CHAPTER II

LITERATURE REVIEW

Anatomy of horse back

The back is the part of the spine between the neck and the tail which supports the thorax and abdomen suspended beneath it. In the pregnant mare it also supports the weight of her fetus. However, it is not designed to carry the weight of a rider and a well-fitting saddle is essential to minimize back problems. The strength of back results from the combination of bones, ligaments, tendons and muscles, to ensure the rigidity of the spine

The neck and tail are much more flexible than the back. The tail is an active fly swatter and an indicator of discomfort(17).

Conformation

The back is the transmission between the hind quarters and the forelimbs, it also carries the rider, so it is one of the important conformation factors in movement. The lumbosacral joint is a key area in the back, as this is where engagement of the hindquarters is determined(18).

To be strong the horse's back should be short; a rule of thumb is that there should be no more than a hand's width between last rib and the point of hip(Fig2.1). A horse with a long back (Fig.2.2) will be weak in the loin region and will find it difficult to engage the hind quarters. A long back makes it more difficult for the horse collect himself and shift his balance. However, a horse that is very short in the back may lack flexibility or not as smooth and springy in it movement as longer-backed

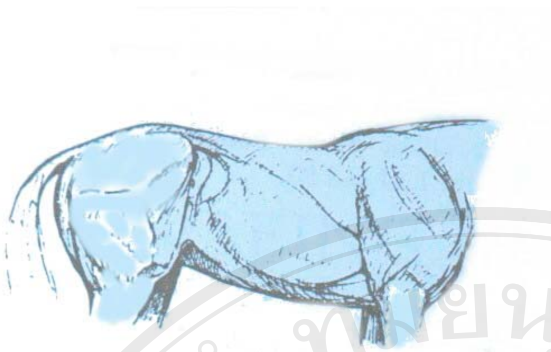


Figure. 2.1: The good back(19**)**

Figure. 2.2 Long back(19**)**

horses. Occasionally roach backed (Fig.2.3) (the opposite of hollow-backed) horses are seen.(17) It is hard to fit a saddle and can make it difficult for the horse to use his back in coordinated effort to lighten the forehand. Any way the back that is hollow (Fig2.4) or dippy makes for a comfortable ride but it even more difficult for the horse to transmit power from the hindquarters.(18)

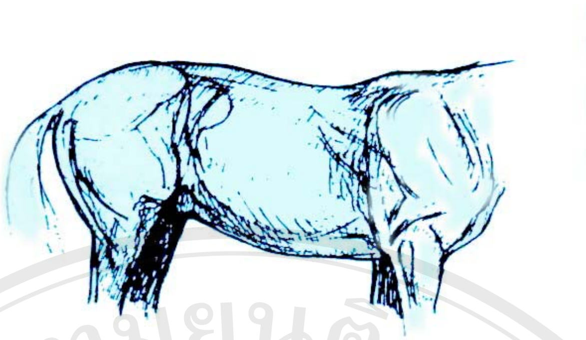


Figure. 2.3 Roach back

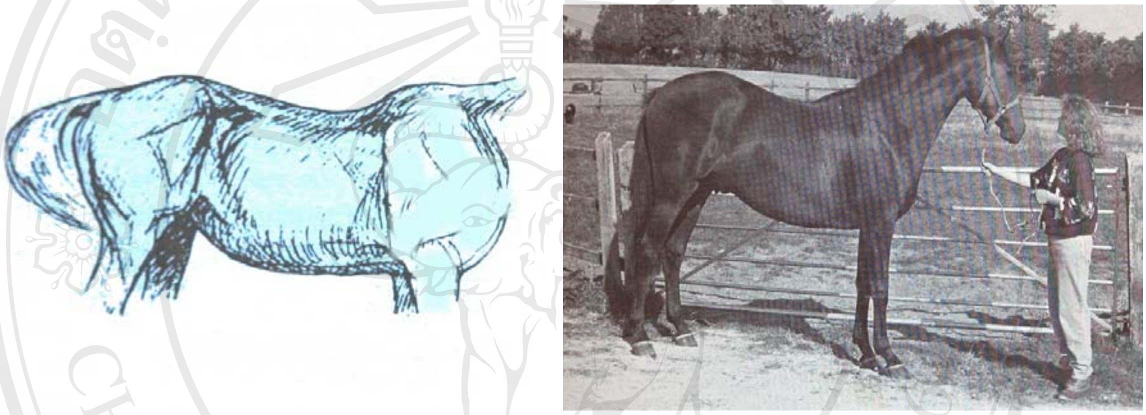


Figure. 2.4 Hollow back(19)

The withers should lie well back and should be clean and of moderate height. Since the back and neck muscles, short, low withers give less space and length for muscles and are associate with short, stubby gaits and moving on the forehand. Extremely high, sharp withers may simply indicate alack of muscle development, but they may be also show that the shoulder is short and steep(18).

The skeleton

The vertebral column is the skeleton of the neck, withers, back and tail. Besides support, the main functions of the vertebral column is providing protection for and house the spinal cord, which carries nerve impulses to and from the brain.

In the horse, the vertebral column can be divided into five regions. The vertebral column consists of 7 cervical vertebrae (cervical spine C1-7), 18 thoracic vertebrae (thoracic spine, T1-18), 6 lumbar vertebrae (lumbar spine, L1-6), 5 sacral vertebrae (S1-5) and between 18 and 22 caudal vertebrae (17)(Fig.2.5)The back from above

The withers are the highest point of the thoracic spine and are formed by the third to the tenth thoracic vertebrae. The withers are held firmly in place by ligaments between the vertebral spines and other muscles and ligaments between the vertebral spines and other muscles and ligaments attached to them, including part of the nuchal ligament. Movement between the horse's thoracic vertebrae is strictly limited.

The lumbar vertebrae make up the loins region. There are normally six lumbar vertebrae but sometime only five; in same breeds, particularly the Arab, an extra thoracic vertebra is often found. The width of the transverse process and the length of the dorsal spines characterize the lumbar vertebrae. The lumbar vertebrae of the horse carry three extra particular facets, making the horse different from most other mammals; these limit movement of the spine in the lumbar region. However, it should be remembered that:

- The loins are the most flexible and vulnerable part of the back.
- A well-designed and correctly fitting saddle, enduring the rider's weight is not taken on the loins or the vertebral column, will help to protected horse's back(17).

Joint

Lumbosacral joint

The lumbosacral joint is part of the spine and acts to transmit the impulsion generated by the hindquarters (Fig 2.5). Its flexibility, although limited, allows the pelvis to rotate forwards under the horse’s body during the canter and gallop and when engaging the hindquarters to raise the back. This rotation mainly takes place when both hind limbs move forwards. Even though the lumbosacral joint has limited action, the ability of the horse to move well is dependent upon its full function.

At the walk and trot both hind legs move in opposite direction; because the lumbosacral joint is incapable of sideways flexion the sacroiliac joints take up some of this movement. For maximum effectiveness the lumbosacral joint should be positioned as far as possible in front of the sacroiliac prominences (point of coup). If a horse’s back is long, there is additional leverage on the lumbosacral joint, increasing the stress put on the area by the rider’s weight and the demands of engagement. This area can be supported and strengthened with the correct muscle development.

a. **b.**

Figure2.5 The lumbosacral joint function: a. in standing position b. during gallop(18)

Ligaments

The ligaments of the spine are important in helping to keep the individual vertebrae in place and giving the back strength and stability.

Supraspinous ligament

The supraspinous ligament runs along the back from the sacrum and joints together the top of the spinous processes of all the lumbar and thoracic vertebrae. In the withers area the ligaments flatten to form a broad sheet, extending on either side almost to the scapular cartilages.

Nuchal ligament

In the neck the supraspinous ligament is modified to from the nuchal ligament, which is strong and elastic. It plays an important role in the functioning of the vertebral column. It consists of two parts. The lamellar part of the nuchal ligament is made up of two sheets running down either side of the neck which attach to the cervical vertebrae. The funicular part runs from the withers up the neck to the poll where it attaches to the occiput of the skull. Where the ligament runs over the wither the supraspinous bursa, which contains lubricating synovial fluid, reduce friction; this lies between the second and fourth thoracic spinous processes and is the site associated with the condition termed fistulous withers.

The two parts work passively yet effectively together to provide support for the head and neck. When the head and neck are lowered, they exert a forward traction on these long lever arms causing flexion of the thoracic vertebrae (Fig.2.6).

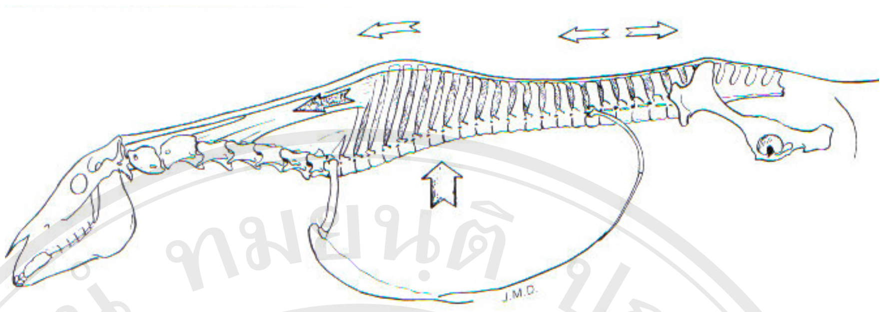


Figure 2.6 a. Lowering the neck places the ligaments under tension, separates the thoracic spinous process and flexes the thoracic spine(20**)**.

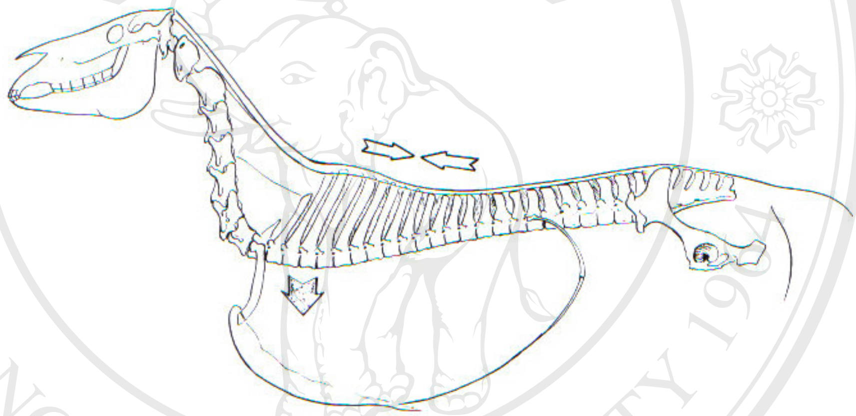


Figure 2.6 b Raising the neck causes cervico-thoracic extension, relaxes the ligaments, brings the spinous processes back together and extends the thoracic spine (20**)**

Musculature

The Thoracolumbar epaxial fascia and musculature are discussed, proceeding from the superficial to deep layers. The thoracolumbar fascia is an aponeurosis that serves as an attachement site for many spinal and proximal limb muscles. The thoracolumbar fascia is strong and attaches to the thoracolumbar spinous processes and the cranial edge of the ilial wing. The first muscular layer (Fig.2.7) includes two thin muscles: The serratus dorsalris cranialis and the serratus dorsalris caudalis. These muscle assist in respiration and have superficial and deep fascial layers that encase the liliocostalis muscle group(21).

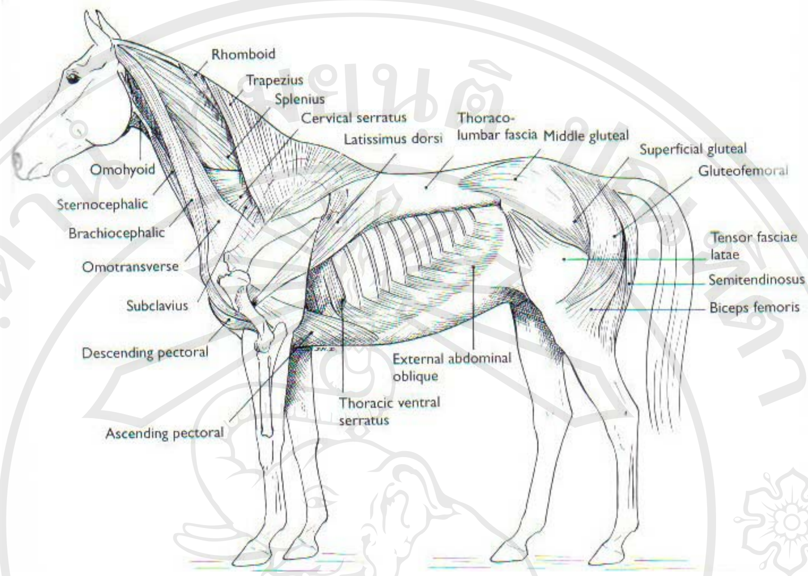


Figure.2.7 Muscle of the neck and trunks: superficial layer(20**)**

The second layer of muscles (Fig.2.8) is the largest group of epaxial muscles and organized into three parallel columns. These include (laterally to medially) the iliocostalis, longissimus, and spinalis muscle groups (Fig2.9) .

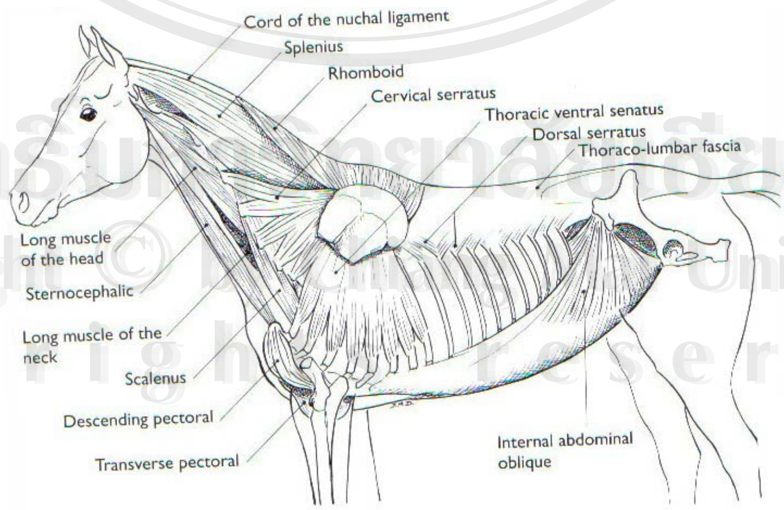


Figure 2.8 a. Muscle of the neck and trunk middle layer lateral view(20**)**

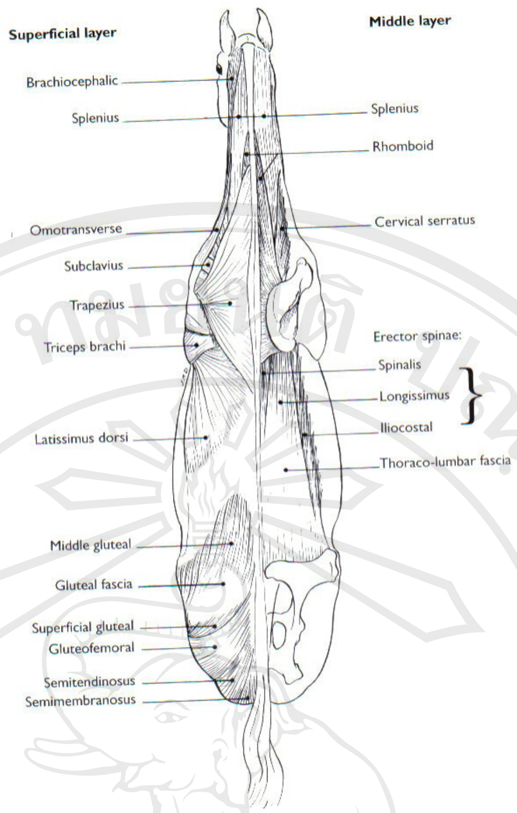


Figure 2.8 b. Muscle of the neck and trunk: dorsal view(20)

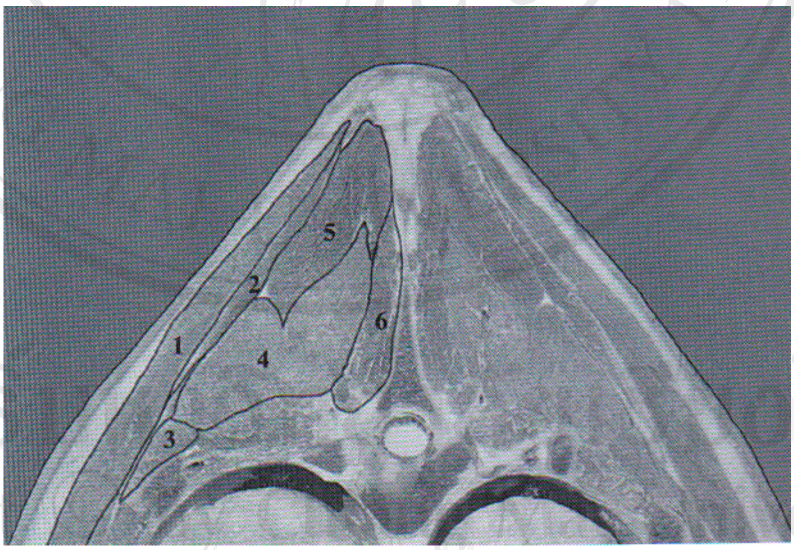


Figure 2.9 Transverse section at the T8 vertebral region. Outline of the muscle represented are: 1) latissimus dorsi; 2) rhomboideus thoraci; 3) iliocostalis; 4) logissimus; 5) spinalis; and 6) multifidi.(21)

The iliocostalis muscles are a thin muscle group that attaches to the angle of the ribs and the tips of the lumbar transverse processes. The longissimus muscles are by far the largest and longest group of back muscles. These muscles primarily attach to the spinous and transverse processes of the thoracolumbar vertebral region and the wing of the ilium and help to support the weight of the saddle and rider. The spinalis muscles cover the lateral aspects of spinous processes of the withers and may be compromised by a narrow saddle. The third layer(Fig2.10), the trasversosspinalis muscle group, is the deepest and most medial muscle group (Fig2.11). The trasversosspinalis muscle group is largely composed of mutifidi muscles in the thoracolumbar vertebral region. The multifidi muscle group is a series of short musculotendimous units that originate from transverse, articular, and mamillary process and insert on adjacent spinous processes. These short muscles span two to four vertebrae and are segmentally innervated by dorsal spinal branches

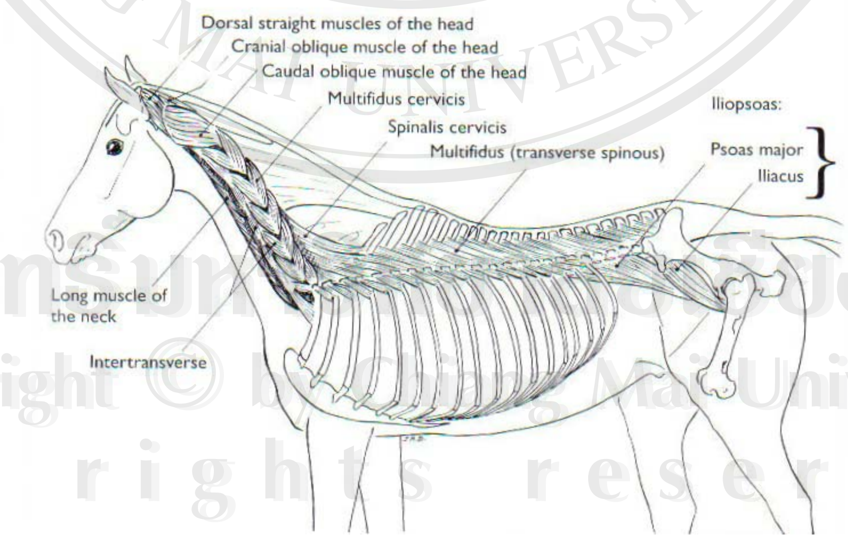


Figure 2.10 Muscle of the neck and trunk deep layer(20).

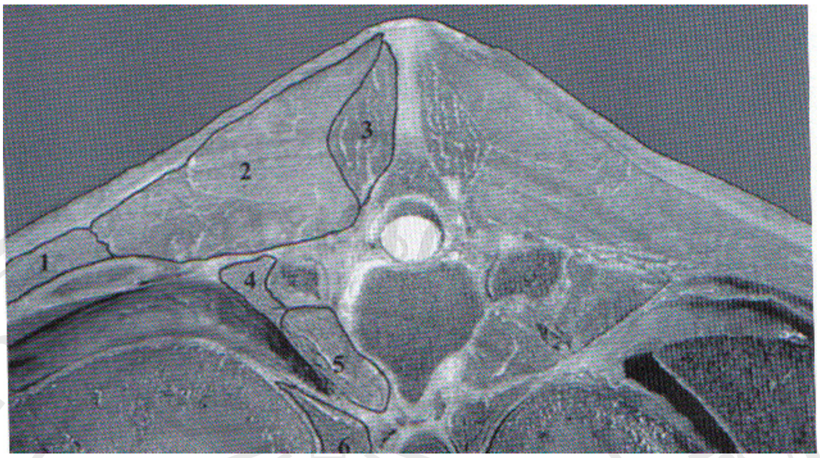


Figure2.11 Transverse section at the T18 vertebral region. Outline of the muscle represented are: 1) iliocostalis; 2) longissimus; 3) multifidi; 4) psoas major; 5) psoas minor, and 6) crus of the diaphragm.(21)

The epaxial muscle muscles produce spinal extension when activated bilaterally and lateral flexion and rotation when activated unilaterally. Superficial muscle groups span one or more vertebral regions, whereas deep spinal muscles usually span a few vertebrae(21). The spinal musculature is important for movement, posture, and flexibility. The superficial spinal muscles are usually more dynamic (higher percentage of type II muscle fibers) and play a role during regional vertebral motion, energy storage, energy, and force redistribution during locomotion (21). These are the sprint or jumping fibers: they are more powerful than type I fibers but much less resistant to fatigue. Deep short spinal muscles have more of a statistic function (higher percentage of type I muscle fibers) and are activated in segmental stabilization, proprioception, and posture. A Clinical condition of the spinal musculature includes muscle strain due to overexertion or trauma.

Nerves

The spinal nerves make up a regular series of 42 pairs that arise from the spinal cord. There are 18 pairs of thoracic spinal nerves and 6 pairs of lumbar spinal nerve.

Function and movement of back

Flexion (Fig.2.12)

The flexor muscles of the thoracolumbar spine can be divided into the following groups, in terms of theirs location, insertion and action:

- The muscles of the latero-ventral wall of the abdomen (rectus and internal oblique), which external their insertions from the sternum to the pubis. Via their attachment to the ribs they are flexors of the whole section, particularly the hinge joint between T17 and L2 and the lumbo- sacral hinge(hip) joint.
- The muscles of the lower lumbar region (poas) extend, cranially,no further than T16 and the 17th rib; They are essentially flexors of thelumbo-sacral hinge joint.

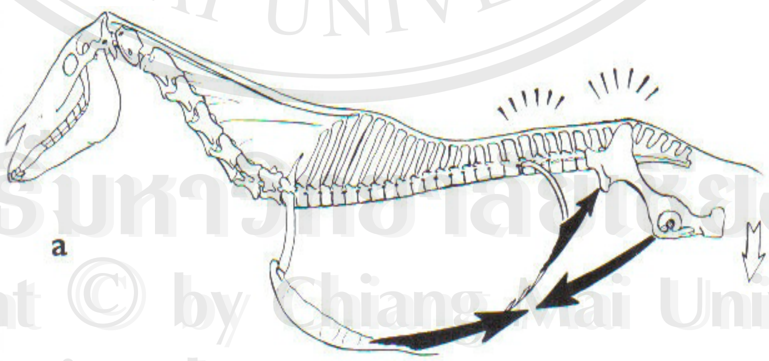
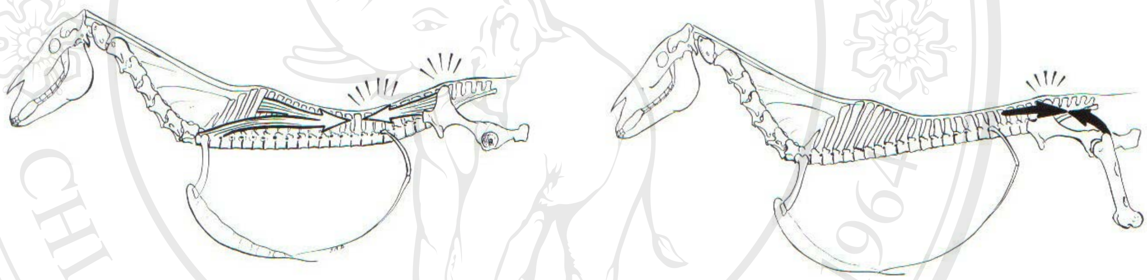


Figure.2.12 Flexors of the vertebral column: a Thoraco-lumbar and lumbo-sacral flexion; concentric contraction of the rectus and internal oblique muscles of the abdomen. b Lumbo-sacral flexion; concentric contraction of psoas major and minor.(20)

Extension (Fig.2.13)

These muscles are similarly divided according to location and function:

- The muscles of the erector spinae group (particularly longissimus and spinalis) with their extensive insertions and multifidus, are extensors of the whole section. Erector spinea is also an extensor of the lumbo-sacral hinge joint.
- The hige joint also benefits from the powerful action of the middle gluteal; this muscle, via its cranial attachments to the thoraco-lumbar fascia, is used to bring the pelvis into alignment with vertebral axis.



a. **b.**

Figure 2.13 Muscles responsible for extension of the vertebral column: a. Thoraco- lumbar and lumbo- sacral extension –longissimus and spinalis of the erector spinae; b. Lumo-sacral extension- middlegluteal.(20**)**

Lateroflexion (Fig. 2.14)

This movement is essentially produced by the iliocostal and longissimus muscles of the erector spinae group and by the oblique abdominal muscles. The psoas and quadratus muscles of the loins contribute in only a minor capacity, as the possibility of inword curvation in the lumbar region is minimal.

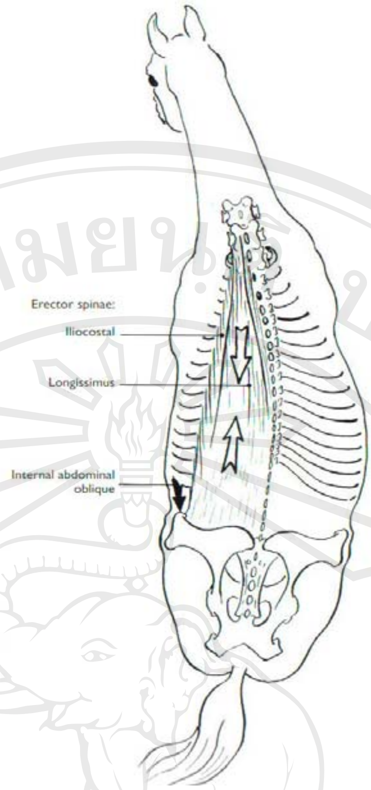


Figure 2.14 Muscle responsible for vertebral lateroflexion.

Rotation (20**)**

The movements involved in rotation and latroflexion are always linked, and all the muscles mentioned above are also rotators of the vertebral column.

Factor of back injuries (17**)**

The horse is designed to move forward at high speed, rather than to jump and move laterally as is required in dressage. The muscles of the back are therefore particularly prone to injury when the horse is asked to carry out difficult manoeuvres.

When working a horse the aim is to round and strengthen the back and engage the hindquarters. A horse's back becomes slightly rounded when the abdominal and spinal flexor muscles are used. The contraction of the abdominal muscles tilts the horse's pelvis and brings the hindquarters more underneath the abdomen. To tilt the pelvis there must be some movement in the lumbosacral and sacroiliac areas together with movement of the associate ligaments. Injury of the sacroiliac ligaments is a common cause of back pain in horses. The jumper's bump, where the point of the croup (sacral tuber of the ilium) becomes overly prominent may be a sign of long-term sacroiliac problems.

As with most sports injuries the problem can be avoided by:

- Thorough warm-up
- Increasing the difficulty of exercises gradually
- Giving short periods of walking and stretching during schooling
- Avoiding tension
- Avoiding fatigue
- Cooling down thoroughly

The saddle fitting (22**)**

Many horses are sore in theirs backs or hampered in their movement because of a poorly fitted saddle. An unbalanced saddle throws the rider off balance, which makes it impossible for the horse to carry him well.

A saddle must fit the horse without pinching, rocking, creating pressure pints or pressing on the horse's spine. This means that the tree must be the right width and shape for the horse's back. A too-wide saddle sits down too low and cause pressure sores on the withers. A too-narrow saddle rides high in front, throwing the rider backward and digging the tree points into the horse's back and shoulder muscles. The saddle must be balanced so that it does not throw the rider backward or forward, and the lowest part of the seat should be in the center. It must be place correctly so that it rest on the saddle muscles, allowing room for the spine and for the movement of the shoulder blades.

Check saddle fit by putting the saddle on the horse without a saddle pad. No part of the saddle should touch the spine; you should be able to fit two fingers between the saddle and the withers when the rider is mounted. Run your hand over the back of the horse's shoulder blade, under the front of the saddle. It should not pinch or dig into the back and shoulder muscles. Look at the balance of the saddle from the side. If it tilts backward or forward, it is out of balance and may hurt the horse's back as well as throw the rider out of balance.

Some horses are more comfortable and move better with a back protector pad. These pads, made of neoprene or other materials, cushion the effect of the saddle and the rider's weight and let the horse's back muscles move more comfortable. Be careful not to unbalance a saddle by stuffing too much padding under it.

The saddle must fit the rider, too. Too small a saddle, too large a saddle or the wrong length of stirrup can put the rider out of balance, making him uncomfortable and hindering the horse's movement.

Pain in animal

The international Association for the Study of Pain has defined pain as an unpleasant sensory or emotional experience associated with actual or potential tissue damage.

Analgesia is the absence of pain, achieved through the use of drugs or other modes of therapy. For both ethical and medical reasons, the veterinarian must ensure that analgesia's provided for every patient that requires it.

Veterinarians are becoming more aware of animal's need for analgesia. Although veterinary patients cannot verbally communicate their perception of pain, all the available evidence indicates that pain perception in humans and animals is similar.

A good rule of thumb is that if a procedure is known to be painful in human, it should be regarded as such in animal patients.

Physiology of Pain

Pain results when nerve cells in the skin or deep tissues (called nociceptors) detect a noxious stimulus. Examples of noxious stimuli include heat, ischemia, distention or stretching, mechanical injury (such as a scalpel incision), or mechanical released by inflammation or tissue damage (including prostaglandins, leukotrienes, bradykinin, proteolytic enzymes, histamine, potassium ions, and serotonin).

Pain receptor converts stimuli to nerve impulses. There are two types of sensory neurons that transmit the majority of pain signals to the spinal cord and pain. *A delta fiber* transmits sharp, discrete pain signals that allow the patient to localize the source the pain to an exact site. These neurons are large and myelinated and conduct signals rapidly. Smaller, non-myelinated *C fibers* transmit dull, aching, or throbbing pain sensation that cannot be exactly localized. It is thought that *somatic pain* (that is, arising from skin, subcutaneous tissue, muscle, bones, or joints) is transmitted by both A delta and C fibers, whereas *visceral pain*(arising from internal organs) is primarily by C fiber only. The information from nociceptors is conveyed to the dorsal horn of the spinal cord, where transmission of pain signals is suppressed or augmented by the affect of neural hormones such as substance P and cholecystokinin. The information is then transmitted to the thalamus and the sensory cortex of the cerebrum, where the perception of pain occurs.

Pain can be classified in several ways. The intensity of pain may be mild, moderate, or severe, and the duration may acute or chronic. *Chronic pain* has a slow onset, a duration of several months or years, and may be unresponsive to drug therapy.

Examination of the back (23).

A veterinarian should first attempt to rule out any lameness from back pain (9). An equine's back is an area where objective physical examination remains difficult. Inspection can reveal asymmetries due to swelling, muscle atrophy and curvature deformities. Palpation may be helpful by assessing the presence of pain and/or muscle spasm. However, it is often difficult to be certain of the significance of mild or moderate responses in relation to the presenting complaint.

If possible, the dorsal midline of the back should be viewed from above as the horse is standing square, to check whether it is correctly aligned. Some degrees of lateral curvature suggest a possibility of a muscle spasm on one side. The symmetry of the pelvis should be checked from behind and quarter, and the back should be inspected for muscle wastage. Abnormal findings could indicate sacroiliac injuries. Where there is damage to the muscles or ligaments of the sacroiliac region, it is usually possible to evoke discomfort by exerting pressure over the tuber coxae and/or over the midline at the lumbar region.

Pinching over the dorsal spinous processes at the withers normally causes 'dipping' of the spine (dorsiflexion), whilst pinching over the sacral region normally causes an extension (ventroflexion). Reluctance to comply, or a rigidity of the spine, may reflect some underlying bony pathology. Similarly, pressure with a blunt point over the dorsal spinous processes, caudal sacrum and flank can be used to stimulate spinal flexion away from the stimulus, enabling assessment of the animal's willingness and ability to carry out this movement.

Firm stroking of the longissimus dorsi with a blunt point normally produces lateral flexion of the thoracic and lumbar spine. Resentment suggests painful muscle involvement, but if it is detected on both sides then it could reflect pain in the vertebral column of the mid-back.

In a straight-line walk and trot, back pain can produce a restricted hindlimb action with poor hock flexion and a tendency to drag the toes of one or both hindlimbs. Sharp turning to flex the spine will be resented, or appear difficult with clumsy or jerky movements. Backing up is also resented. Radiography of an equine back requires high powered examination equipment and is associated with considerable radiation scatter. Its use is limited to a few specialized centers. Clinical pathology is generally non-specific, but serves to rule out other causes of reduced performance of the horse (e.g. anemia, intercurrent infections, and chronic rhabdomyolysis).

Limiting Factors in veterinarian evaluation of back problems

Inability to Define Back pain

Quantifying the degree of pain in animals and establishing the precise site of pain has always been difficult, and horses with back pain are no exception. The situation is further complicated, as the major clinical sign recognized in many horses with a back problem is impaired performance and not thoracolumbar pain. On the other hand, there must be any horses that apparently perform

Monitoring sign of pain

Not only the most of pain evaluation in animal is base on behavioral observation but also the common-descriptive method is using for measurement in study However, No research study uses quantitative measuring or pressure algometry for the efficacy of EA treatment in the horse. In this study uses pressure algometry to evaluate pain level that is follow that is scientific method to evaluation and reevaluation. Quantitative measurement of back pain using pressure algometer

Conventional treatment back pain

Treatments of back pain

Treatments of back pain can be divided into 4 groups: 1) medication, 2) surgery, 3) physical therapy, and 4) alternative medicine. With medical management, the most common drugs administered systemically are non-steroidal anti-inflammatory drugs, tranquilizers, muscle relaxants, corticosteroids and estrogen (24, 25). The most commonly injected drugs in the region of pain are corticosteroids, local anesthetics, and local anti-inflammatory agents that are usually mixtures of mercury salts and oil (25). The materials most commonly applied to the skin over the painful region are liniments and dimethyl sulfoxide (25). The advantage of these methods is that they can relieve back pain. However, there are some disadvantages, especially considering cost-effectiveness factors, as well as adverse drug reactions, drug interactions and expenses. Surgery is invasive, expensive and requires intensive post-operative care.

Physical therapy includes rest, moist heat, swimming, therapeutic ultrasound, cutaneous electrical stimulations,and magnetic filed therapy (26).

Rest and time are the most important factors influencing the outcomes of physical therapy. In the human, restriction of activity, rest and even bed rest are the traditional medical treatment for back pain. Rest is the most common treatment advised by physician apart from analgesics. John Hunter (1794) fist proposed rest as a treatment, in a treatise on wound and inflammation. The concept of therapeutic rest seems to have arisen about the time, based on new pathologic ideas of inflammation. (241 rest) Healing process in horse requires at least 6 months. Severely affected horses should be given stall rest for 30 days, followed by 2-3 months of controlled-paddock rest. Then, light exercise may begin with gradual increases in the intensity and duration of the work (9).

The harmful effects of rest

Prolonged immobilization is a method known of producing a severe disuse syndrome (bortz rest). The sportsman knows that deconditioning begins within a week or two of inactivity. Deconditioning leads to loss of: strength, endurance, flexibility, coordination, and fitness. Rest is a completely passive approach that leads to fear avoidance, catastrophizing, and stress. It actually prescribes iatrogenic disability and illness behavior.

Therapeutic ultrasound is used to reduce pain and inflammation. Magnetic field therapy is used routinely in show jumpers for long-term management of back pain (9). Cutaneous electrical stimulation is beneficial in relieving pain, muscle spasm and delaying muscle atrophy. Therapeutic ultrasound, cutaneous electrical stimulation and magnetic filed therapy are relatively expensive.

Alternative methods include acupuncture and chiropractic manipulation (26). Chiropractic manipulation may benefit in relieving pain, and muscle spasm in an injured back. A few studies reported that most conventional treatments for equine back pain were ineffective or were effective for only a few weeks, while acupuncture was very useful treatment for this condition (27-30).

Traditional Concepts of Acupuncture(31)

Acupuncture may be thought of in two ways: (1) as traditional Chinese medicine and (2) as Western medicine or modern neurophysiology. The Chinese consider that life exists as a balance of opposites. For example dark and light, up and down, male and female. These opposites are termed yin (negative) and yang (positive). The interaction of these opposites is the vital flow of life (energy or chi). This energy travels along these specific pathways in the body call meridians. It is along these specific pathways that one may manipulate the flow of energy, just as a switch may control the flow of electricity. According to traditional Chinese medicine, disease is caused by an imbalance in this flow of energy, with the affected organ having a dearth or an excess of energy. The goal of treatment is to re-establish the flow and balance of energy. For example, if an organ has too much energy, decreasing the input or increasing the output of energy may treat it. Stimulation of specific acupuncture points or combinations of acupuncture points adjusts this energy flow, re-establishes balance, and allows healing to occur.

These principles of Chinese medicine are not mean to reflect the scientific mechanisms of the cure of disease and the alleviation of pain. These observations, which are based on thousands of years of experience, may eventually be explained by modern neurophysiology.

Scientific concept of Acupuncture

Basic Neurophysiology

The analgesic effect of electro-acupuncture is believed to be mediated via various mechanisms. The gate control theory (32) is one of the possible mechanisms. By stimulating local large fiber afferents (Aβ fiber), acupuncture maneuver conveys the signals through dorsal column of the spinal cord. Collateral fibers from the dorsal column then enter the substantia gelatinosa. It has been postulated that impulses in these collaterals or interneurons on which they end inhibit transmission of pain from the dorsal root pain fiber (type C and Aδ) to the spinothalamic neurons(33-35). Neurochemical change in the central nervous system is another possible mechanism (36, 37).This mechanism is closely relate to physiologic analgesia system (33, 38) in which the brain itself is able to suppress the input of pain signals from the nervous system. The descending pathways that originate at various levels in the brain, including the cerebral cortex, basal forebrain, and several brainstem regions mediate this system. It is commonly modulated through the periaqueductal gray-raphe magnus nucleus-dorsal horns of the spinal cord. (37-39). On this pathway, the nerve fibers drive from periaqueductal gray, the area proved to contain beta-endorphin terminals originating from the hypothalamus and contain a relatively high density of opioid receptor (33, 36). Secretion of enkephalin at these endings send signals to raphe megnus nucleus located in the lower pon and upper medulla. The fibers originating in raphe magnus nucleus but terminating in the dorsal horns of the spinal cord secrete serotonin at their ending (so-calling descending serotonin pathways). The serotonin in turn causes local cord neurons to secrete encephalon, which is believed to inhibit both incoming type C, and A δ pain fibers where they synapse in the dorsal horn. Thus, the important trasmitters involved in this analgesic system are serotonin and opioid peptides.

The role of serotonin concerning electro-acupuncture analgesia was investigated in various animal experimental models. An increase in 5-hydroxytryptamine (5-HT) content takes place in cerebrum, raphe area, and spinal cord is found after electro-acupuncture. Damage of the dorsal and medial raphe nuclei attenuate the effect of electro-acupuncture. Moreover, a decrease of electro-acupuncture analgesia is also observed in a series of experiments after electrolytic damage of the raphe megnus nucleus or after the selective chemical injury using 5,6-dihydroxytryptamine, a procedure known to cause degeneration of the descending 5-HT fibers. Injection of p-chlorophenylalanine (pCPA), a 5-HT synthesis inhibitor, into lateral ventricle of the rabbit in a paradigm which reduces 5-HT in the diencephalon, inhibits acupuncture analgesia. Similar results were reported with intrapeitoneal injection. Significant attenuation of acupuncture analgesia is noticed when amygdala, nucleus accumbens, habenulla, periaqueductal gray, or the spinal cord were microinjected with cinancerine (5-HT blocker), suggesting multiple site of action at different levels. Conversely, several studies indicate that 5-HT precursor loading potentiates acupuncture analgesia. Thus, this suggests a pivotal role of central 5-HT in acupuncture analgesia.

Besides the role of central 5-HT, analgesic mechanism mediated via opioid pathway is demonstrated. The acupuncture analgesia in human(37) and animal models (40-42) is reversible by naloxone, a specific opioid antagonist. Indicating the participation of endogenous opiods in acupuncture analgesia (Fig2.15). In animal models, the role of spinal enkephalin and dynorphin is believed to involved in acupuncture analgesia at spinal level. An increase in total endorphin content after EA is found in several brain regions. However, a positive correlation between the degree of analgesia induced and endophin content is observed only in the midbrain area (e.g., periaqueductal gray) and septum-accumbens. An increase in beta-endorphin level is also found in human CSF and plasma when low frequency EA is given (43). However, neither changes in CSF nor plasma beta-endorphin relates to the effectiveness of acupuncture for pain relief. Stimulation of acupuncture points triggers the pituitary gland to release adrenocorticothropic hormone (ACTH), which stimulates the adrenal glands to release cortisol into the bloodsteam. Serum cortisol is a natural steroid anti-inflammatory agent which acts to reduce inflammation and pain in affected areas(44).

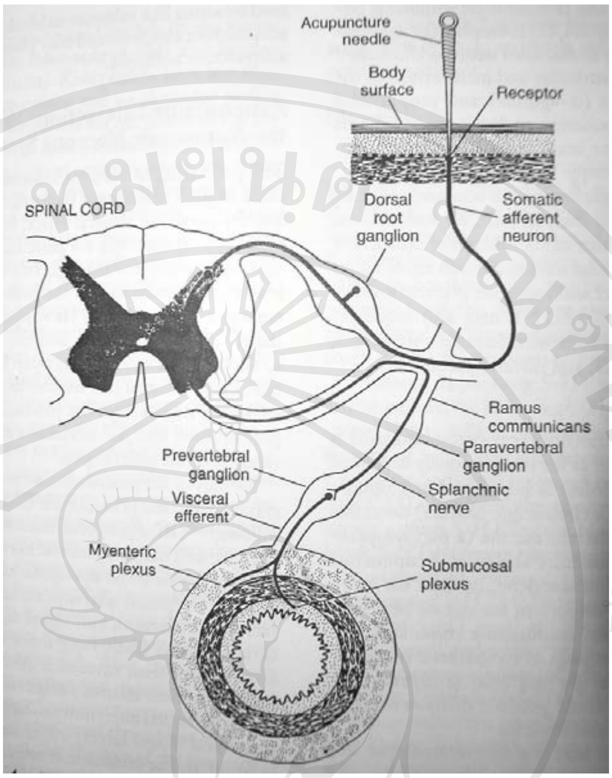


Figure 2.15 Acupuncture and pathway

Acupuncture point

In traditional Chinese veterinary acupuncture, acupuncture points are known as xue, which means passing through a hole or an outlet. According to traditional Chinese medicine, each acupuncture point is connected to a specific organ and reflects the condition of that organ. When an organ or an area is out of balance or injured related acupuncture points may become tender or harder, or they may change color. When points are treated by acupuncture, the desired effect is Thought to flow through the point along the appropriate meridian and eventually to the affected organ. This traditional view may be through of as an attempt to explain the neurophysiologic concept of visceral, somatic, and somatovisceral reflexes(45).

Anatomically, an acupuncture point is a small, 2-to 5-mm area in the skin that locates over a specific landmark. These landmarks are located by the identification of specific anatomic depressions or protuberances or by the use of an ohmmeter or an acupuncture point finder. The acupuncture points are specific anatomic locations that indicate with areas of decreased electrical resistance.

Histologic investigation of nerves and vessels perforating the fascia revealed a specific arrangement of connective tissue. Nerves were enveloped by concentric laminae of collagen fiber, whereas the spaces between this lminae and also between the nerves and vessels were filled with loose connective- tissue containing fat cells and capillary (Fig.2.16)

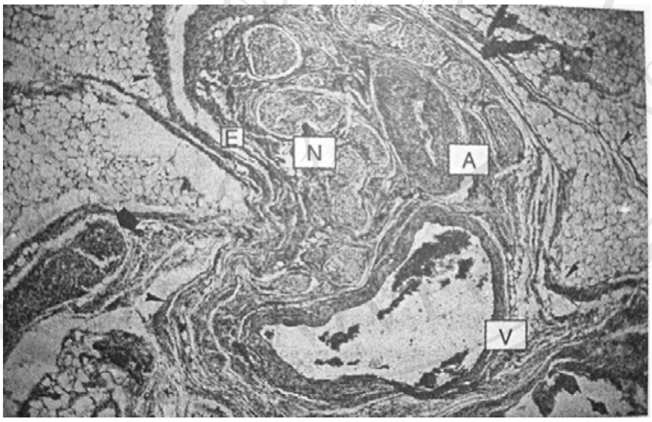


Figure. 2.16 Histologic structure of bundle perforating the fascia at acupuncture points. A, Artery; E. epineurium; N, nerve; V, vein.

A sheath of rather compact connective tissue embraced the nerves and vessels, defining the nerve-vessel bundle where it perforates the fascia (Fig 2.17). Corresponding findings were found in canine specimens.

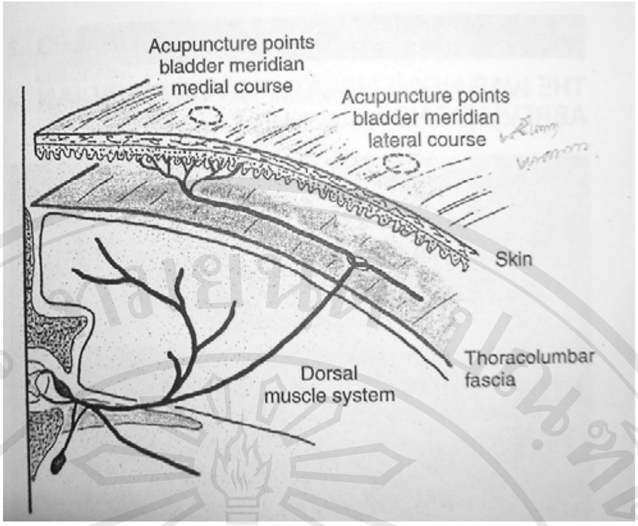


Figure. 2.17 Cutaneous nerve entering the dermis at an acupuncture point along the Bladder meridian.

Meridians

In traditional Chinese medicine, meridians are pathways in which energy and blood circulates. Twelve paired and two unpaired meridains exits; paired meridians are distributed symmetrically throughout the body. No scientific evidence suggests that meridians are separate anatomic areas. Some evidence, however, indicates that meridians may be delineated along paths of lower electrical resistance(45).

Charts

The traditional Chinese method has transposed points from humans to animals and among different species of animals. These points are well-documented in humans. The charts are anatomical drawings containing points, points and meridians, or meridians alone. Charts depicting acupuncture points are also available for horses and farm animals (Fig 2.18.)(46).

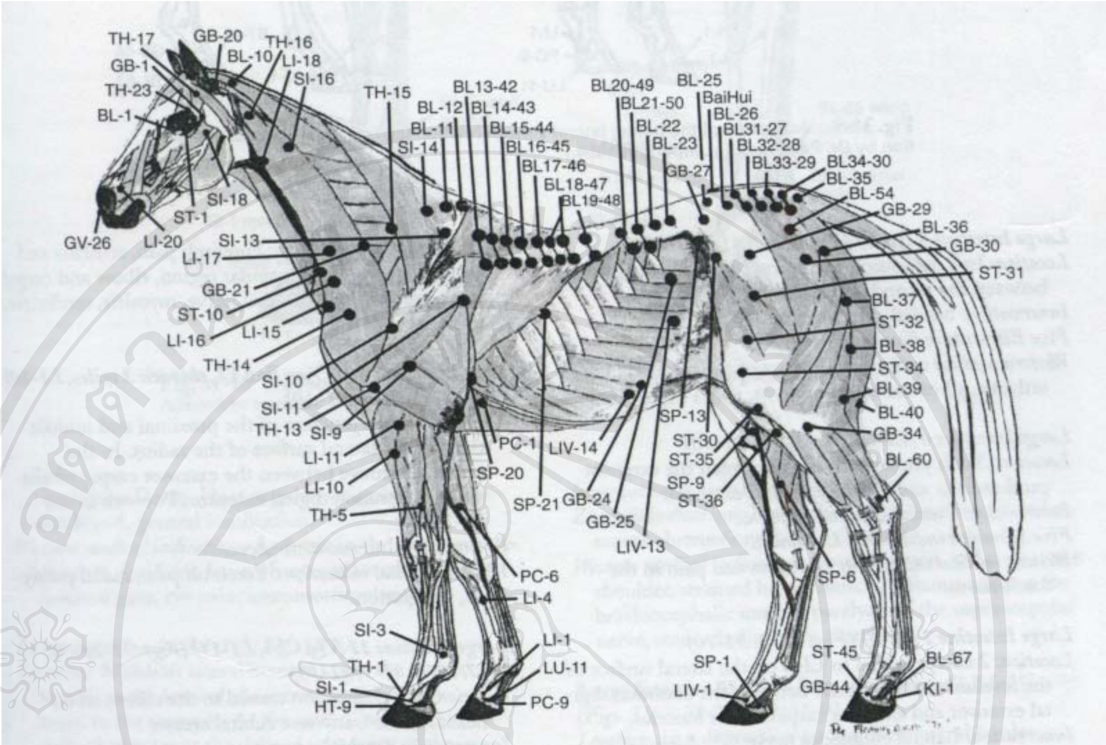


Figure2.18. Acupuncture points of the horse, lateral view in relation to muscle.

Acupuncture points used for back pain(47).

The nomenclature of acupuncture points in animals is very confusing at the present time. There are three nomenclature systems used in the original references, however, none of them is internationally accepted. In order to make this paper more readable and understable, Xie 1996 designed the acupuncture points used and listed them in terms of number, name and location as show in table 2.1.

Table 2.1 Acupuncture points in terms of number, name and location (47).

#	Chineses Pin-Yin name	Other names	Location
1	Duan-xue	(GV-6)	In the depressions between the spinous processes of the last thoracic and the first lumbar verterbrae along the midline.
2	Bai-Hui	T2	In the depression between the spinous processes of the last lumbar and first sacral vertebrae.
3	Yao-qian	T8	Six-cm lateral to the dorsal midline between the spinous processes of the first and second lumbar vertebrae.
4	Yao-zhong	T7	Six-cm lateral to the dorsal midline between the spinous processes of the second and third lumbar vertebrae.
5	Yao-hou	T6	Six-cm lateral to the dorsal midline between the spinous processes of the third and fourth lumbar vertebrae.
6	Shen-peng	T5	Six cm cranial to #7(Shen-shu) and six cm lateral to midline.
7	Shen-shu	T3	Six cm cranial to #2(Bai-Hui).
8	Shen-jiao	T4	Six cm cranial to #7(Shen-shu).
9	Ba-jiao	T9A, B, C, D; BL-31, 32, 33, 34	There are four points on each side. Each point locates along a line 4.5-cm lateral to mid line and between the spinous processes of the two adjacent sacral vertebrae.
10	Du-shu	BL-13	In the eight intercostal space and the muscular groove between the longissimus and iliocostalis.
11	Fei-zhi-shu	BL-12, BL-14	In the ninth intercostal space and the muscular groove between the longissimus and iliocostalis.
12	Gan-Zhi-shu	BL-18 Sobin64	In the thirteenth intercostal space and the muscular groove between the longissimus and iliocostalis.
13	Pi-shu	BL-19, T10	In the fifteenth intercostal space and the muscular groove between the longissimus and iliocostalis.
14	Guan-yuan-shu	BL-21, T11	In the depression caudal to the last rib and the muscular groove between the longissimus and iliocostalis.

15	Ba-shan	HL1	In the depression midpoint between the greater trochanter of femur and #2 (Bai-hui).
16	Lu-gu	HL2	In the depression at the junction of the middle and distal 1/3 of the greater trochanter of femur.
17	Ju-liao	HL3	In the depression caudoventral to the tuber coxae.
18	Huan-tiao	HL4	In the depression six cm cranial to the greater trochanter of femur.
19	Da-kua	HL7	In the depression six cm cranioventral to the greater trochanter of femur.
20	Xiao-kua	HL8	In the depression 3.5 cm caudoventral to the third trochanter.
21	Hui-yang	Bl-35, HL10	Six-cm craniolateral to the tail root and at the upper end of the muscle groove between the biceps femoris muscle and the semitendinosus.
22	Xie-qi	BL-36	In the muscle groove between the biceps femoris muscle and the semitendinosus and horizontal to the anus.
23	Han-gou	HL11 BL-37	In the muscle groove between the biceps femoris muscle and the semitendinosus and 7cm distal to #22 (Xie-qi).
24	Yang-wa	HL12 BL-38	In the muscle groove between the biceps femoris muscle and the semitendinosus and 7cm distal to #23 (Han-gou).
25	Qian-shen	HL13 BL-39	In the muscle groove between the biceps femoris muscle and the semitendinosus and 7cm distal to #24 (Yang-wa).
26	Zhao-hai	K3	At the midpoint between the medial malleolus of the tibia and the tuber calcaneus.
27	Khu-lun	BL60	At the midpoint between the lateral malleolus of the tibia and the tuber calcaneus.
28	Shen-tang	HL15	At the Saphenous vein 12-cm ventral to the skin fold of the thigh.

Stimulation of Acupuncture points

Acupuncture points can be stimulated in many ways. These include 1.) Traditional (or conventional) needle acupuncture, which is a filiform or round-shape needle, is used and any acupuncture points except for acupuncture points on the blood vessels can be administrated. Since this method does not often cause any bleeding, it is commonly called “White needling” (no blood standing on needle). This acupuncture method has been recommended as the treatment of choice for chronic back pain by many practitioners(48-56). Martin et al.(53). Used the acupuncture point’s #2 to 9, 11, 13, 26 and 27 refered in table 1 for treatment of chronic back pain in horses. Of fifteen horses, thirteen horses were improved after 2 to 17 (mean 8) weekly traditional needle acupuncture treatments. In other references(48, 51, 52, 54),the acupuncture points #2, 6, 7, 8, 19 and 20 were recommended. The combination of the acupuncture points #2, 17, 18, and 21 were documented for back pain by using a traditional needle insertion depth of 6 cm and stimulating 20 to 30 minutes, with one treatment every 3 days for a total of 3 to 6 treatments(49). 2.) Acupuncture or point injection, which is a method with which vitamin B1 or other solutions are injected into some acupuncture points. Martin et al. (53, 57). Used saline acupuncture to treat chronic back pain in horses. One hundred thirty-nine out of 155 horses had an alleviation of clinical signs of back pain after 7 to 12 (mean 9) treatments. Ten horses had discomfort the day after treatment. Of fifty animals with chronic back pain, forty-nine animals were cured after 3 daily acupuncture treatments using vitamin B1 (250mg per day) at acupuncture points #3, 5 and 7 (58). Tang healed all fifty horses and cattle with acute back pain using injections of 25% megnesium sulfate (20-30 ml) into a single acupuncture points #2 (59). Of eight horses with chronic back pain, seven horses were cured after five acupuncture treatments by injection of 10 to 20 ml of 2% procaine or 10 ml of 15% dextrose into the acupuncture points #2 with one treatment every other three days(60). 3.) Pneumo-acupunture or air injection is a method in which a certain amount of air is introduced or injected into the subcutaneouse tissue around some specific acupuncture points. Of the twelve horses with chronic lumbar and coxa pain, eleven horses were improved after pneumo-acupuncture treatment by using acupuncture points#19 and 7(60). 4.) Electro-acupuncture is a method in which an electric current is passed to the animal through the needle and into the points. It is recommended for treatment of equine musculoskeletal disorders(61). The acupuncture points #2, 3, 4 and 5 are documented for electro-acupuncture treatment of back pain in horses(49). Xie (62) applied Electro-acupuncture to treat seven horses with chronic back pain by using 80-120 Hz of frequency and eight acupuncture points#1, 2, 4, 6 and 7. Each treatment was used for thirty minutes. After three weekly treatments, 2 horses returned to normal work, and 4 horses had an alleviation of clinical signs of back pain, and 1 horse had alleviation but back pain recurred one month later. 5.) Fire-needling acupuncture may be considered a combination of conventional needle acupuncture and cauterization. As soon as the specific needle is hot, it is inserted into some acupuncture points. Zhao applied fire-needling acupuncture on points #2, 7 and 19 to treat chronic back pain in horses. Of 51 horses, 49 were improved after only one treatment (32 horses) or two (17 horses) acupuncture treatments(63). However, fire-needling acupuncture may cause tissue damage. Care must be taken to prevent infection. Antibiotic ointment should be filled up in the site of the acupuncture needle insertion and kept from washing for 2 days after withdrawing the needle. The points should not be used again until one month later. 6.) Cupping acupuncture is an ancient method of a combined vacuum and thermotherapy. It causes extravasation of blood in the treated area. Yu(49) used 4 points for cupping. The most cranial point was #10 and the caudal most point was #7. The remaining 2 points were equidistantly located between the most cranial and caudal points on this muscular groove. The acupuncture points were stimulated by insertion of a small wide needle 1-1.5 cm deep, and by cupping each point for 10 to 15 minutes. The animal should be walked slowly for 1 to 2 hours twice a day after treatment. The treatment might be repeated if there were no effective result 7 to 15 days after the first treatment. 7.) Hemo-acupuncture, this method is used to draw blood from some acupuncture points which are located on the vein. The hemo-acupuncture can be applied only for an acute condition of back pain by using the point#28 (49, 50). The point should be used only one time during a three-week period. 8.) Warm needling acupuncture is a method by which a needle is heated by igniting either moxa and alcohol cotton after the needle is inserted into an acupuncture points. Recently a warm-needling acupuncture stimulator has been used in the clinic. It works well in human patients. 9.) Vinergar-liquor hot moxibustion, this method has a fancy Chinese name of "Sieging the warship with fire." The animal should be restrained. The hair on the back is moistened with warm vinegar. Sometime, a vinegar-soaked cotton cloth is covered on the operation area. The liquor (about 50-70% alcohol) is then poured on the operation area and ignited. If the flame is insufficient, more liquor is sprayed on the cloth using a syringe; if the flame is too strong, vinegar is on the cloth. The procedure may last for 10 to 45 minutes. Xie (47) treated 3 horses with very chronic back pain with this technique for 30 to 40 minutes. Two horses had significant relief from back pain. One horse was partially improved. Wang(43).

Treated chronic back pain in horses and cattle by insertion of a small wide needle into acupuncture points # 7, 4 and 5, followed by vinegar-liquor hot moxibustion for 5 to 10 minutes. All forty-five cases were improved after one treatment. Fu (64). Injected 50 % alcohol into points #2, 6, 7 and 8 with 5 ml each point, and then used vinegar-liquor hot moxibustion to cure all 5 horses with back pain. 10.) Laser acupuncture in medicine has about 20 years of history. Irradiation with a laser light beam acupuncture point is considered as laser acupuncture. Martin et al applied a low-powered infrared laser acupuncture for treatment of 15 horses with chronic back pain by using focusing irradiation for 2 minutes at each point on 5-9 acupuncture points. Eleven horses were improved after 2-to-16 treatments. None of the 15 horses had discomfort on the day after treatment as compared with invasive acupuncture(53, 65). Scattering irradiation from a CO_2 laser was also recommended for this condition(66) .The disadvantage is the initial cost of the equipment. 11.) Hot-packing acupuncture is an ancient therapy specifically for chronic back pain in horses and is still used by local veterinarians in China(48, 50). Stir-fry 5kg of wheat barn with1.5kg of vinegar in the pan until 40 to 60 °C is reached, then fill up two cloth sack with the hot barn-vinegar mixture. Alternately apply one of two hot sacksion the affected back area until the horses begin to sweat. This method is performed once every day for several days. It is a very cheap and easy method. It is a kind of thermotherapy plus the effect of acupuncture points and herbal medicine. Wheat barn and vinegar are considered as Chinese medicines and have a function of activation blood and Qi (Chi).

Adverse effect of Electro-Acupuncture

Most adverse effects of acupuncture are local (e.g. contusion, hematoma, skin and soft tissue infection) However, the adverse effects will be minimal if performed by skillful physician acupuncturist using sterile technique. If the adverse effects such as bleeding occurred, this will be stop by pressure, ice pack and topical antiseptic.

In addition, horse may have slight discomfort from needle insertion and may have minimal skin contraction while stimulating the needle with electrical devices.