feeling with the hand.

Pastern: the area between the fetlock joint and the coronary band.

Patella: a triangular sesamoid bone situated at the front of the stifle; also called the knee cap.

Pathological: a condition pertaining to disease.

Pelvis: the bone structure comprising the sacrum and paired os coxae attached to the vertebral column at the sacroiliac joint and enabling a stable attachment for the hind limbs.

Peripheral circulatory system: the part of the circulatory system which carries blood to the outer parts of the body such as the legs.

Phalanx: any of the three bones below the fetlock; the long pastern bone, short pastern bone, and coffin bone.

Plasma: the liquid portion of the blood, containing the suspended particulate components.

Platelets: disc-shaped structures found in the blood of all mammals and chiefly known for their role in blood coagulation; also called blood platelets. (*See also* Thrombocytes.)

Plexus: a network of lymphatic vessels, nerves, veins, or arteries.

Posterior: situated behind, or in the back of, a structure; towards the rear end of the body.

Poultice: a soft, moist mass of the consistency of cooked cereal, spread between layers of muslin, linen, gauze, or towels, and applied hot to a given area in order to create moist local heat or counter irritation.

Prognosis: the prospect of recovery from a disease or injury.

Progressive: advancing, going from bad to worse; advancing in severity.

Proprioceptor: specialised nerve endings located in soft tissue. Function to monitor and co-ordinate muscle activity.

Proud flesh: excessive granulation tissue.

Proximal: a point near to the centre of the body.

Pulmonary: pertaining to the lungs.

Pulse: rhythmic throbbing of an artery which may be felt with the finger; caused by blood forced through the vessel by contractions of the heart.

Pus: a fluid resulting from an infected inflammatory process. Is of a creamy texture, may be white, yellow or pale green.

Rasping: filing the teeth with a rasp to provide dental care.

Red blood cells: haemoglobin-carrying corpuscles in the blood which transport oxygen.

Reflex arc: the neural arc used in a reflex action.

Regeneration: the natural renewal of a structure, as of a tissue part.

Ringbone: a general term which applies to bony enlargements and areas of new bone growth below the fetlock.

Roach back: a conformation fault in which the back is arched and convex. This fault predisposes a horse to forging and shortens the gait of the animal.

Rotation: the process of turning around an axis.

Rupture: a breaking or tearing of tissue.

Sacroiliac: pertaining to the sacrum and ilium, denoting the joint or articulation between the sacrum and ilium and associated ligaments.

Sacrum: the triangular bone just behind the lumbar vertebrae, wedged dorsally between the two wings of the hip bone.

Saddle sore: a simple inflammation of hair follicles (usually on the withers) caused by friction between the horse and the saddle.

Sand cracks: cracks in the hoof wall.

Scar tissue: tissue remaining after the healing of a wound or other morbid process.

Sebaceous: a thick, fatty semifluid substance secreted by the skin.

Seedy toe: a disease of the hoof wall in the toe region in which the hoof wall is separated from the white line.

Septum: a dividing wall or partition.

Sequestra: pieces of dead bone that have been broken off or become separated, during the process of necrosis, from the sound bone.

Sesamoid: a small nodular bone embedded in a tendon or joint capsule.

Sesamoiditis: an inflammation of the proximal sesamoid bones, usually involving both osteitis and periostitis.

Shin buck: *See* Bucked shins.

Sickle hock: deviations in the angle of the hock as seen from the side; the cannon slopes forward due to excessive angulation of the hock.

Sinusitis: inflammation of a sinus, marked by discharge of pus from one or both nostrils.

Spasm: a sudden, involuntary contraction of a muscle or constriction of a passage.

Spavin test: a test in which the affected leg is held acutely flexed for about two minutes, then released immediately before the horse is trotted; the test is considered positive for bone spavin if lameness is markedly increased for the horse's first few steps.

Splints: rigid or flexible appliances for the fixation of displaced or movable parts; the two small bones lying behind the cannon bones.

Sprain: a joint injury in which some of the fibres of a ligament are ruptured.

Strain: an overstretching or overexertion of some part of the musculature.

Stress: forcibly exerted influence or pressure.

Subacute: somewhat acute, between acute and chronic.

Subluxation: an incomplete or partial dislocation.

Supraspinous: above a spine or spinous process.

Suspensory: a ligament, bone, muscle, sling or bandage which holds up a part.

Synovial fluid: a transparent fluid, resembling the white of an egg, secreted by the synovial membrane and contained in joint cavities, bursae and tendon sheaths for lubrication.

Tendon: a fibrous cord of connective tissue which attaches muscle to bone or other structures.

Thorax, thoracic: the chest; the part of the body between the neck and the diaphragm, encased by the ribs.

Thrombocytes: blood platelets.

Tied in at the knee: a condition occurring when the flexor tendons appear to be too close to the cannon bone just below the knee.

Tissue: an aggregation of similarly specialised cells united in the performance of a particular function.

Trauma: a wound or injury.

Ultrasonics: the use of controlled doses of high frequency sound (radiation) for therapeutic treatment.

Vein: a vessel through which the blood passes from various organs or parts back to the heart.

Venous: pertaining to the veins.

Voluntary: accomplished in accordance with the will.

Windgalls: also called windpuffs; a distension (overfilling) of the synovial sheath between the suspensory ligament and the cannon bone, or of the synovial sheath between the long pastern and the middle inferior sesamoidean ligament.

Wobbler: a disease which affects the cervical spinal cord and vertebrae of young horses; it is a sporadic, non-paralytic condition marked by inco-ordination. Also known as equine inco-ordination.

Index