Flexural Limb Deformities 2023

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Flexural deformities are a common condition of growing horses in which a joint is held in an abnormally flexed or extended position. They affect soft tissue structures and occur in the sagittal plane, as opposed to angular limb deformities, which primarily affect osseous structures and occur in the frontal plane. Persistent hyperflexion has been termed “contracted tendons,” even though in most cases the tendon units are not actually contracted, but are just functionally too short relative to the associated osseous structures. “Contracted tendons” implies a defect in the tendon itself and is incorrect in light of the proposed pathogeneses; this term should consequently be avoided. Tendon contractions can occur as a result of scarring secondary to tendon injury; this is sometimes seen in adult horses but is rare in foals. More broadly, hyperextension deformities will be considered as part of the flexural deformity complex in this chapter.

By convention, a deformity is named according to the joint involved and not the tendon. Most often an animal suffers from one type of deformity only, but several areas can be affected in severe congenital flexural deformities. The forelimbs are more commonly affected, and the problem can be encountered in more than one limb at the same time. Flexural deformities present at birth are referred to as congenital deformities. Acquired flexural deformities develop during the remainder of the animal’s life, although in typical age groups. Congenital flexural deformities most commonly affect the metacarpophalangeal (MCP) joint or the carpal region. Much less commonly the tarsal region, metatarsophalangeal (MTP) joint, and distal and proximal interphalangeal (PIP) joints are affected. Congential lateral luxation of the patella can also create a functional flexural deformity of the stifle. Acquired flexural deformities affect the distal interphalangeal (DIP) joint and MCP joints most frequently with the MTP and PIP joints less frequently affected.

CONGENITAL FLEXURAL DEFORMITIES

Pathogenesis

Some causes mentioned are speculative and lack scientific evidence of their existence. Work is needed to understand the intricate details that lead to the development of such deformities.

Intrauterine malpositioning is a commonly mentioned cause of the problem. This could actually be the case in an abnormally large foal relative to the size of the mare, where intrauterine crowding leads to development of the problem. This, however, is the exception to the rule. More likely, congenital flexural deformities are multifactorial in their origin and therefore difficult to explain.

Diseases acquired by the mare during pregnancy can lead to the development of flexural deformities in the foal *in utero*. A multitude of agents and causes have been associated with the problem, including ingestion of locoweed and hybrid Sudan grass during pregnancy, a dominant gene mutation in a sire, equine goiter, an influenza outbreak, neuromuscular disorders, and defects in cross-linking of elastin and collagen caused by lathyrism. A glycogen branching enzyme deficiency was recently documented in Quarter Horse foals, which caused transient flexural deformities. The evidence in these cases may be only circumstantial, accentutating the need for further investigations into the development of congenital deformities.

An early report stated that 20% of 608 fetuses and newborn foals submitted for necropsy suffered from miscellaneous limb contractures, which underscores the trend noted by clinicians that the incidence of flexural limb deformities is increasing.

Diagnosis
A flexural limb deformity, whether a flexural or digital hyperextension deformity, is considered congenital when it is present at birth. The problem is easily recognized in most cases and should be evaluated by a veterinarian at that time.

Digital Hyperextension Deformities
Newborn foals can be presented with a mild degree of digital hyperextension. Such foals might be unable to maintain their toes on the ground; while standing, their MCP or MTP joints are angled more acutely than normal, and the animals are reluctant to ambulate. The problem is caused by flaccidity of the flexor muscles and usually corrects itself within a few weeks because of negative allometric growth of the tendons relative to the bones and increased muscle tone. In more severe cases, the foals walk on the palmar or plantar aspect of the phalangeal region where skin lesions rapidly develop as a result of abnormal loading. These severe hyperextension deformities have to be distinguished from the milder forms and the skin must be protected accordingly. Radiographic and ultrasonographic evaluations should not be necessary to diagnose the deformity because in most cases, no abnormalties will be found.

Flexural Deformities
Congenital flexural deformities may cause dystocia if severe enough or the owner may report that the foal is unable to stand. Some flexural deformities may be overlooked in recumbent foals if the joints can be manually straightened, but should become apparent once the foal is assisted to stand. Joints should be manipulated to see if manual straightening is possible.
Distal Interphalangeal Region
Flexural deformities of the DIP joint are more common as an acquired deformity. A flexural deformity of the DIP joint seen at birth is usually associated with a flexural deformity of the fetlock.

Metacarpo/Metatarsophalangeal Region

Mild cases of MCP/MTP flexural deformities can be overlooked if the foal is examined in grass or deep bedding while more severe cases may be unable to stand unassisted. Mild flexural deformities will usually resolve spontaneously in four to five days with limited exercise. Cases which do not respond to conservative therapy can be splinted and/or treated medically. One author reports that if there are no osseous changes to the joint or the joint can be manually straightened, the prognosis is good for all degrees of severity of MCP/MTP flexural deformities. If the deformity is very severe, radiographs should be taken first to rule out abnormally formed bones, which decreases the prognosis to poor.

Carpal Region

Carpal flexural deformities are usually bilateral and in mild cases, the foal can stand but cannot completely straighten the carpi. Mild cases are usually self-correcting in four to five days with limited exercise but if the deformity does not resolve spontaneously, other treatments may be instituted (see below). More severely affected cases may be unable to stand and the common digital extensor tendon may rupture secondary to the flexural deformity (see below). If the limbs can be manually straightened (which may require sedation), the chance of resolution using splints or casts is good but the prognosis is guarded if the carpus cannot be manually straightened.

Proximal Interphalangeal Region

Congenital PIP joint flexural deformities are rarely reported and often involve both osseous and soft tissue abnormalities. Cases may show subluxation of the PIP joint or ankylosis of the PIP joint in more severe cases.

Tarsal Region

Congenital flexural deformities of the tarsal region are rare and are most often the result of incomplete ossification of the tarsal bones resulting in a secondary flexural deformity. Cases must be identified before the bones are irretrievably damaged, after which time there is no effective treatment. Radiography is indicated in these cases for this reason.

Ruptured Common Digital Extensor Tendon

This relatively common congenital disorder has some pathognomonic features that simplify the diagnosis. Affected foals display a characteristic swelling in the tendon sheath at the dorsolateral aspect of the carpus, which is recognised soon after birth but rare cases may not be evident for up to three weeks. Rupture of the common digital extensor tendon is often seen secondary to a flexural deformity and less commonly can lead to a flexural deformity. The foal often has a slightly bowlegged and an over-at-the-knees stance. This stance is caused by the lack of support at the dorsolateral aspect of the carpus, which is normally conferred by the intact common digital extensor tendon. Therefore, it is not truly a flexural deformity, but it clinically appears as one. The two ends of the partially or completely ruptured tendon can be palpated in the tendon sheath. With time, these ends proliferate, making their detection during palpation even easier.

During walking, affected animals throw their forelimbs forward, extend them completely, and retract them slightly before contacting the ground. A foal with a ruptured common digital extensor tendon often knuckles at the MCP joint during walking and might buckle in the carpal region while standing. In severe cases the foal may not be able to stand straight without knuckling forward.

Radiography for the Diagnosis

Flexural deformities, which can be diagnosed on the basis of clinical signs do not need to be radiographed, but is useful to identify abnormalities that may alter the prognosis for correction of the deformity. Radiographs of carpal flexural deformities that can not be manually straightened may reveal incomplete ossification or wedging of the carpal bones, decreasing the prognosis for correction. The same applies for the less common tarsal flexural deformities.

Treatment

Digital Hyperextension Deformities

Most foals with mild digital hyperextension do not need treatment other than minimal attention and trimming of the feet; the condition is self correcting.[31] Moderate exercise is indicated to strengthen the musculotendinous unit; therefore, access to pasture is allowed. Excessive exercise is contraindicated because fatigue often aggravates the problem. The animals should be carefully observed, and if the problem worsens, further treatment should be promptly initiated. Severe digital hyperextension problems must be treated immediately, because neglect soon leads to necrosis and traumatization of the skin in the palmar or plantar phalangeal region and jeopardizes treatment.

Swimming

Swimming has been advocated as excellent controlled physiotherapy. The animal is supported in a swimming pool or pond by one or two helpers or a rescue net. The paddling action of the foal in the water is carried out against the resistance of the water and without placing weight on the limbs. The resultant increase in muscle tone brings about rapid amelioration of symptoms.

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Trimming is often unnecessary but the toe can be shortened with rasping and the palmar/plantar half of the foot also lightly rasped for increased contact with the ground. In more severely affected foals in which the toe is lifted off the ground and the foal is ambulating on the palmar/plantar pastern, application of glue-on shoes or similar devices with palmar or plantar extensions helps maintain the hoof sole on the ground. Ready made or custom made extensions are used; a cuff type shoe is available (Dallmer cuff shoes) or the extension can be made from light aluminum, which is cut to shape, curved over the toe for contact and attached with acrylic adhesive (Equilox). Some farriers feel that any shoe should be attached with adhesive tape only in foals under three weeks of age to avoid heat trauma to the delicate foot and contracture of the heels. Extensions are changed at 10 day intervals although some foals dislodge the extensions before this. These devices constrict the foot and can cause deformation of the foot if left in place too long.

Bandaging

Light bandaging of the phalangeal region is indicated to minimize skin trauma in foals which walk on the back of their pasterns but the bandages should not be substantial enough to completely support the distal limb. Splint bandages and casts incorporating the foot are contraindicated because they totally support the distal limb, leading to a further loss of tone of the already hypotonic flexor tendon units. Additionally, development of pressure sores on the delicate skin is a common untoward sequela.
Application of some padding over the elongated braces attached to the foot will protect the palmar or plantar aspect of the phalangeal region, decrease the excessive hyperextension angle' and decrease the likelihood that the extensions will be dislodged by the mare or the foal. Daily swimming would strengthen, aside from the cardiopulmonary system, the muscles, tendons, and ligaments and in doing so helps to correct the deformity. Carefully dosed anti-inflammatory drugs are indicated to keep the foal comfortable.

Surgical Management

Tenoplasty has been described as a possible surgical management technique for severe digital hyperextension problems in small or miniature foal patients, but it is currently not recommended.

Flexural Deformities

Nonsurgical Management

There are many available treatment modalities for the treatment of congenital flexural deformities and they can all be used in conjunction with one another. It is important to ascertain whether the foal can stand without assistance as in these cases, specific treatment is often not required.

Exercise

Congenital flexural deformities are best treated with moderate exercise. In many cases, the foal is unwilling to stand and walk and needs regular encouragement to do so, especially if a cast or a splint is applied. The treatments discussed below can then be used singly or in combination.

Analgesics

Both the primary cause and the effects of treatment of flexural deformities may be painful and affected foals should be treated with non-steroidal anti-inflammatory drugs. However, these drugs should be given judiciously because of the potentially detrimental side effects, including gastric ulceration and nephrotoxicity. Administration of phenylbutazone at 1.1 mg/kg body weight IV or orally once a day or flunixin meglumine at 1.1 mg/kg IV or orally once daily and concurrent treatment with omeprazole (4mg/kg orally once daily) or ranitidine (6.6 mg/kg orally three times a day, or 1.5 mg/kg IV three times a day) as gastric protectants has been proposed. Ideally biochemical monitoring of the foal's renal parameters (BUN, creatinine, and total protein) should be performed in these cases.

Intravenous Oxytetracycline

Administration of oxytetracycline has become popular as an initial treatment for congenital flexural deformities. A single dose of 3 g oxytetracycline in 250 to 500 mL of physiologic saline is administered slowly by the intravenous route. The treatment may be repeated once or twice within the first weeks of life if necessary. Previously, it was thought to act by chelation of calcium and inhibition of muscle contraction, although intuitively if this were the mechanism of action a more widespread effect on the body would be noted. A more recent *in vitro* study showed that oxytetracycline induced a dose-dependent inhibition of collagen gel contraction by equine myofibroblasts. Oxytetracycline also induced a dose-dependent decrease in matrix metalloproteinase 1 (MMP-1) mRNA expression by equine myofibroblasts. Results of this study indicate that oxytetracycline inhibits tractional structuring of collagen fibrils by equine myofibroblasts through a MMP-1–mediated mechanism.

In young foals, oxytetracycline administration can make the developing ligaments and tendons more susceptible to elongation during normal weightbearing, resulting in correction of the deformity within 24 to 48 hours. In a comparative study, the clinical effect of a single 44 mg/kg dose of intravenous oxytetracycline in normal foals and foals with flexural deformities was examined. Treatment with oxytetracycline resulted in a significant decrease in the MCP joint angle as measured radiographically in both affected and unaffected foals. Joints returned to their pre-treatment angles by four days after treatment. Oxytetracycline therapy had no significant effect on the DIP joint angle and therefore is unlikely to be of use for flexural deformities of the DIP joint based on these data. No alterations in renal biochemical parameters were detected after a single dose. However, oxytetracycline induced acute renal failure in a foal, which was successfully treated by hemodialysis. This underscores the importance of biochemical monitoring in these cases, particularly in systemically ill foals.

Mild cases of flexural deformities can respond to this treatment with complete correction. In more severe cases, the response is minimal and other treatment modalities must be used.

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Toe Extensions

Application of a dorsal hoof extension using acrylic alone or in combination with a lightweight foot plate protects the toe from excessive wear and increases the tensile forces in the deep digital flexor tendons during ambulation facilitating a delay in breakover in foals suffering from flexural deformities of the DIP and MCP/MTP joints.

However, in severe deformities toe extensions, if not being braced back along the dorsal hoof wall, can exert significant forces at the toe leading to distraction and separation of the dorsal hoof wall, infection of the white line and pain.

To help maintain these devices on the feet, numerous holes of approximately 2 mm in diameter and depth can be drilled into the dorsal hoof wall. The hoof acrylic used to achieve the dorsal extension is spread over the dorsal hoof wall and worked into the holes to add stability to the device. The acrylic, interdigitating with the dorsal hoof wall, serves as an anchoring device and prolongs the life of the extensions. Filling in the space between the extension and the dorsal hoof wall decreases the risk of the foal's stepping on the extensions or stumbling over them.

These devices may be successfully applied in newborn foals with mild flexural deformities of the DIP or MCP joints, when the foal cannot bear weight without knuckling over. Extending the dorsal hoof wall adds the necessary elongation to compensate for the lack of extension in the phalangeal region and allows the foal to stand without knuckling. Once the foal is able to ambulate, correction of the deformity is usually achieved within 2 weeks, at which time the extensions are removed or typically become detached.

The toes must be protected from excessive wear as foals are allowed free exercise. A special half-round glue-on shoe has been developed for this purpose, with a toe extension built into its design.

Splints and Casts

Splints and casts are effective for treating flexural deformities. Splints and casts are useful in cases of MCP/MTP, carpal, and some tarsal flexural deformities. The PIP and DIP joints are difficult to immobilize without casting. Foals suffering from flexural deformities of the DIP joint that are unresponsive to hoof extensions can be treated with half-limb casts, incorporating the feet. This treatment causes relaxation of the muscle–tendon units correcting the problem.

Splints have the advantage over casts that they can be removed regularly, are easily reapplied, can be applied under sedation and are more cost effective than repeated casting. Casts cannot be reset regularly (unless they have been bivalved) without added expense, often require general anaesthesia to apply and do not allow inspection of the flexural deformity and the skin under the cast. Because the forced extension of the affected limb in a cast or a splint is painful and requires analgesia, some clinicans avoid the use of casts, preferring instead to use splints, which can be placed on the leg for 12 hours and then left off for 12 hours. Splints however, can move out of position on the limb, creating pressure sores. Some clinicians favor the use of casts for these reasons. Casts have to be changed at least every 2 weeks to keep pace with the growth of the foal.

Splints can be made from a variety of materials including PVC pipe, wood, and fibreglass and can be custom made to the limb. Splints made from PVC pipe or wood have the disadvantage of a lack of conformation to the limb and the potential to cause pressure sores. More severe problems such as distal limb necrosis as a result of improperly applied splints have been reported. Splints should be placed over enough padding that the skin is protected from excoriation, but little enough that the splints do not shift out of position. The splints will often rotate around the leg and it is often quite difficult to keep them in the desired position.

Splints that have been custom fit to the contour of the limb are very useful and decrease the likelihood of complications because of their "custom made" nature. In foals with a single limb affected, the custom splint can be made from the contralateral unaffected leg. The splint is made from a splinting material consisting of a double layer of seven strips of fibreglass encased in a synthetic padding (Dynacast Prelude) using the unaffected limb as a template. The same construct can be made from strips of 10cm casting material stacked and encased in padding. The technique is detailed in Chapter 17. The disparity between the affected limb and the splint created from the unaffected limb can be substantial. The affected leg is then padded with the same amount of padding used when preparing the splint. The splint is placed on the affected limb and forced into the splint configuration under bandage pressure. The splint is reset on a daily basis and the leg examined for any evidence of the splint rubbing. Each day the limb should be able to be pulled further into the splint.

Some foals will require sedation to apply the splints to facilitate maximal extension of the affected joint and to allow the splints to be placed on the limb properly. Alpha-2 agonists such as xylazine or detomidine are useful for this purpose and have the added benefit of providing analgesia.

Splints are preferably used in flexural deformities of the MCP and carpal region, especially in mild carpal flexural deformities. Foals which buckle forward on their MCP/MTP joints have lax flexor tendons and tight extensor tendons; these foals should be splinted to allow loading of the flexor tendons. In these cases care is taken to avoid incorporation of the phalangeal region into the splint. Splints have to be well padded and changed regularly. It is important to use new, dry padding at each bandage change to minimize development of pressure sores.

Foals that are unable to rise and nurse must be assisted many times daily. Stretching of tendons and associated contracted soft-tissue structures (e.g., joint capsules) is painful; therefore, administration of low doses of anti-inflammatory drugs is necessary (see "analgesics" above).

Surgical Management

Surgical intervention is seldom necessary with congenital flexural deformities and is used in severe cases or those which do not respond to medical therapy. Surgical

treatment is most commonly carried out for carpal flexural deformities and transection of the flexor carpi ulnaris and the ulnaris lateralis tendons 2 cm proximal to the accessory carpal bone can result in the correction of mild carpal deformities. A recent report of 135 procedures on 72 horses documented a successful outcome, defined as a straight palmar carpal angle, in 82% of the cases. Cases were graded as 1, 2, or 3 in order of increasing severity. Lower grades with less than 40 degrees of flexion carried the best prognosis and the success rate in grade 3 cases fell to 57%. The surgery is performed under general anaesthesia and a vertical incision is made over the lateral aspect of the accessory carpal bone and the tendons identified deep to the fascia. It is advisable to manipulate the limb immediately prior to surgery, while the foal is under anesthesia, to ascertain if these tendons tighten when forceful carpal extension is applied. If these tendons are the structures preventing extension of the carpus, once they have been transected surgically, the limb can be manually straightened. After surgery, box confinement is recommended for a few days and then access to a small paddock or yard is allowed. The limb is kept bandaged until the sutures are removed.
Occasionally surgical transection of the flexor tendons and palmar capsule of the middle carpal and antebrachiocarpal joint is required to allow the limb to be straightened but these cases carry a worse prognosis. The carpal canal is opened through a medial approach; the joints are identified and subsequently opened through a horizontal incision.

Flexural deformities of the MCP/MTP joint, which do not respond to medical treatment can be treated surgically by transection of the flexor tendons or suspensory ligament, but these salvage procedures are not recommended for animals intended for an athletic future. Severe MCP/MTP flexural deformities secondary to abnormally formed bones have been treated using an arthrodesis and resulted in pasture sound horses.

PIP joint flexural deformities resulting in subluxation may be treated by means of an arthrodesis.

Ruptured Common Digital Extensor Tendon
Nonsurgical Management
Foals with ruptured common digital extensor tendons are best confined to a box stall, because they tend to stumble frequently. Within a few weeks, locomotion normalizes without any other treatment and more exercise can be allowed.

Application of a well-padded splint bandage to stabilize the MCP joint and allow the foal to walk without stumbling is the treatment of choice when treatment is required. The use of a thermoplastic splinting material (Plastazote) or a custom made fibreglass splint has had excellent results (see splinting above). The splints must be monitored carefully for slipping or developing sores and are usually required for several weeks until the ruptured ends have fibrosed and allow a return to a normal ambulation. The prognosis for recovery is excellent but some foals have a persistent thickening over the dorsal carpus for six to 12 months. Aspiration of the synovial fluid from the tendon sheath is discouraged because of the risk of infection.

Surgical Management

It is generally accepted that ruptured common digital extensor tendons should not be treated surgically because of the favorable prognosis with conservative management. The risk of complications secondary to surgery outweighs any improvement of the prognosis. However, thorough removal of all fibrin clots from the tendon sheath through a surgical incision, followed by installation of a suction drain and cast immobilization, has resulted in excellent cosmetic appearance of the limbs.

ACQUIRED FLEXURAL DEFORMITIES

Pathogenesis

There are several pathways for the development of acquired deformities. It has been suggested that acquired flexural deformities are part of the developmental orthopedic disease (DOD) complex, which also includes angular limb deformities, osteochondrosis, physitis, and cervical vertebral malarticulations or malformations. Although they are a condition of the developing horse, the DOD complex initially was defined as conditions resulting from a failure of the conversion of cartilage to bone and in the context of this definition, acquired flexural deformities were not included. However, it is likely that acquired flexural deformities occur as a result of pain and may therefore be a sequela to the conditions listed above. It is likely that the etiopathogenesis of acquired flexural deformities is multifactorial and complex but several theories have been proposed for its occurrence. The two main theories are a mismatch in bone and tendon/ligament growth and contraction of the musculotendinous unit in response to pain.

It has been postulated that in rapidly growing foals, the longitudinal growth of the bone is greater than the potential of the tendon unit to elongate passively at a corresponding rate. Most acquired flexural deformities are encountered between 4 weeks and 4 months of age and again at the yearling age, an observation that supports the theory. Rapid bone growth occurring between 4 weeks and 4 months can induce a flexural deformity in the distal interphalangeal joint. Passive elongation of the tendon might be limited because of the relatively unyielding accessory ligament of the deep digital flexor tendon, which originates at the proximal and palmar aspects of the third metacarpal bone (MCIII) and joins the tendon in the midmetacarpal region. Passive elongation proximal to that region, therefore, has little influence on prevention of the problem. Because of the functional shortening of the deep digital flexor tendon unit, excessive tension is exerted on the distal phalanx, which results in palmar rotation of the entire foot and the development of the typical club-footed stance.

The rate of bone growth is determined by genetics and nutrition. Foals can be overfed either by heavily lactating mares or by excessive supplementation with concentrates.

An abrupt change from inadequate—both in quality and quantity—nutrition to abundant nutrition also can induce the problem in yearlings.

At 3 months of age, growth at the distal MCIII has ceased but continues to occur at the distal radius. The accessory ligament of the superficial digital flexor tendon originates just proximal to the distal radial growth plate from the caudal aspect of that bone. Rapid growth of the radius around 1 year of age can result in a functional shortening of the superficial flexor tendon unit and development of a flexural MCP deformity. This theory was validated experimentally when foals previously kept on a poor ration were fed free-choice high-quality feed at the yearling age and subsequently developed flexural deformity. However, the development of the problem might be more related to nutritional imbalances than excessive high-energy intake.
Other authors have theorized that longitudinal bone growth is insufficient at any age to create a relative shortening of the flexor tendons. They postulated that rapid growth increased tension within the flexor tendons and that this could induce pain, ultimately leading to the development of flexural deformities. Flexural deformities often have an acute onset of 24 to 48 hours, which also supports this theory:whereas muscle contractions can develop in such a short period, bone lengthening would take longer.
A study of skeletally normal foals revealed that most of the cells in the deep digital flexor tendon and its accessory ligament are myofibroblasts. These cells have contractile ability and therefore might play a role in the development of flexural deformities.

This leads to pain as the primary inciting factor associated with acquired flexural deformities. Any painful condition could be responsible for the *flexion withdrawal reflex* and the resultant muscle contraction, leading to an altered stance and it is common for lameness in the affected limb to precede development of an acquired flexural deformity. Osteochondrosis, osteoarthritis, infectious joint disease, acute severe trauma to osseous and soft-tissue structures, bruised feet as a result of prolonged exercise on hard ground, or overzealous foot trimming leading to solar bruising and hoof problems are just a few conditions, which may precipitate an acquired flexural deformity. Such painful processes can induce muscle contractions, leading to the development of flexural deformities. Although pain can be the inciting factor in acute-onset flexural deformities, more permanent states of flexion of the musculotendinous unit can occur with contracture of the flexor aspect of the joint capsule and maintain the deformity, underscoring the need for early diagnosis and effective management.

Diagnosis
Acquired flexural deformities are seen more often than acquired hyperextension deformities. Continuous overload of certain limbs can, in selected cases, induce hyperextension deformities. Acquired flexural deformities can also be encountered after ruptures of flexor tendons. The onset of acquired deformities can be divided into two periods of the foal's growth (Table 1). Early diagnosis is important to increase the chance of complete resolution but diagnosis may be made difficult by the foal being

out at pasture with the mare, especially for DIP joint deformities, which may be hidden by the grass. Regular examination on a hard level surface will aid early detection of acquired deformities. The MCP and DIP joints are most commonly affected.

Distal Interphalangeal Region

Flexural deformities of the DIP joint occur primarily in foals between one and four months of age and almost always affect the forelimbs. The condition is usually bilateral although one limb may be more severely affected. Deformities of the DIP joint involve the deep digital flexor tendon as this tendon inserts on the solar surface of the distal phalanx and is responsible for flexion of the DIP joint. Initially, the dorsal hoof wall assumes a more vertical angle and the heels may not contact the ground if the condition has occurred acutely. With the foot in this conformation, two sequelae result. First, the heels overgrow because of the lack of ground contact and the foot appears “boxy” as the heels approach the length of the toe. Secondly, the toe is under greater stress and wear, which can widen the white line and lead to flaring of the distal hoof wall. In more slowly developing cases, the heels may maintain contact with the ground and overgrow. These changes in the conformation of the foot are the result of the deformity and not a cause.

The deformities are divided in stages I and II. Stage I deformities have a more upright dorsal hoof wall where the angle described by the dorsal hoof wall and sole is greater then 60 degrees but less than 90 degrees and the wall has not passed the vertical plane. In stage II deformities, the dorsal hoof wall has passed 90 degrees and is beyond the vertical plane. Stage II deformities have a worse prognosis for resolution than stage I deformities and the prognosis declines with the length of time prior to treatment. This classification scheme is useful for description of the deformity and formulation of a prognosis, but does not always dictate the preferred method of treatment.

The longer the condition is neglected, the worse the deformity becomes. Permanent changes of the associated soft-tissue structures occur, and the abnormally loaded bones remodel according to Wolff’s law. The deformation and distraction of the dorsal hoof wall can lead to seedy toe or subsolar abscesses, in turn causing more pain.

Metacarpophalangeal/Metatarsophalangeal Region

These flexural deformities can be congenital but are also an acquired flexural deformity in animals from 10 to 18 months of age. Both front and back limbs can be affected, but acquired MTP joint flexural deformities are much less common than those affecting the MCP joint. Acquired flexural deformities of the MCP joint are initially characterized by a straighter MCP angle. The foot usually appears normal and is in contact with the ground but the pastern assumes a more upright position and if left untreated, the MCP joint knuckles forward. Knuckling over in the MCP region is seen in more severe cases and in cases in which treatment has been neglected for a long time.

Three grades of severity of acquired MCP/MTP flexural deformities have been described. *Mild deformities* show a straight MCP/MTP region and rarely flex to greater than 180 degrees; in other words the joint remains caudal to the foot at all times, albeit with a straighter angle than normal. *Moderate deformities* have greater than 180 degrees of flexion, which causes the MCP/MTP joint to be dorsal to the foot, but when walking these horses can extend their joints to a position caudal to the foot. *Severe deformities* have greater than 180 degrees of flexion at all times and in these cases, the flexor tendons and suspensory ligament are lax and the extensor tendons prevent further flexion of the joint. In these cases, the extensor tendons are prominent on the dorsal aspect of the leg. The speed at which such a deformity develops greatly depends on the degree of pain present, the pain threshold of the patient, the growth rate, the amount of exercise allowed, and possibly the foot-trimming techniques employed. It is important to diagnose a flexural deformity as early as possible, and promoting client awareness can be helpful in this regard.

Deformities of the MCP/MTP joint can involve one or both the deep and superficial digital flexor tendons (and less frequently the suspensory ligament) as these structures all support the palmar/plantar surface of the joint. The choice of surgical treatment, should surgery be required, is affected by which tendon is considered to be involved in the deformity. Identification of the primarily affected tendon is not always straightforward. Palpation of the flexor tendons should allow determination of which structure is tightest: the deep digital flexor tendon unit, the superficial digital flexor tendon unit, or the suspensory ligament. Application of pressure to the dorsal joint region in a palmar direction tenses the tendons and the structure with the most tension in it is the first released at surgery. Palpation and passive manipulation of the involved region should be carried out with the limb in a non–weight-bearing position to recognize potential adhesions between the tendinous structures.

Flexural deformities also develop after prolonged periods of not bearing weight, such as that occasioned by radial paralysis or following conservative fracture treatment (classically olecranon fractures). Depending on their management, deformities can become permanent and debilitating despite healing of the original ailment. The joint region involved with the flexural deformity can be fixed by the contracture, without osseous ankylosis present (fibrodesis).

Acquired flexural deformities of the MCP joint have also been reported in mature horses secondary to desmitis of the accessory ligament of the deep digital flexor tendon and in a case of non-responsive digital sheath sepsis, which led to rupture of the flexor tendons within the sheath.

Cases detected and treated early carry a good prognosis for correction with conservative treatment. On author reported that mild cases requiring corrective shoeing only had a good prognosis for resolution. Cases requiring surgical intervention carried a guarded to poor prognosis.

Proximal Interphalangeal Region

Acquired flexural deformities of the PIP joint have been primarily diagnosed bilaterally in the hindlimbs of rapidly growing weanlings. It occurs in foals with straight hindlimb conformation in the same time period as acquired flexural deformities of the MCP joint. The biomechanical basis of the condition has been postulated as shortening of the deep digital flexor musculotendinous unit and a concurrent laxity in the superficial digital flexor tendon, which inserts adjacent to the PIP joint. Usually a dorsal subluxation is diagnosed and is accompanied by an audible click as the foal walks. Radiographs might show osteoarthritis in chronic cases.

Radiography for the Diagnosis

As for congenital flexural deformities, radiography is not required for the diagnosis of flexural deformities, which can be made on the basis of clinical signs. However, radiography is useful to identify abnormalities, which may alter the prognosis for correction of the deformity. Secondary radiographic changes can occur as a consequence of the deformity; in relation to the DIP joint these include modelling of the dorsodistal aspect of the distal phalanx, rotation of the distal phalanx in the hoof capsule, or osteoarthritis of the DIP joint and worsen the prognosis. MCP/MTP joint flexural deformities may show evidence of osteoarthritis in the MCP/MTP or PIP joints secondary to chronic subluxation.

Treatment

Early recognition and treatment of flexural deformities improves the prognosis, especially if pain-mediated flexion is involved, as these will become worse with time if left untreated. If an underlying cause of the pain can be identified, it should be addressed first. Medical or nonsurgical treatment is indicated initially for all but severely affected cases. If nonsurgical treatment does not improve the flexural deformity, surgery should be considered. Surgery should be considered as the initial treatment of severely affected cases.

Common Treatment Principles

Nutrition

Nutrition, along with genetics, control the growth rate of the foal. Overfeeding of foals can occur either by heavily lactating mares or excessive supplementation with concentrates. Alterations in the growth rate may also occur when the nutritional plane increases suddenly, especially after a period of relative deficiency such as after weaning or after a change of ownership. When a flexural deformity occurs in an unweaned foal, the energy content of the diet should be reduced either by early weaning of the foal or a decrease in the mare's concentrate ration. Weaning at 10 weeks of age did not usually affect the foal's size as a yearling in one hospital. The mineral balance of the ration for both the mare and the foal should also be balanced with respect primarily to calcium and phosphorus, as research has shown that calcium/phosphorus imbalances are also implicated in developmental diseases.

Older foals and yearlings should have the concentrate portion of the diet reduced to a minimum and be fed hay and a balanced mineral supplement. Presumably, if contraction of the musculotendinous unit in response to pain is the more accepted etiopathogenesis for acquired flexural deformities, then prevention should be aimed at monitoring growth and weight and adjustment of the diet accordingly.

Additionally, it is advisable to evaluate soil and drinking water samples for their mineral and trace mineral composition; adjustments should be implemented immediately after identifying inadequate levels.

Physiotherapy/Exercise

Opinions differ on the role of exercise in the treatment of flexural deformities. If the deformity is secondary to a painful condition, then exercise limitation and analgesics would be of benefit. Uncontrolled exercise may exacerbate the painful stimuli and the deleterious loading of the contralateral limb.

Analgesics

Both the inciting cause and treatment of acquired flexural deformities is a painful process. To aid the foal in standing and ambulating, nonsteroidal anti-inflammatory drugs are given at low doses as for congenital flexural deformities. Foals with painful limbs tend to lie down for longer periods, which can aggravate the flexural problem and underscores the need for analgesics. (See “analgesics” in “treatment of congenital flexural deformities” for a fuller discussion.)

Distal Interphalangeal Region

Nonsurgical Management

DIP joint flexural deformities in which the foal is bearing weight on the toe generally benefit from controlled exercise on a firm surface to allow stretching of the deep digital flexor musculotendinous unit combined with analgesics; however, it is important that the toe region is protected to prevent excessive wear and possible development of a septic process. Turnout in a small yard that is sufficiently small to prevent uncontrolled exercise is probably a reasonable choice.

Farriery

The overgrown heels of DIP flexural deformities giving the typical “boxy” conformation to the foot may prevent proper realignment of the hoof-pastern axis if the heel contacts the ground. The heels should be rasped back gradually. Radical trimming of the heel will only serve to increase strain forces on the dorsal toe because of the smaller sole surface making contact with the ground. Similarly, if the heel has been lifted off the ground by the deformity, the heels should not be rasped as this will only apply greater forces and leverage to the dorsal laminae and the distodorsal aspect of the distal phalanx. Judicious trimming of the heel combined with application of a toe extension and protection, however, can be an effective treatment.

Application of a toe extension or a glue-on rubber shoe is effective for many flexural deformities of the DIP joint by increasing tension in the deep digital flexor tendon, although some clinicians and farriers do not agree that their use is always beneficial. Another useful purpose of toe extensions is protection of the toe and prevention of excessive wear in that region. Simple application of a shoe with a toe extension, without filling or bracing the extension against the dorsal hoof wall with hoof acrylic, can cause frequent stumbling and abnormal flaring of the dorsal hoof wall.

The argument against toe extensions is that if the flexural deformity is secondary to a painful stimulus, further tension on the DDFT will exacerbate this painful element and some clinicians support elevation of the heel to reduce pain, encourage relaxation in the DDFT and change the weight bearing surface of the foot from the toe to the entire sole; however, other clinicians feel that elevating the heel leads to a worsening of the deformity. There are likely a subset of cases of DIP flexural deformities, which will respond to a toe extension and another subset which will respond to heel elevation. (See also "toe extensions" in "treatment of congenital flexural deformities")

Cast Application
Cast application in foals causes temporary weakening of the tendons. The distal limbs of affected foals may be covered with a fiberglass cast that incorporates the feet for 10 days to a maximum of 14 days. After cast removal, the weakened tendons allow correction of the problem. Despite the fact that the weakening persists for only a few days, one author has achieved permanent correction of the problem with this technique. However, because of the potential complications associated with this type of treatment, cast application is rarely used.

Surgical Management
Surgical intervention is indicated in foals unresponsive to conservative treatment and in severely affected foals. Corrective trimming can be carried out when the foal is anesthetised.
Desmotomy of the Accessory (Check) Ligament of the Deep Digital Flexor Tendon
The treatment of choice for stage I flexural deformities is desmotomy of the accessory ligament of the deep digital flexor tendon (ALDDFT) (inferior check ligament). The ligament may be approached from the lateral or medial aspect of the limb. If both limbs require surgery, they can both be approached with the horse in dorsal recumbency, the horse can be turned half way through surgery from left to right lateral recumbency, or one limb can be approached medially and one laterally with the horse in lateral recumbency. The advantages of a lateral approach are avoidance of the major neurovascular bundle, located medial at this level and the more lateral position of the ligament. The major advantage to the medial approach is cosmetic although the procedure is more difficult.

A 5-cm skin incision, centered at the junction between the proximal and middle third of the MCIII, is made over the deep digital flexor tendon. The subcutaneous tissues are bluntly separated and the tendinous structures identified. With the medial approach, the neurovascular bundle overlying the deep digital flexor tendon and its accessory ligament are identified and reflected away from deeper structures. Palpation of the paratenon surrounding the deep digital flexor tendon and its accessory ligament allows separation between the two structures.

A curved hemostatic forceps is introduced and advanced following the slightly curved surface of the tendon to the opposite side, where the forceps is spread and turned. The ALDDFT lying dorsal to the tendon is elevated to the level of the skin incision. Manipulation of the foot in a dorsal direction tightens the ligament and ensures the isolation of the correct structure. Once the ligament is positively identified, it is sharply transected with a scalpel blade. Dorsal rotation of the DIP joint produces at least a 1-cm gap between the transected ends of the ligament. The gap is inspected and palpated, and any remaining fiber strands of the ALDDFT are transected. The paratenon, subcutaneous tissues, and skin are closed using 2-0 or 3-0 absorbable suture materials in a continuous pattern. Intradermal placement of the skin suture is advised for a better cosmetic result. Postoperatively, a pressure bandage is applied and maintained for 2 to 3 weeks and changed at 3- to 4-day intervals.

Correction or improvement of the deformity is usually observed immediately. In some cases, however, it takes a few days until it is complete. Occasionally, application of a toe protection or extension is needed. Young foals and those without long-standing contracture are allowed controlled exercise within 3 to 6 days after the surgery. Free pasture exercise is encouraged after 2 weeks. In older foals and those with chronic or severe contracture, limiting exercise for a period of months might prevent excessive fibroplasia at the surgery site. To relieve potential pain, nonsteroidal anti-inflammatory agents may be administered at low doses.

An ultrasound-guided tenotomy of the ALDDFT has been described in standing horses. The surgery applying this technique was more successful in restoring a normal hoof conformation in the younger horses treated (median age of six months) compared to the older group of horses (median age 12 months). The age of surgery did not affect the cosmetic outcome.

Postoperative fibroplasia occurring at the surgery site reunites the transected ends of the ligament with time. In selected cases, fibroplasia in that region is excessive and results in a cosmetically undesirable appearance. Bandaging for three weeks after surgery improves the cosmetic outcome and lessens scarring at the surgical site.

Cosmetically unacceptable results can also occur from tendinitis that can be induced from exercise when the tendon has been protected by the contracted accessory ligament for a long time. Tendinitis can be avoided with longer periods of controlled exercise. Daily massage of the swelling can reduce the size.

In horses intended for showing or pleasure riding, the prognosis for athletic function is good; in one study 86% of horses treated before one year of age were subsequently used for their intended purpose. Cases treated after one year of age had a lower success rate of 78%. One author reported a good prognosis for surgical correction of mild cases but a poor response of severely affected cases to an desmotomy of the ALDDFT. Other authors reported that Standardbred foals treated for DIP joint flexural deformities could reach their athletic potential but that the prognosis was better if the foal was treated at a younger age. In this series, no foals treated after eight months of age had a favourable outcome.

Tenotomy of the Deep Digital Flexor Tendon

Stage II flexural deformities might not correct after desmotomy of the ALDDFT although this intervention is commonly used as the first surgical approach. Tenotomy of the deep digital flexor tendon can then be used successfully for correction but the deformity is reported to reappear in many cases within months of surgery. Some clinicians feel that cases with a hoof-ground angle of greater than 115 degrees usually require a deep digital flexor tenotomy. Initially, such a tenotomy had been viewed at as a salvage procedure; however, many animals have developed into sound riding horses although the prognosis for return to function is usually guarded.

Two main sites for the surgical procedure have been proposed: mid-metacarpus or mid-pastern. The distal approach centers at the palmar and median aspect of the pastern region and enters through the digital flexor tendon sheath just distal to the bifurcation of the superficial digital flexor tendon. The deep digital flexor tendon is identified, exteriorized, and transected with a scalpel blade. Immediate retraction of the proximal stump into the tendon sheath is noted. The tendon sheath may or may not be sutured using routine technique in addition to the subcutaneous tissue and the skin. While the animal is under anesthesia, the feet are trimmed to a shape as normal as possible.

Postoperative correction is often immediate but can be associated with substantial pain. Administration of nonsteroidal anti-inflammatory agents is therefore routine.Because of the time it takes for some stage II flexural deformities to develop, the soft-tissue structures, such as joint capsule, ligaments, and periarticular tissues at the palmar aspect of the phalanges, may be significantly contracted. Transection of the deep digital flexor tendon at the level of the PIP joint does not often result in a marked elevation of the toe during weightbearing, as it does after rupture of this tendon in the region of the navicular bone. Nevertheless, in selected cases, application of a shoe with a heel extension is necessary.

Transection of the deep digital flexor tendon at the midmetacarpal level is also advocated. The procedure is carried out through a medial or lateral approach. The advantage of this approach is the greater distance from the feet and the fact that a tendon sheath is not invaded. Additionally, the procedure is easier to perform at the midmetacarpal level and can be performed as a standing procedure. However, scarring associated with marked disfigurement of the tenotomy site can be an undesirable sequela. Postoperative management is identical to that used with the other technique. Recurrence of the deformity is a potential problem following this technique, as the tendon ends my reunite, initially with scar tissue followed by its contracture.

Metacarpophalangeal Region

Nonsurgical Management

Nonsurgical management includes proper nutrition, physiotherapy, analgesics, corrective shoeing, and application of splints.

Physiotherapy

Hopping an animal is a further attempt to bring about correction of the deformity without surgery. One limb of a foal is elevated and held in that position while a helper leads the animal at a walk. During the support phase of the elevated limb, most of the weight is transmitted to the person holding the limb. The opposite limb is quickly advanced and all the weight brought to bear on it. By repeating this type of physiotherapy several times daily, a potential stretching of the musculotendinous unit can be achieved. Exercise is an important type of therapy, but it should be carried out in a controlled manner. Excessive exercise leads to fatigue, which should be avoided.

Farriery

Corrective shoeing can successfully eliminate flexural deformities of the MCP joint. Raising the heel with wedge pads results in a more acute angle of the MCP joint as a result of partial relaxation of the deep digital flexor tendon. Raising the heels by the use of a wedge pad or shoe has been suggested to decrease the strain in the deep digital flexor tendon while increasing the strain on the superficial digital flexor tendon and the palmar joint structures. Some authors have questioned the effectiveness of such treatment, but clinically, an improvement is possible. Conversely, some clinicians recommend lowering the heel to invoke a reverse myotactic reflex. Toe extensions have been advocated and have proved very effective, especially when the condition was diagnosed early. As the animal walks, breakover occurs later, and through this, greater tensile stress is exerted on the flexor tendons.

Splints

Splint application can bring about some correction, especially in cases recognized early. Care must be taken to prevent development of pressure sores. Splints that position the MCP joint caudal to the foot loading the horse's weight onto the flexor tendons during weightbearing can be useful.

Surgical Management

Horses that are unresponsive to conservative management are candidates for surgical correction. Some clinicians feel that any horse with a MCP angle of greater than 180 degrees (forward of the hoof) are immediate surgical candidates.

Because both the superficial and deep digital flexor tendons cross the palmar/plantar surface of the MCP/MTP joint, either or both can contribute to flexural deformities of this region. Distinguishing which tendon is primarily affected through palpation is not necessarily straight forward. Both desmotomies of the ALDDFT and accessory ligament of the superficial digital flexor tendon (ALSDFT) have been used for flexural deformities of this joint and can be used together for the treatment of severe deformities. Using the angle of the MCP region when the joint is in forced extension, guidelines exist for selection of the correct surgical procedure. Flexural deformities with a MCP angle of less than 180 degrees usually respond to desmotomies of the ALDDFT or ALSDFT. For MCP angles of 180 degrees, the surgical procedures above are used in conjunction with a splint and severe cases with a MCP angle of greater than 180 degrees benefit from both desmotomies plus a tenotomy of the superficial digital flexor tendon. The aim of all surgical procedures for MCP/MTP flexural deformities is to return the regional angle to less than 180 degrees facilitating loading of the flexor tendons.

Desmotomy of the Accessory (Check) Ligament of the Deep Digital Flexor Tendon

If the deep digital flexor tendon was tighter during palpation and manipulation, its accessory ligament should be transected using the technique described earlier.[76] Application of a preshaped polyvinylchloride half-pipe splint is necessary for 2 to 3 weeks to maintain the metacarpophalangeal angle in the normal range.

Desmotomy of the Accessory (Check) Ligament of the Superficial Digital Flexor Tendon

Transection of the ALSDFT should be performed when this tendon is tighter during manipulation. Two surgical approaches have been developed. The surgical landmarks for both approaches are the same and consist of the medial distal physis of the radius, the chestnut, and the cephalic vein. An approximately 10-cm skin incision is centered along the chestnut and made craniad to the cephalic vein. The subcutaneous tissue is bluntly separated, and communicating branches to the cephalic vein are isolated, double ligated, and transected between ligatures.

One surgical technique approaches the accessory ligament craniad to the flexor carpi radialis muscle. The oval foramen in the carpal fascia can serve as the distal border of the desmotomy incision. The carpal fascia is transected carefully, and the ensheathed flexor carpi radialis muscle is identified. Both the cephalic vein and the flexor carpi radialis muscle are displaced using a self-retaining retractor. The desmotomy of the fan-shaped accessory ligament is performed taking care to avoid inadvertent injury to the palmar carpal rete. After transection of the ligament, the radial head of the deep digital flexor muscle appears and the carpal sheath becomes visible. Hemostasis is established, and routine closure of the carpal fascia, subcutaneous tissues, and skin is carried out.

An alternative approach involves invasion of the sheath of the flexor carpi radialis tendon. After reflecting the flexor carpi radialis tendon in the sheath with a self-retaining retractor, the craniolateral wall and accessory ligament are identified. A curved Kelly forceps is placed under the distal border and spread. Transection of the ligament is then performed in a distal to proximal direction. Care is taken to avoid injury to the nutrient artery of the superficial flexor tendon, which enters along the proximal border of the accessory ligament. After transection, the same anatomic structures are visible as mentioned with the first technique. Inadvertent incision of the carpal sheath is of no consequence. Closure of the tendon sheath is carried out usinga continuous suture pattern with 2-0 or 3-0 synthetic absorbable material. The rest of the closure is routine.

Additionally, a tenoscopic surgical approach has been developed, which allows a shorter convalescent period and fewer incisional complications.

A recent *in vitro* study revealed that desmotomy of the ALSDFT was associated with significantly increased strains on the superficial digital flexor tendon and the suspensory ligament and significant alterations in the angles of the MCP and carpal joints. Lengthening of the superficial digital flexor musculotendinous unit after desmotomy of the ALSDFT can be associated with increased strain on the suspensory ligament.

Postoperatively, a sterile pressure bandage is applied and maintained for 2 to 3 weeks. The bandage is changed at 3- to 4-day intervals. A shoe with an elevated heel may be used post-operatively to preferentially load the superficial digital flexor tendon.
In severe cases, the accessory ligaments of both the deep and the superficial digital flexor tendons are transected.

Transection of the Suspensory Branches
As an additional alternative procedure, desmotomy of the medial and lateral branch of the suspensory ligament may be performed for salvage purposes in persistent cases. However, subluxation of the PIP joint is to be expected.

A stab incision is performed directly over the suspensory branch, the subcutaneous tissues are separated with a Kelly forceps, and a curved tenotome is introduced. By applying pressure with a sawing motion, the previously undermined suspensory branch is transected. Care should be taken to avoid inadvertent injury to the palmar artery and vein and the MCP joint capsule. The skin is closed using a few simple interrupted sutures. The same procedure is performed on the other side of the limb.

Horses with chronic or severe flexural deformities respond poorly to any treatment, including surgery, and superior check ligament desmotomies do not carry as good a prognosis as inferior check ligament desmotomies. Severe flexural deformities following prolonged non–weight-bearing lameness do not respond to desmotomy of either of the two accessory ligaments. Such cases should be treated either with a tenoplasty as the lengthening procedure in both flexor tendons, followed by long-term cast application, or with an osteotomy in conjunction with a MCP arthrodesis although euthanasia is a valid consideration in these cases.

Carpal Region

Nonsurgical Management

Foals with long-term debilitating injuries that prevent weightbearing on the limb should be treated with splints early in the convalescent period to prevent development of a flexural deformity. Passive stretching exercises are indicated. These two therapies are combined with controlled exercise if the original injury allows it. A contracture typically occurs suddenly over a few days after several weeks of not weightbearing on the limb. Therefore, physiotherapy should not be delayed. Care should be taken to prevent development of pressure sores under the splint.

Surgical Management

In cases resistant to conservative treatment, tenotomy of the ulnaris lateralis and flexor carpi ulnaris tendons can be performed with good results. The same surgical procedure is performed as described earlier. Passive manipulation of the carpal region at that time demonstrates the greater mobility gained through this procedure.

Postoperatively, a well-padded pressure bandage is applied and a splint centered over the carpal region is incorporated. While the horse is under anesthesia, the limb is forced into a straight position. The splint bandage is changed regularly and maintained for about 2 weeks. Hand-walking exercise is important for the first 3 to 4 weeks. As soon as the animal is weightbearing well on the limb, the splint is removed.

Proximal Interphalangeal Region

Nonsurgical Management

Rest is not usually an effective management tool in these cases. The periarticular tissues may fibrose , and eventually the clicking noise is not heard anymore. However, a marked bend at the joint level will be visible. Osteoarthritis could develop, necessitating an arthrodesis of the PIP joint to render the animal pain free again.

The clicking sound associated with dorsal snapping of the PIP and MCP area could also be observed in foals with persistent foal hoof at the tip of the hooves, resulting in an elongated hoof configuration. Trimming of the hoof was successful in eliminating the clicking sound and the snapping of the proximal interphalangeal and metacarpophalangeal area. This approach should be tried before surgical intervention is performed.

Surgical Management

Affected horses may respond to exercise restriction and analgesics but in cases unresponsive to medical treatment, surgical transection of the accessory ligament of the deep digital flexor tendon and the tendon of the medial head of the deep digital flexor tendon at the level of the chestnut has been reported. Three horses treated surgically with this method had resolution of the subluxation and the one horse for whom follow-up information was available was sound after ten months.

COMPLICATIONS

Nonsurgical Management

Splint-associated pressure sores are the most often encountered complication and septic arthritis following injudicious use of splints has been reported. To avoid such complications, padding is placed around sites of predilection. Once necrosis is present, local pressure has to be avoided in that area. Application of a donut-shaped pad around the periphery of the lesion can assist in that effort. Alternate application or temporary removal of the splint may be attempted. Daily topical wound care is necessary, especially in the initial period.

Surgical Management

Persistent hematoma formation, especially at the site of transection of the ALSDFT, wound dehiscence, and infections are the most common complications encountered after surgical treatment. Whenever fever, leukocytosis, warmth at the surgery site, or increased pain are noted, an evaluation of the incision should be made and the necessary steps taken immediately.

Table 1: Age of onset of the most commonly encountered flexural deformities

Age of Onset	**Deformity**
CONGENITAL DEFORMITIES	
Birth up to one month of age	Carpus Metacarpophalangeal Region
Less commonly	Metatrasopalangeal Region Proximal Interphalangeal Region Distal Interphalangeal Region
Rarely	Tarsal Region
ACQUIRED DEFORMITIES	
One to 4 months of age	Distal Interphalangeal Region
One to 6 months of age	Metacarpophalangelal Region Proximal Interphalangeal Region
Less commonly	Metatarsophalangeal Region