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ANGULAR AND FLEXURAL LIMB DEFORMITIES

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ANGULAR LIMB DEFORMITIES

Angular limb deformities are defined as lateral or medial deviations to the long axis of the leg in the frontal plane. Of these, lateral deviations distal to the carpus are the most common, and are termed carpus valgus. Tarsus valgus and fetlock varus are also relatively common. Rotational deformities can occur concurrently with angular deformities, and it is this condition that gives the toed in or toed out appearance to the limb. There is no scientific data to confirm a breed or gender predilection for angular deformities, but many feel there is a genetic predisposition for angular deformities that can be passed on from the dam or sire to their foals. Mild carpus valgus and a toed out appearance is considered normal in foals, and both frequently correct without intervention as the foal grows and the chest widens. In fact, recent evidence suggests that mild carpus valgus conformation decreases the risk of carpal bone fractures in racing Thoroughbreds.

Angular limb deformities are usually considered to be congenital defects. None the less, they can be termed as developmental when the normal valgus conformation of the neonate fails to correct or worsens. There may be multiple contributing factors to worsening of an angular limb deformity, and accurate determination of these factors is important for the development of an appropriate treatment plan. Considerations in the formulation of treatment protocols should include genetics, nutrition, amount of exercise, skeletal maturity, and age of the foal.

Causes of angular deformities include laxity of periarticular ligaments, defective or delayed ossification, fracture, luxation of the cuboidal bones of the tarsus or carpus, trauma to or infection of the physis, and asynchronous longitudinal growth of the metaphysis and epiphysis. Of these many causes, asynchronous metaphyseal growth is by far the most common cause of angular limb deformities. Most of the growth from the distal radial and tibial physes occurs during the first 6 months of life, while the distal metacarpal and metatarsal physes have active growth only during the first 3 months. Since the greatest impact on limb angulation is made during periods of rapid growth, early identification and frequent re-evaluation is helpful to achieve a favorable result.

DIAGNOSIS

Diagnosis of carpus valgus is made by a combination of clinical and radiographic evaluation. It is critical for foals to be observed carefully during normal weight bearing and ambulation, and to have them stand as squarely as possible with the foot directly below the upper limb. Alterations of limb position from this neutral stance can either mask or exacerbate the deformity. Equally important is for the clinician to position him or herself directly in front of the long axis of the leg, and not necessarily in front of the toe. The hoof wall of the affected limb should be evaluated for uneven wear, and the presence or absence of laxity in the affected joint can often best be evaluated with the foal restrained in lateral recumbency. Diagnosis of fetlock and hock deformities is generally more difficult than for the carpus, largely due to the lack of long bones distal to the fetlock that are useful for the initial visual assessment by owners and veterinarians. Tarsus valgus deformities often are unrecognized, perhaps from lack of observation of the foal from behind, as well as from the inherent offset position of the tarsus.

Dorsopalmar/plantar radiographs of the limb taken on long cassettes are extremely useful to document the degree of deviation, but care should be taken when interpreting joint angulation sequentially over time, as slight variations in obliquity can produce large changes in perceived angulation. The intersection of lines drawn along the long axis of the bones on each side of the affected area are not only useful in angle determination, but provide information regarding the source of the deviation by identifying the pivot point. Additional views are often indicated to rule out additional problems. These include wedging of the epiphysis, abnormal contour of cuboidal bones, and crushing of cuboidal bones.

CONSERVATIVE MANAGEMENT

Ligamentous laxity is most common in very young foals, and usually does not require surgical intervention. Restriction of exercise in these patients is extremely important, and keeping the mare and foal confined for most of the day with only brief periods of exercise will not only minimize stress on the ligamentous tissues but decrease the risk of damage to boney structures in the affected joint(s). The hooves should be balanced as it shows uneven wear, but trying to correct an angular deformity by over-trimming the feet is likely to cause more problems than it solves. Frequent clinical and radiographic evaluations are very important during conservative management of these abnormalities. Digital photography can be highly useful for making comparisons of limb angulation over time. In general, lack of improvement over a 2-week period (especially in the case of fetlock deformities) should be considered as an indication that further and more aggressive treatment is necessary. Angular limb deformities of the fetlock or phalanges should be treated with surgical intervention by 30-45 days after birth, while abnormalities originating from the distal tibia or radius can be treated conservatively for 60-90 days after birth if progress is being carefully documented. However, if the deformity is severe or the condition is worsening in the face of conservative treatment, immediate surgical intervention should be strongly considered.

Tube casts, braces, and splints have also been advocated in the management of angular limb deformities, and have their place in the management of this condition. Specifically, angular deformities associated with ligamentous laxity, immaturity of associated cuboidal bones, or collapse of the cuboidal bones can benefit from axial alignment obtained by these devices, but great care must be exercised in their application and temporal evaluation to avoid serious complications in the form of pressure-induced sores and necrosis secondary to excessive pressure.

SURGICAL MANAGEMENT

Surgical management of foals with angular limb deformities involves either accelerating growth on the concave aspect of the limb, retarding growth on the convex side of the limb, or a combination of the two procedures. The most common approach is to stimulate growth on the concave side of the deformity by using hemicircumferential transaction of the periosteum and periosteal elevation. The mechanism of this procedure is thought to be related to the mechanical release of the periosteal restraint to growth on the side of the physi
where the procedure is performed, and a common observation following transaction is the retraction of the periosteum after being cut, suggesting that the tissue was under considerable tension. The procedure is easy to perform, has minimal complications, and does not result in overcorrection of the limb. Additionally, it can be repeated in 4-6 weeks if indicated, with the expectation of further correction.

The surgery is performed under general anesthesia, and can be done on an out-patient basis in most situations. Dorsal recumbency is preferred, as it improves hemostasis and allows for bilateral surgery to be performed without repositioning of the foal. For carpus valgus deformities, a 1.5 to 2.0 cm incision is made 2 cm proximal to the distal radial physis on the lateral aspect of the limb. Blunt dissection is used to create a tract extending transversely from the dorsal aspect of the radius to the caudal aspect, with care exercised to be confident that the tract passes directly over bone and not over tendons. A reverse curve blade is then introduced into the tract and the periosteum is transected sharply. An additional periosteal cut is made along the lateral aspect of the distal radius in a proximal to distal direction that bisects the first cut, and the 4 corners are elevated away from the bone. This modification to the original technique is thought to provide a greater release of periosteal tension. It is important to remove the cartilaginous or ossified (depending on the foal’s age) end of the rudimentary ulna with rongeurs, which otherwise can act as a tether on the lateral side of the limb and delay correction.

There is recent evidence to suggest that this hemicircumferential transaction of the periosteum and periosteal elevation is no more effective than stall rest and foot balancing in experimental foals where carpus valgus was induced by application of a transphyseal bridge on the lateral aspect of the distal radial physis. In spite of this information, many equine surgeons continue to rely on the technique as their first choice for surgical management of routine angular limb deformities.

Surgical disruption of normal endochondral ossification on the convex side of the deformity is also a useful surgical tool in the management of angular limb deformities. A bridge across the physis is usually made with bone screws placed on either side of the physis connected by wire, but placement of a large surgical staple across the physis is also commonly used in some surgical practices. Screws and wires are placed through stab incisions on the lateral aspect of the distal radius. The distal screw is placed in the center of the epiphysis and the proximal screw is placed 2.0 cm proximal to the physis, and a tract is bluntly dissected between the screws over the surface of the bone. Two 18 or 20 gauge figure of 8 are placed over the screws and tightened prior to complete insertion of the screws. When the screws are fully tightened, the wires slide partially up the beveled screw head, thereby providing additional tightening of the wire. This bridge delays growth on one side while it continues on the other side, allowing the limb to straighten. Once the limb is straight, the implants must be removed to prevent overcorrection, and normal limb growth can continue. Transphyseal bridging allows severe deformities to be corrected relatively quickly, and is often combined with periosteal stripping in older foals or in foals with severe deformities.

PROGNOSIS
The prognosis for correction of angular limb deformities is generally considered to be good to excellent. Prognosis is dependent on severity, age of the foal at the time of diagnosis, and type of deviation. Carpus and tarsus valgus usually carries a better prognosis than carpus varus or deformities of the fetlock. However, angular limb deformities of the carpus or tarsus originating from cuboidal bone collapse have a guarded to poor prognosis because of secondary osteoarthritis that develops with age and increased exercise. This is particularly true in the carpus, but many cases of tarsal bone collapse can achieve athletic soundness if the distal tarsal osteoarthritis (juvenile bone spavin) can be managed until the affected joints ankylose or are surgically arthrodesed. In one study of foals with incomplete ossification of the tarsal bones, 73% had tarsus valgus deformities, and only 32% of the foals were able to reach their intended use as adults.

FLEXURAL LIMB DEFORMITIES
Flexural limb deformities are defined as abnormalities of limb positioning where the foal is unable to fully extend the limb. Usually this type of limb hyperflexion results from a difference in the length of the musculotendinous unit relative to the length of the bone. Flexural limb deformities can be either congenital or acquired, and can occur either in the uterus or long after foaling. Anatomical structures involved include the flexor tendons, suspensory apparatus, joint capsule and surrounding fascia, bone, and skin.

CONGENITAL FLEXURAL DEFORMITIES
Congenital deformities are by definition present at birth, and the cause is oftentimes unknown. Uterine malposition and presence of an oversized fetus are often considered as causes, but are difficult to document, particularly when considering the size of the uterus and the foals ability to move within it prior to parturition. Known causes include maternal exposure to influenza, Sudan grass, loco weed, and other teratogens. The carpus, fetlocks, and tarsus are usually involved in decreasing order of frequency, and involvement of multiple joints is common. Flexural deformities of the carpus are frequently associated with dystocia, and can result in the loss of the foal and impaired fertility in the mare from damage during parturition. Severe flexural deformities are often associated with arthrogryposis and spinal deformities, and treatment is rarely successful in these advanced cases.

Mild flexural deformities of the carpus or fetlock are the most common presentation, and frequently resolve with minimal veterinary intervention if the foal is able to stand and nurse. Physical therapy is very useful in mild to moderate cases, and can be performed by manually extending the limbs 4-6 times per day for 10-15 minutes per session. Forcing the foal to rise and ambulate is also helpful for stretching the affected tissues. For more severe cases where the foal is unable to rise and stand without assistance, heavy bandages and the use of splints can provide additional assistance, but must be carefully monitored. Some clinicians favor the use of casts to correct congenital flexural deformities, but the incidence of complications in the form of pressure sores and skin necrosis is high due to the inability to adequate monitor conditions under the cast. Splints should be reset at least every 12 hours and the limb(s) given adequate opportunity to perfuse before reapplication, and they must be monitored continually for slipping and rotation.
Ideally, foals in splints should be hospitalized, and the splints removed every 4-6 hours for a 4-6 hour period before reaplication. Commercial braces are available (Almanza Corrective Boot; Equine Bracing Solutions, Trumansburg, NY) that allow adjustment of the degree of extension for a specific region of the limb. Intravenous oxytetracycline has been used with high success, but also carries with it potential complications, including renal failure, diarrhea, or excessive laxity of normal joints. Confirmation of normal renal function prior to treatment is important, and documentation of normal serum creatinine levels prior to administration is especially recommended in foals that may have concurrent problems or are dehydrated. Two to four grams diluted to 1 liter over 30-60 minutes are generally administered, and can be given daily to every other day for 3 or 4 treatments. Treatment with oxytetracycline is more effective the sooner it is given. Management of pain that occurs from stretching of the palmar tissues with use of non-steroidal anti-inflammatory drugs may be indicated. Surgical intervention is usually not necessary for management of congenital flexural deformities, but should be considered for severe defects or for foals who are not improving with conservative management. Surgical options for flexural deformity, depending on the location of the deformity, include proximal and distal check ligament desmotomy, palmar carpal joint capsule transaction, tenotomy of the ulnaris lateralis and flexor carpi ulnaris tendons, and fetlock arthrodesis.

The prognosis for congenital flexural deformities is generally good if they respond favorably to treatment during the first 2 weeks of life. Dorsal buckling at the carpus may continue for several months, but generally resolves if the foal has been able to stand, nurse, and ambulate relatively soon after parturition.

Rupture of the common or lateral digital extensor tendon can be misdiagnosed as a flexural limb deformity of the fetlock or carpus because the foal often knuckles forward when walking. These problems are recognized soon after birth, but in rare cases can occur as late as 3 weeks after foaling. Presentation includes a characteristic knuckling at the fetlock and/or carpus, fluctuant swelling at the dorsolateral surface of the carpus where the rupture has occurred, and palpable laxity in the extensor tendons. This condition is often seen in conjunction with contraction of the flexor tendons. Treatment is usually conservative, and involves splint application over a heavily padded bandage to prevent knuckling and trauma to the dorsal aspect of the fetlock and pastern. Splints placed dorsally are the most effective, but like all splints must be carefully monitored and reset frequently to prevent complications. Stall confinement is recommended initially, and splinting is usually necessary for several weeks to allow adequate fibrosis between the ruptured tendon ends and the return of a normal gait. The prognosis is excellent for full functional recovery, but foals may have thickening over the dorsal aspect of the carpus for 6-12 months.

ACQUIRED FLEXURAL DEFORMITIES

Acquired flexural limb deformities can develop anytime from birth until 2 years of age. The most common sites of involvement include the distal interphalangeal joint, the metacarpophalangeal joint, and the carpus. Usually, acquired flexural deformities of the coffin joint (club foot) are recognized between 3 and 6 months of age, deformities at the carpus are noted between 1 and 6 months of age, and abnormalities of the fetlock angulation are recognized later, between 9 and 18 months of age. The etiology for these deformities is believed to be related to a genetic predisposition for rapid growth, over-nutrition, and pain. During periods of rapid bone growth the potential for lengthening of the associated tendons is limited by the accessory or check ligaments, resulting in a discrepancy in length between the bone and tendon/check ligament unit. Additionally, pain associated with physeal dysplasia (physsitis/epiphysitis) may result in decreased weight bearing on the affected limb, which initiates a secondary contraction and shortening of the musculotendinous unit. Finally, any source of pain in the affected limb can result in prolonged reduction in weight bearing and a resultant flexural deformity.

Clinical signs associated with flexural deformity of the coffin joint include bulging at the coronary band, an increased heel length relative to the toe, and eventually loss of contact between the heel and the ground. The dorsal surface of the hoof wall can develop a dish shape as the contracture progresses, and rotation of the third phalanx along with modeling changes at the tip of P3 can be seen in chronic or severe cases. These horses often develop a back at the knee (calf kneed) conformation as well. Conservative treatment includes exercise restrictions, frequent but gradual lowering of the heels, decreased caloric intake, and pain management with non-steroidal anti-inflammatory medications. Weaning of younger foals is often recommended, and acrylic reinforcement or lengthening of the toe may be indicated if toe wear is excessive or a fulcrum is needed to stretch the deep digital flexor tendon. Some clinicians advocate raising the heel will relieve stress on the deep digital flexor tendon and reduce pain, but this technique can result in a gradual worsening of the deformity if the tendon is not physically stretched by non-painful weight bearing. Surgical intervention is indicated if improvement of clinical signs is not seen within 1-2 months, if the deformity is severe at first presentation, or if the condition is worsening in the face of treatment.

The treatment of choice is a desmotomy of the accessory ligament of the deep digital flexor tendon, also known as an inferior check ligament desmotomy. This procedure, when combined with additional corrective trimming, carries a good prognosis for improvement of hoof conformation and function. Desmotomy of the accessory ligament of the deep digital flexor tendon can be performed on either the medial or the lateral aspect of the limb. Many surgeons prefer using the lateral approach, as it minimizes the risk of injury to the neurovascular bundle that is closely associated with the ligament on the medial side. The horse is positioned in dorsal recumbency, and the check ligament is identified with careful blunt dissection through a 4 cm incision located over the deep digital flexor tendon at the proximal third of the metacarpus. Blunt dissection is used to separate the ligament from its loose fascial attachment to the deep digital flexor tendon, and it is transected sharply. Careful inspection of the deep or medial aspect of the surgical field often reveals additional fibers of the ligament which should also be cut. Owners need to be advised of the potential for a cosmetic blemish, but special bandaging techniques can be useful to minimize postoperative scarring at the surgery site. Severe cases, where the dorsal aspect of the hoof wall goes beyond the vertical, may require a tenotomy of the deep digital flexor tendon, but a check ligament desmotomy should always be attempted first if athletic use of the horse is required.
Acquired flexural deformity of the carpus is usually recognized soon after foaling, and conservative management is usually successful. Treatment includes nutritional evaluation for the foal, and correction if indicated, but in general the goal is to reduce energy intake and slow growth. This is accomplished by decreasing the mare’s caloric intake to decrease volume and quality of the milk, and to limit the foal’s access to grain. Oftentimes weaning the foal offers the best option to control diet and get the most expedient correction of the deformity, but total correction can take weeks to months of careful management. Pain in managed with judicious use of non-steroidal anti-inflammatory drugs and limitations to the foal’s turnout schedule. Physical therapy, splints, bandages and oxytetracycline can also be of benefit in addition to correction of the underlying problem.

Acquired flexural deformity of the fetlock joint is usually seen in yearlings, and conservative management is the same as for other flexural deformities. Contracture of the superficial digital flexor tendon is the most common cause of this deformity, but involvement of the deep digital flexor tendon may also be a factor. Surgical transaction of the accessory ligament of the superficial digital flexor tendon may be indicated for deformities that do not respond to surgical correction, and is often times performed bilaterally. However, selection of the best surgical procedure can be difficult because multiple structures supporting the fetlock may prevent normal extension of the joint. Careful palpation of the suspensory ligament and flexor tendons just proximal to the fetlock while the horse is fully weight bearing and the fetlock is pushed palmarally into full extension will usually reveal which structures are the tightest. For horses with fetlock angle equal to or greater than 180 degrees, cutting both accessory ligaments may be necessary to achieve correction.

PROGNOSIS
The prognosis for horses with mild or moderate flexural deformities of the coffin joint is generally good for full athletic use, including those patients that require desmotomy of the distal check ligament. Deformity of the fetlock joint does not carry as good a prognosis in general, as this condition is often times more difficult to correct initially, and may recur in horses that initially seemed to respond well to either conservative or surgical treatment. The prognosis for horses with flexural limb deformities requiring tenotomy of either the deep or superficial digital flexor tendon is poor for athletic use, but fair to good for light pleasure riding or reproduction.