Clinical Techniques in Equine Practice

Diagnosis, Assessment, and Treatment Strategies for Angular Limb Deformities in the Foal

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Incomplete ossification is an important parameter to keep in mind in newly born foals with angular limb deformities (ALD). Because these animals need immediate veterinary attention, client education is of pivotal interest. In most other inciting causes of ALD, time is not as important. Many deformities may correct on their own as long as skeletal maturity is present. Especially in foals with mild to moderate valgus deformities of the carpal region treatment may be postponed until 8 to 10 months of age, because at this time some accelerated growth is usually noted at the lateral aspect of the radius, correcting the deformity. Varus deformities of the third metacarpal/metatarsal bones (McIII/MtIII) should be diagnosed in the first couple of months of age and treated immediately, because around 3 months of age, the distal physis of these bones closes. After that time surgical growth manipulations are ineffective. Care should be taken to also evaluate the proximal phalanx, because frequently an opposing deformity develops in this bone, seemingly straightening the limb axis, but orienting the joint not parallel to the ground, which results in an abnormal ambulation of the foal and disproportionate loads exerted on the medial versus lateral aspect of the joint and subsequent development of arthritis. Some foals are born with "offset" or bench knees. This conformational defect may prevent some foals from ever becoming successful athletes. There is some controversy among specialists as to the development of this deformity. One school of thought is a lateral displacement of the small carpal bones within the carpal region, whereas the other explains the deformity as a combination of a valgus deformity of the radius with a varus deformity of McIII. The purpose of this article is to critically discuss the development and treatment strategies of ALD. The actual management of the different problems is discussed in a subsequent article.
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In this article the following issues are discussed: definition of angular limb deformities (ALD), their etiology, the anatomical location where they occur, the diagnosis of ALD, and the discussion of the treatment strategies. Because of the importance of endochondral ossification of the carpal and tarsal region in the development of ALD, this process is initially briefly elucidated. The main emphasis is given to the strategies applied in the management of ALDs that can be manipulated surgically. There are other techniques used in the care of the growing foal such as hoof care and exercise manipulation. These are equally important and should be part of the concurrent management of the young horse to produce a correctly conformed adult.

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Bone Formation and Growth

Maturation of the skeleton from the primordial or precursor cartilage to bone is a very complicated process and occurs mainly during the later stages of gestation. Radiographs taken of the carpal and tarsal regions of aborted fetuses at 230 days of gestation reveal only partial ossification of the diaphyses and metaphyses of the long bones as well as of the calcaneus.[1] Other bones are not ossified at all at that time. For instance, intraarticular injections of contrast medium provide outlines of the bone templates in their normal shapes, although they consist of precursor cartilage only. Ossification of these structures begins in the center and expands radially in all directions to the periphery.[2,3] At about 260 days of gestation, ossification centers are noticed in the distal radial epiphysis, distal tibial epiphysis, talus, and accessory carpal bone. Later, ossification centers in the intermediate, radial, and third carpal bones, and the central, third, and fourth tarsal bones develop. At around 290 days, the proximal epiphyses of the third metacarpal/third metatarsal bone (McIII/MtIII) appear,

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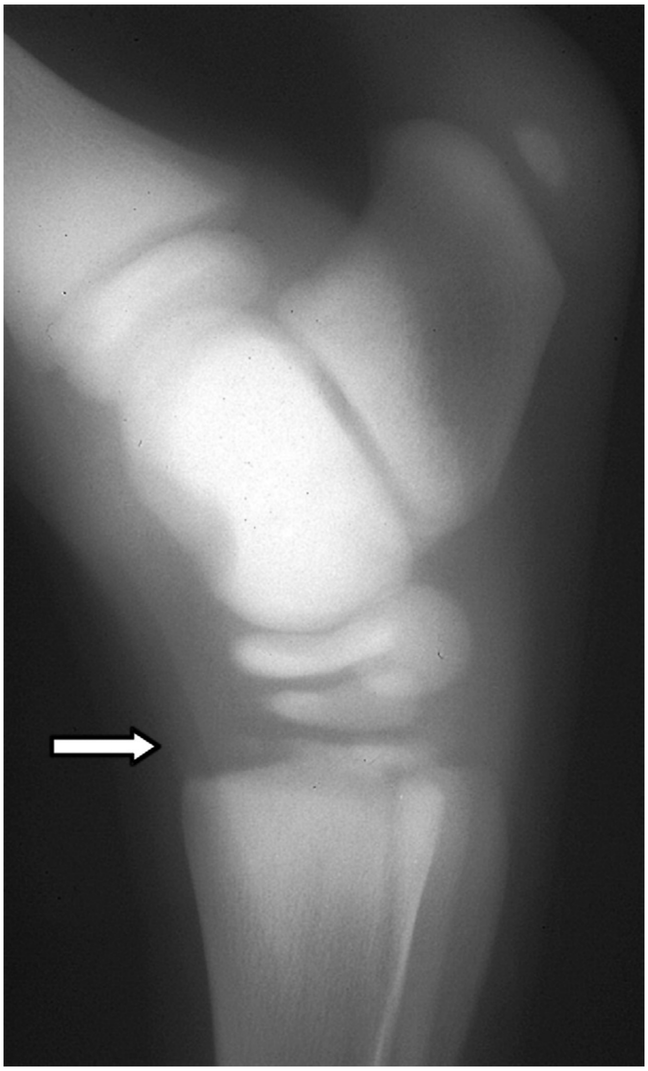

Figure 1 Lateromedial radiographic view of the tarsal region of 290-day-old fetus. Note the third and central tarsal bones are only rudimentarily ossified and the proximal epiphysis of MtIII (arrow) is not yet fused with the rest of the bone.

and they unite shortly thereafter with the metaphyses of these bones (Fig. 1). After 300 days of gestation, all bones of the carpus and tarsus are visible radiographically. However, the ulnar styloid process—phylogenetically part of the ulna, which is the last ossification center to appear, is still not seen at this time. During the remaining days of gestation, ossification progresses toward the periphery, and the bones acquire their final shape. At birth, the edges of these bones are still somewhat rounded, but the "radiographic joint spaces" are within normal limits. These spaces consist of two layers of cartilage in addition to the actual joint space.[3-5]

The vast majority of longitudinal growth in the long bones occurs in the metaphyseal region of the physis. Some growth is attributed to the epiphysis, growing both toward the articular cartilage and the physis. Bone growth begins with the formation of cartilage, which subsequently degenerates, calcifies, is reabsorbed and replaced by trabecular bone in response to the amount of stress that is experienced at the physis (Fig. 2). This is a coordinated effort. It requires two complete steps in that the cartilage must first degenerate, be calcified, and then be removed and replaced by trabecular

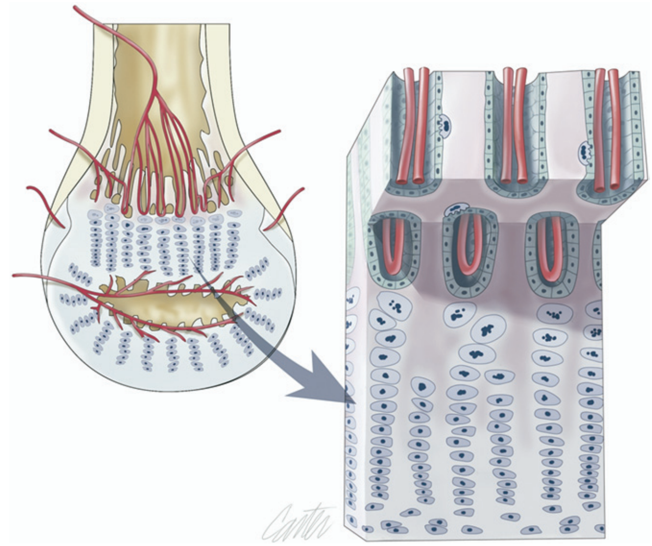

Figure 2 Drawing of the distal McIII with metaphysis, physis, and epiphysis. (Color version of figure is available online.)

bone. It has a self-straightening mechanism, which can be supplemented surgically (see later discussion).

Definition

Animals with ALD present with either a valgus deformity (lateral deviation of the limb distal to the location of the deformity) or a varus deformity (medial deviation of the limb distal to the location of the problem)[6] (Fig. 3). Either type of deviation is usually associated with a certain degree of axial rotation. In foals with valgus deformity, this is displayed as an outward rotation (splay foot), and in cases of varus deformity, as a medial rotation of the feet (pigeon toes). In most cases, these deformities are initially merely postural, through a rotation of the limb axis toward either the outside or the inside, respectively. With time, however, the bone adapts to abnormal loading, according to Wolff's law,[7] and differential

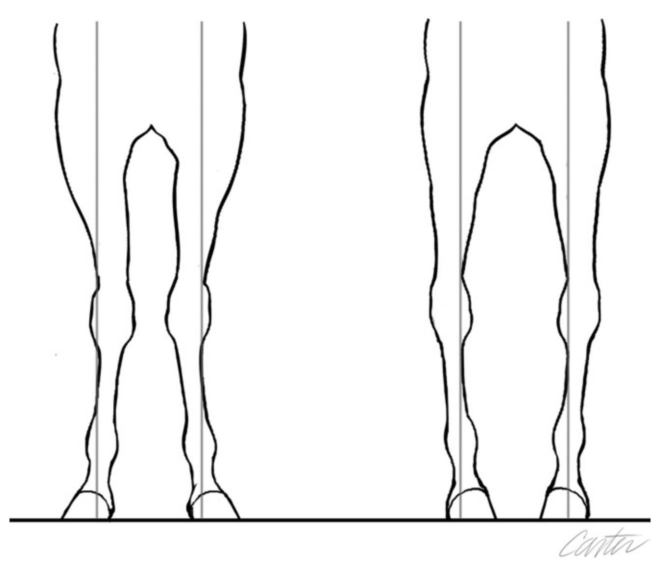

Figure 3 Drawing of a foal with a valgus deformity in the distal radius region (left) and a foal with a varus deformity of the same location (right).

metaphyseal growth results in the development of a permanent rotational deformity.[6]

Etiology

ALD can be divided into two main categories: acquired angular deformities and congenital angular deformities. They are of different pathologic origin. Congenital angular deformities, in most instances, have normal physes and result from a disparity in growth of the physeal complex causing angulation of the long axis of the limb originating at the region of the physis. Acquired angular limb deformities generally involve pathologic physes where normal anatomic alignment was present and disruptions in normal bone formation have resulted in the creation of a weakened structural area that collapses. Considerations for treatment must take into account that in acquired angular deformities, there may not be a normal physis, which can be manipulated. The deformity generally occurs later in the period of bone growth leaving less normal bone growth activity to be manipulated.

Compensatory ALD can occur in remote sites in the affected limb because of disproportionate loading of a growth plate distally. Such compensatory deviations may straighten the limb axis, but when the foal ambulates, the joint involved rotates outward, because the joint is not oriented at a right angle to the long axis of the limb (Fig. 4).

Location of the Angular Deformity

The angular deformities that need to be monitored and can be altered by different methods are located in the mid and distal limb and originate at different sites. One angular deformity of concern is the *diaphyseal* angular deformity that originates along the diaphysis of the bone and not in the physis or metaphysis. These deformities are more rare than deformities in the physeal region; however, they must be diagnosed because they require a different assessment and treatment strategy than physeal and metaphyseal deformities (Fig. 5). Straightening of the diaphysis occurs naturally through appositional growth at the concave aspect and bone resorption on the convex aspect of the bone, but the joint surfaces may remain mal-aligned. The assessment of a diaphyseal deformity requires that the joints be evaluated, and that the treatment be directed at making sure the joints are parallel to each other and perpendicular to the long axis of the limb.

The second kind is an *articular* ALD that originates within a joint of the limb. The most common such deviation is a valgus deformity of the carpal region, but tarsal articular deformities occur as well. These deformities are caused by a mal-alignment of the articular components within the joint region as a result of a disparity in the width of the cuboidal carpal bones, the small tarsal bones, or laxity of the periarticular supporting soft tissues. This disparity may be brought about by inadequate ossification of the above-mentioned bones or by locally excessive loads predisposed by ALD of the physes.

Articular angular deformities originating in the tarsus are a difficult problem because they often involve crushing of the bones to the point that the normal anatomic structure cannot be reestablished.

Angular deformities originating at the physeal growth area, either in the physis, epiphysis, or metaphysis, are the most common kind of deformity that has to be dealt with clinically.

Diagnosis

Diagnosis is based on inspection, manipulation, and diagnostic imaging techniques. The foal is observed from several angles, most importantly from the front and back. To evaluate the limb, the clinician positions himself or herself perpendicular to a frontal plane through the examined limb (Fig. 6). Splayfooted foals, with or without ALD, are therefore evaluated from a craniolateral position, allowing observation for proper alignment of the toe and carpus or tarsus, respectively. Ideally the toe must point in the same direction as the carpus. Most newly born foals are weak, thin chested, and, in relation to their size, long-legged. To provide some support to the forelimbs, which are connected to the chest only by seven muscle pairs, the proximal ulna is braced on the side of the chest. This results in an outward rotation of the entire limb and a toed-out posture (Fig. 7). With increasing strength and age, the chest fills out and the connecting muscles become stronger, leading to an inward rotation of the limb and correction of the toed-out posture. Should the carpus or tarsus point outward but the toes point straight forward, however, a varus deformity of the distal limb is present, which may go unnoticed for a few months. Once the limb rotates into a normal position, the feet attain a toed-in posture. Unfortunately, the distal McIII/MtIII experiences longitudinal growth only for 3 to 4 months, after which the physis closes and about in this period the problem is noticed.

Palpation and manipulation of the limb help differentiate between articular and physeal deformities. If application of manual pressure to the medial aspect of the carpal region straightens out a valgus deformity, the cause of the deformity is either incomplete ossification or flaccidity of the periarticular supporting structures. If the limb cannot be straightened with manipulation, changes of the osseous structures of the region are involved.

Observation of the foal as it walks toward and away from the clinician also provides valuable clues. If the joints are aligned parallel to the ground, all the joint movements occur in the same planes and no outward or inward rotation of a joint is noticed. However pigeon-toed foals frequently rotate their metacarpophalangeal/metatarsophalangeal (MCP/MTP) joints outward while advancing the limb. This is caused by the joints not being oriented parallel to the ground, which is found occasionally in foals with marked varus deformities in the distal McIII/MtIII (see Fig. 4). With time a compensatory deformity in the proximal phalanx may develop, resulting in a visual straightening of the limb axis. The radiographic evaluation will however reveal an oblique orientation of the joint relative to the other joints and the ground (see Fig. 4B).

The only diagnostic aid that allows exact determination of the location and degree of the deformity is radiography. It is important to use long, narrow cassettes for the radiographs and to include as much of the bones proximal and distal to the deformity as possible. The dorsopalmar/dorsoplantar views are most important, except in the tarsus, where the

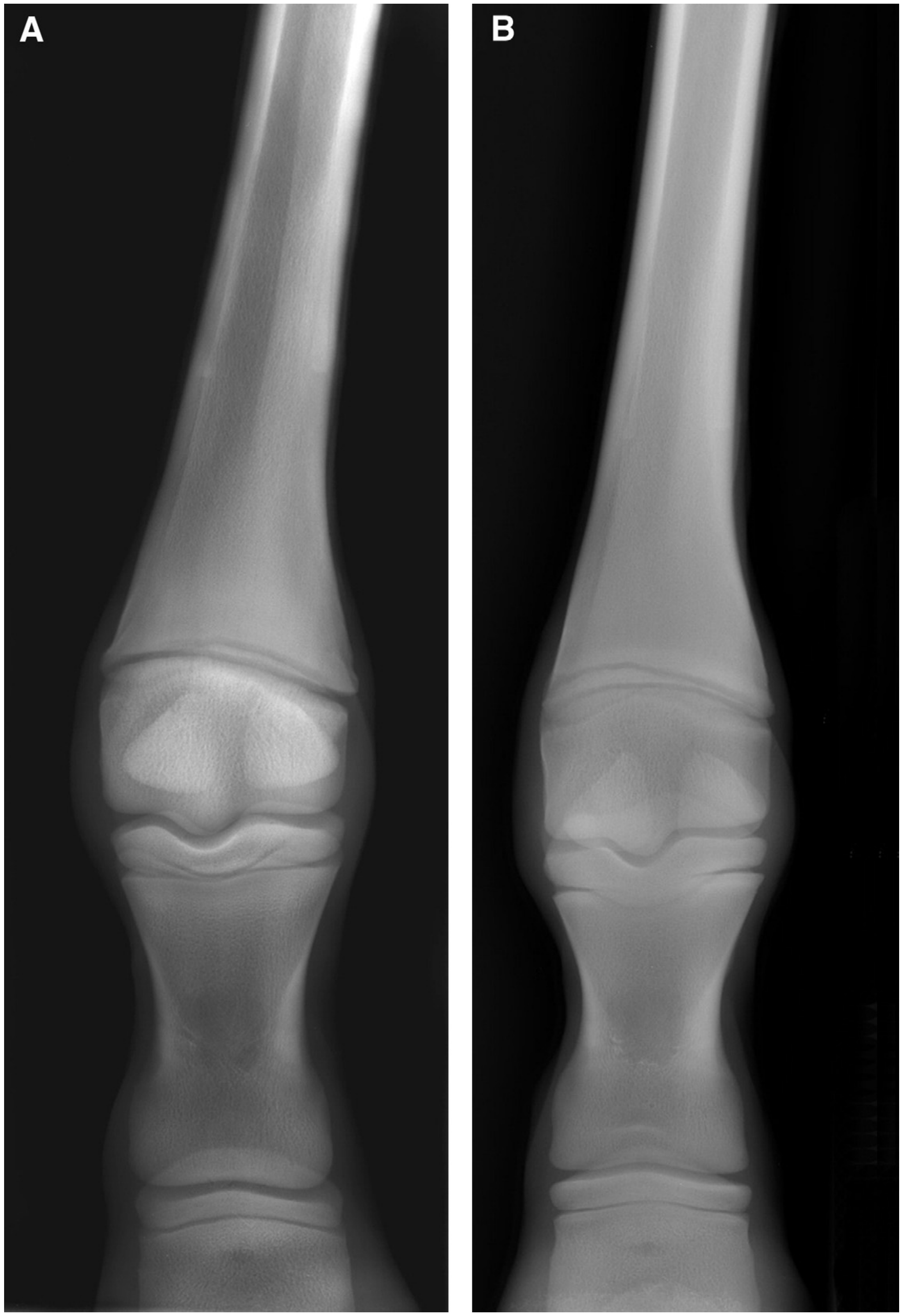

Figure 4 Dorsoplantar radiographic view of the distal MtIII and metacarpophalangeal region. (A) Radiograph taken at 2 days of age. Note the marked deviation in the epiphysis (wedge-shaped) and the metaphysis of the bone. (B) Identical radiographic view of the same foal 15 days later. The foal was kept in a stall and the deviation improved, but at the expense of the proximal phalanx, where the lateral aspect is now 3 mm shorter than the medial. The joint is not parallel to the ground anymore.

Figure 5 Dorsopalmar radiographic projection of an entire third metatarsal bone showing a diaphyseal valgus deformity.

lateromedial view is preferred. The radiographs should be taken at a right angle to the frontal plane of the limb (the sagittal plane of the tarsus). The bones constituting the distal McIII/MtIII and phalangeal region should be aligned in one plane for the radiographs, allowing interpretation of the articular orientation and differentiation of deformities.

The need for early diagnosis cannot be overemphasized, especially in foals with incomplete ossification. The soft precursor cartilage is deformed through the uneven axial loads and, combined with the rapid progression of endochondral ossification, may result in a permanent deformity within 2 weeks after birth.

Compound manually not correctable deformities present an added challenge. However, if diagnosed within the first 1 to 2 months of life, correction is possible. Unfortunately this is rarely done and therefore these deformities have to be accepted if it does not jeopardize the overall athletic soundness of the animal. Frequently foals with a varus deformity in the MCP region also display a slight valgus deformity in the

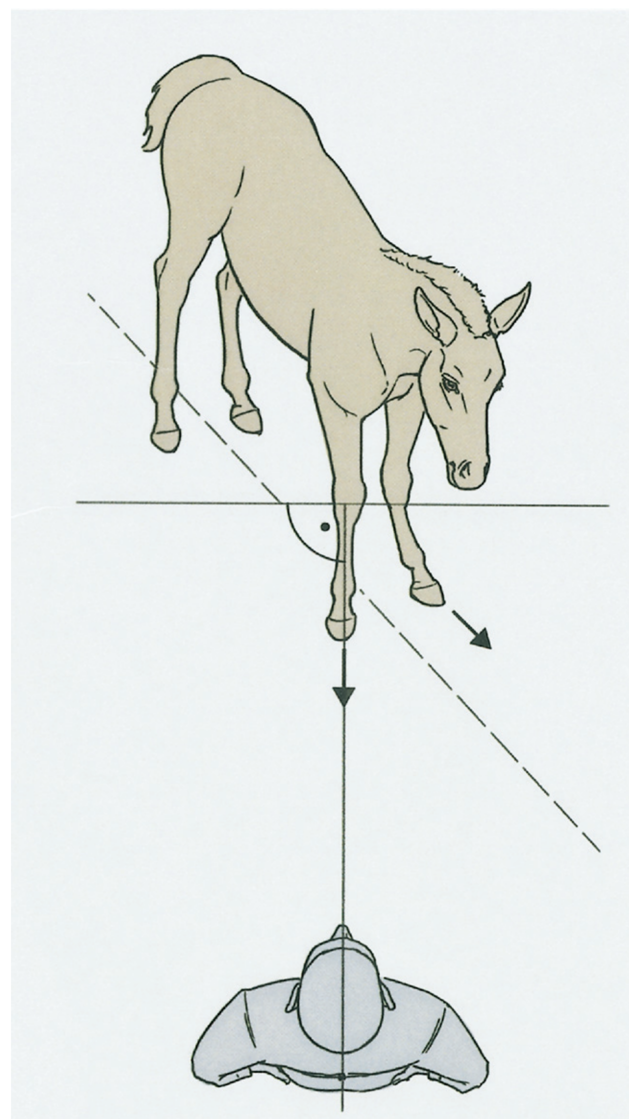

Figure 6 Proper evaluation of a foal with a carpal valgus deformity. The observer positions himself at a right angle relative to the frontal plane through the carpal region. The feet point into the same direction; therefore, there is no need for immediate surgical correction. (Color version of figure is available online.)

Figure 7 Frontal view of a 1-month-old foal showing a valgus deformity in both carpal regions. At this age, this is acceptable and surgical intervention should not be attempted unless no improvement occurs.

carpal region, which balances the horse's weight-bearing axis over the foot (see additional discussion in a subsequent article). This necessitates the visual evaluation of the entire limb at the time of the diagnosis, and caution in using radiographs as the sole diagnostic aid.

Treatment Strategies

Management of ALD in foals must begin early. The period of growth in the foal is the most rapid nearest birth and gradually slows until each physis ceases growing at its physiologic predisposition for closure. Foals are seldom born "correct," if viewed in the light of desired adult conformation. Changes and corrections are brought about by physiologic controls, which guide the growth process toward a straighter, more balanced mature animal.[8] The veterinarian's role is to alter this process only when intervention is necessary to assure a good end result. It is equally important to know when to abstain from intervention, in situations where it is known that the foal will correct on its own, as it is to know when to affect a change in foals, which may not be able to correct the deformity. Above all, an incorrect intervention, which results in the creation of an inferior adult confirmation, must be avoided.

Angular deformities of the limb resulting from incomplete ossification or mal-alignment of the joints are treated by external support to realign the axis of the limb and allow maturation of the carpal, and usually also the tarsal, bones to the point that they are not subjected to weight bearing in excess of their ability to withstand a load. Treatment can be attempted using external casting generally referred to as "tube casting," or can be done by means of various external bracing techniques (see subsequent article). If a physeal angular deformity accompanies the articular deformity, surgical treatment of the angular deformity of the physis is necessary as well.

If the angular deformity caused by the crushing of the small tarsal bones is severe, and the horse has no use other than athletic endeavors, treatment is not indicated. If, however, the breeding value of the foals is substantial, treatment by external coaptation is a possibility. Reduction of exercise through stall rest may be adequate to promote stability to the limb and prevent further deterioration and complete loss of the ability to bear weight. Tube casting and braces are more difficult to apply to the hind limbs and are less successful than application of the appliances to the forelimbs; however, in instances where there is little alternative, the use of these appliances is indicated. Once ossification has progressed to the periphery of the deformed primordial cartilage, the deformity is uncorrectable (Fig. 8).

Emergency treatment in the form of mechanical support to the area is indicated anytime the angular deformity is continuing to worsen in the face of treatment. Physeal growth manipulation may be necessary to reverse the angulation of the limb created by collapse or decreased growth rate of one side of the physis relative to the opposite side. This often necessitates aggressive surgical treatment. Medical treatment should accompany the surgical treatment to normalize physeal bone growth and prevent further production of abnormal bone. In general, this involves restriction of exercise until the structure of the physis can be augmented by means of

Figure 8 Lateromedial radiographic view of the tarsal region of a 6-week-old foal with a deformed third tarsal bone because of incomplete ossification at the time of birth without exercise restriction and immediate external coaptation.

new bone formation, systemic medication in the form of nonsteroidal antiinflammatory drugs to prevent excessive pain and secondary contraction of the flexor tendons, and in refractory cases, the administration of anabolic steroids in an attempt to enhance maturation and strengthen the growth plate complex. Surgical treatment follows the same guidelines as with congenital deformities.

Congenital angular deformities must be coerced into correction by means of a planned disparity in growth at the physeal level that results in reduction of the angulation of the limb. To discuss how this is accomplished, a working knowledge of the anatomy of the physeal region is necessary (see Fig. 2).

The physis is a growth area of the long bones that persists after birth. Growth of the bones must occur axially at the level of the physis with new bone being added to the metaphyseal side, pushing the epiphyses farther away from the nutrient foramen. Epiphyseal and physeal growth must also occur in a circumferential direction to enlarge the distal ends of the bones and create a weight-bearing surface area appropriate for the eventual adult size of the horse. Slight elongation of a bone, originating at the epiphysis, occurs as well. This elongation is proportional to the generalized enlargement of the epiphyseal area. This, however, is a small amount compared with the metaphyseal growth of the bone.

The clinician should be guided to apply the management technique with the least invasiveness that will result in a correct grown individual. Careful observation is the minimum each foal should be afforded. Surgery is generally considered the most invasive, though there are variations in the degree of invasiveness of the surgical procedures available. Hoof care, external bracing, and exercise manipulation are also useful in specific situations. Rapid accurate and economical correction is the desired goal to aim for.

Observation alone is the preferred course when the foal will correct on its own. A minor surgical manipulation should be used when minor adjustments are needed and a more invasive intervention is necessary when major correction is needed. A necessary intervention must not be delayed beyond the time when the remaining growth can correct the defect.

Indications for intervention fall into 3 general categories that should be considered when evaluating a foal. Those indications are the following: (1) too severe a deformity to correct on its own, within the foal's expected growth potential; (2) a deformity that is being corrected too slowly by natural means to reach correct conformation before the end of the growth period; and (3) a growth deformity that is leading to, or will lead to, a secondary deformity or injury.

Before surgical treatment is selected, one must be cognizant of the type of deformity present and the ability of being able to perform the surgical manipulation to correct it. Therefore, the type of deformity present must be identified before recommending surgery. Surgical manipulation possibilities consist of the acceleration or retardation of bone growth at the physis. Some deformities are not the result of a disparity in physeal growth and have no chance of responding to surgical manipulation of physeal growth. In these cases surgical treatment will result in an inferior response.

The surgical procedures of hemicircumferential periosteal transection and transphyseal bridging are well described.[9-12] Deciding between the two techniques is primarily a function of the amount of correction necessary and the amount of growth left in the physis involved. Periosteal transection works best on a rapidly growing physis, because it is the rate of growth at the time of periosteal transection that is most important; therefore, it is the preferred technique in young foals.[13] The response to transection is neutralized once the transected periosteum heals at approximately 30 to 40 days.

In older animals (age is relevant to each individual physis and its physiologic closure date) transphyseal bridging must be strongly considered because it is not growth rate dependent and can be left in place as long as necessary until correction occurs. Therefore, it is the amount of growth left at the level of the physis before closure that governs how much correction can be obtained with transphyseal bridging. The amount of total growth and the time span over which this growth occurs is different for different physes. Knowledge of physeal growth parameters and experience must guide application of the surgical techniques. In severe deformities both procedures can be combined. Surgical correction is straightforward and often easier than the decision of when to apply the correction. The decision about surgery is not always easy, since correct foal conformation is not the same as correct adult conformation. Any decision to intervene must be made with the overriding understanding as to what adult conformation will result from the foal conformation at hand.

Figure 9 (A) A frontal view of a 1-month-old foal with a varus deformity of the right front fetlock region. (B) A dorsopalmar radiographic projection of the right metacarpal and phalangeal region (note the limb was flexed at the carpus and its distal aspect left hanging to achieve an x-ray with all the bones located in the same frontal plane). The varus deviation is easily appreciated.

Figure 10 Frontal view of 7-month-old foal with a mild degree of carpal valgus deformity. This type of conformation is within normal limits. (Color version of figure is available online.)

Conformation Evaluation

As previously mentioned, most foals are born crooked (Fig. 9). Carpal (distal radial) valgus and MCP/MTP (distal McIII or MtIII) varus are most common. Correction by natural means of the carpal valgus deformity is the rule. Natural correction is not completed immediately, however. Correction of carpal valgus to within 5° to 7° of being straight should occur by about 4 months of age; then a plateau is often reached and the rate of correction slows until 8 to 10 months of age, when growth by the lateral aspect of the physis brings about final straightening before functional metaphyseal growth plate closure occurs near 1.5 years of age. Therefore, normal weanling conformation is a mild degree of valgus deformity at the carpus, not perfectly straight (Fig. 10). Perfectly straight weanlings often develop a varus deformity (bow legged) as final growth occurs.[14]

Deformities located in the MCP/MTP (see Fig. 4A) (distal MtIII, McIII) must be correct by 4 months of age because metaphyseal growth plate function in this area stops at this time. Correct conformation should be axially straight from the metacarpus/metatarsus through the foot. Unlike the distal radius, metacarpal/metatarsal correction should occur continuously, and correction should be rapid enough to attain a straight limb by 4 months of age. If progress is not sufficient to ensure correction, surgical intervention is indicated in sufficient time to attain correction. The foal, however, should appear to remain slightly "toed out" because of the valgus conformation normally present at the carpus at the cessation of MtIII/McIII growth. Foals presented with a carpal valgus deviation, but sagittally correct phalanges, will develop a varus deformity once maturity of the fetlock region is attained. This becomes more apparent as carpal straightening occurs at 6 to 8 months of age. Owners often confuse this change with delayed development of a varus deformity in the fetlock region. It must be emphasized again, that at this time the physis of McIII/MtIII is closed and not capable of developing a valgus or varus deformity anymore. One must

Figure 11 Dorsopalmar radiographic view of the metacarpophalangeal region showing a varus deformity in the distal McIII and an opposing valgus deformity in the proximal phalanx, resulting in a straight limb axis.

be astute and assure that the degree of "toe-out" appearance at the MCP/MTP region is proportional to the remaining degree of valgus deformity at the carpus. The axial alignment should be straight through the metacarpus and phalanges. Observing only the conformation of the phalanges often results in overlooking a MCP/MTP varus deformity, which becomes clinically more obvious as the carpal valgus resolves.

According to Wolff's law, the architecture of living bone continuously adapts to the surrounding operational stresses, which results in precise and efficient structural patterns.[7] This law can also be observed in foals with a varus deformity in the MCP/MTP region. If these animals are left without treatment it can be observed that the angular deformity cor-

Figure 12 Frontal view of yearling foal with laterally "offset" carpi and metatarsi in relation to the radii.

Figure 13 Composite dorsopalmar/dorsoplantar radiographic view of a foal with a marked valgus deformity in the distal radius region and a varus deformity in the proximal McIII metaphysis. The carpal region is obliquely oriented toward the lateral side, leading to a "bench-knee" conformation.

rects on its own (see Fig. 4); however, the joint rotates outward during walking and jogging. A radiographic examination of this region reveals that the limb axis is more or less straight but that there is still a growth disparity between the lateral and medial side of McIII/MtIII. Additionally a growth disparity in the opposite direction can be observed in the proximal phalanx, resulting in the joint not being oriented parallel to the ground[7] (Fig. 11). Because of this abnormal movement, these animals have a poor prognosis for a future athletic career. Therefore it is of utmost importance to recognize the potential of the development of a compensatory deformity in the proximal phalanx at a very early age and take precautions to prevent it.

As mentioned earlier, widening of the chest of the foal, with growth and strength acquisition, tends to rotate the limbs from the "toe out" to the straight position. The feet of forward facing, narrow-chested foals tend to rotate to "toe in" for the same reason. Therefore, any tendency toward varus must be corrected in the carpal valgus, narrow- chested foal to prevent a resultant toe-in adult. Foals must be guided toward the mild carpal valgus with apparent toe-out fetlock conformation at the time of weaning to develop in a correct adult. All manipulations should be aimed toward this end result.

Some deformities have no chance of responding to physeal manipulation (Fig. 12). Rotational deformities are those deformities that originate from torsion of the limb around the vertical weight-bearing axis. Rotational deformities are very common in young foals with narrow chests. They appear to be originating from very high in the limb. Because most of these deformities are of habitual origin, not growth or developmental causes, they resolve themselves with age as the chest broadens and the humerus and elbow joint are rotated outwardly to realign the dorsal/cranial aspect of the limb more nearly with the sagittal plane of the horse's body. Rotational deformities that do not correct well, however, are deformities that originate distal to the carpus with the sagittal plane of the MCP joint being rotated medially or laterally from the sagittal plane described by the carpus. These deformities are not correctable surgically. In general, rotational deformities that originate by torsion of the limb around a central axis of the long bones of the forelimb are not treatable surgically and should be selected against when electing surgical treatment.

Flexural deformities are deformities that occur in the joints, which deviate from the expected correct frontal plane position. This is an entirely different subject with different pathologic origins, and treatments (see separate article in this issue).

Axial deformities, or what is commonly referred to as "offset" or "bench" knees, need to be addressed in that they influence the evaluation of angular deformities that originate in the physis. There exists controversy whether these deformities can be changed by means of surgical manipulation or not. It is the senior author's belief that axial deformities realign the central axis of weight bearing of the forearm over the medial aspect of the distal limb and accentuate varus angular limb deformities. The most common axial deformity is the mal-alignment of the long axis of the carpus and metacarpus with the long axis of the radius, resulting in the distal limb being positioned more lateral than the radius (see Fig. 9A).

This deformity is best viewed by examining the horse visually from the front. Offset knee deformity presents a particular problem when combined with a significant varus deformity of the distal metacarpus. The problem for the horse occurs because the lateral offset of the carpus and metacarpus places the center of weight bearing of the proximal limb over the medial aspect of the carpus and metacarpus. The second author defines this type of deformity as a combination of a valgus deformity of the distal radius with a varus deformity of the third metacarpal bone[6] (Fig. 13). This configuration accentuates the forces of weight bearing along the medial aspect of the limb and increases the probability of injury. Therefore, in the presence of axial deformities, varus deformities of the carpus and significant such deformities of the metacarpus become a more severe problem. While nothing can be done about the axial deformity, it makes treatment of any varus deformity more important.

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