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Angular Limb Deformities in Foals

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Introduction

Angular limb deformities in foals are common problems that are likely to face the equine practitioner. In recent years, the increasing value of individual animals has led horse owners to seek veterinary care for their foals with angular limb deformities. Many veterinarians would be able to diagnose and treat angular limb deformities with the equipment already on hand in a typical companion animal practice. If these conditions are recognized and treated at an early age, many foals can have normal limb angulation restored and can go on to athletic careers.

Definitions

Angular limb deformities are defined as an axial deviation of the limb when viewed in the frontal plane.\(^1\,^2\) A valgus angular limb deformity is characterized by lateral deviation of the limb distal to the lesion. In contrast, a varus deformity exists if the limb deviates medially.\(^1\,^3\) Angular limb deformities may be divided into the following categories: 1) instability of the joint due to laxity in periarticular supporting structures; 2) imbalanced long bone growth; 3) defects in endochondral ossification; and, 4) direct trauma to the limb.\(^4\)

Incidence

Angular limb deformities are being seen with a greater frequency in foals of all breeds. It is also noted that angular limb deformities occur with equal frequency in both fillies and colts.\(^5\) Angular limb deformities most commonly occur in the carpus (distal radius, carpal bones or metacarpus), followed by the tarsus (tibia or metatarsus) and the proximal phalanx.\(^5\) Foals can either be born with angular limb deformities or the defect can be acquired within the first several weeks of life.\(^2\)

Diagnosis

Any foal presented with an angular limb deformity requires a complete history and physical examination to confirm the diagnosis. The veterinarian should first visually examine the leg and estimate the degree of angulation and where the deviation is centered.\(^2\) Any evidence of trauma or swellings should be noted. The foal should be observed when exercised to determine if lameness exists. Generally, the foal is not lame in the affected leg. Occasionally, the foal with a unilateral deviation may be lame in the leg which is opposite the deformity. Careful palpation and manipulation of the affected limb should be included in the physical examination. In cases of laxity of periarticular supporting structures or collapse of the carpal bones, the deviation may be temporarily corrected when the limb is manipulated. If the deformity cannot be manually corrected, asymmetric growth of a long bone should be suspected.\(^2\)

A thorough radiographic evaluation of the limb is an important part of the diagnostic workup with angular limb deformities in foal. Dorsopalmar/dorsoplantar and lateral views should be taken in all cases. When taking these radiographs, it is helpful to position the foal’s leg as naturally as possible.\(^4\) The practitioner should also be certain to use cassettes of sufficient size to show at least one-

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half of the long bone above and below the joint in question.\textsuperscript{1} The radiographs should be carefully examined for abnormalities in the metaphysis, epiphysis and epiphysis. During evaluation of the carpus and tarsus, the carpal and tarsal bones should be evaluated for hypoplasia or subluxation.\textsuperscript{2}

The dorsopalmar/dorsoplantar views are most helpful for determining the pivot point and the geometric degree of angulation. A straight edge should be used to draw lines through the center of the proximal and distal long bones. Where these two lines intersect will provide the pivot point. The angle formed between these two lines is the degree of angulation.\textsuperscript{2} In cases where the pivot point is in the epiphysis and in cases of complicated carpal deformities that involve multiple bones or joints, a different method of analysis can be used. This method of evaluation utilizes horizontal lines drawn through the distal radial physis, antebrachiocarpal, midcarpal and carpometacarpal joints. These lines should be parallel to each other and perpendicular to the lines drawn through the center of the long bones. If these lines are not parallel to each other, the partial deviation in each joint can be measured.\textsuperscript{4,5}

The pivot point of an angular limb deformity will help the practitioner determine where the lesion is centered. In cases of asynchronous growth in the metaphyseal region of long bones, the pivot point will be located over the physis. Asynchronous growth at the distal epiphysis will have a radiographic pivot point located distal to the physis. A pivot point located within a carpal joint is suggestive of carpal bone hypoplasia.\textsuperscript{2}

**Etiology**

The etiology of angular limb deformities in foals can be complex and is thought to be due to several factors.\textsuperscript{2} An understanding of the underlying causes of angular limb deformities, will help in deciding on a rational course of treatment. When discussing the etiology of angular limb, it is usually helpful to divide the problem into either congenital or developmental in origin.

Intrauterine malpositioning of the fetus is thought to be a major factor in the etiology of congenital limb deviations. Abnormal uterine position contributes to uneven long bone growth, defective ossification of carpal bones and laxity of periarticular support structures.\textsuperscript{6} Overfeeding the pregnant mare in the last half of gestation may result in a malpositioned fetus, which in turn may lead to an angular limb deformity at birth.

Skeletal immaturity is another leading cause of congenital angular limb deformities. It is noted that the carpal and tarsal bones undergo ossification during the last two to three months of gestation.\textsuperscript{1,5} If the foal is born early, the cartilage layer of these bones will be thicker than normal and the periarticular support structures are more likely to be loose. The uneven pressure applied to these bones results in a congenital deformity that progressively worsens as the carpal or tarsal bones ossify in their abnormal shape.\textsuperscript{1,2}

Defective ossification of the carpal and tarsal bones may result in a congenital deviation in a foal of normal gestational length. Radiographically, the practitioner will see carpal or tarsal bones that are too small, having abnormal shape and also having a thicker than normal cartilage layer.\textsuperscript{1} Clefts or separations in the articular cartilage have also been observed. It is believed that this type of congenital limb deformity has an etiology similar to osteochondrosis.\textsuperscript{1,2} Hypothyroidism may also play a role in defective ossification of the carpal and tarsal bones. Thyroid hormone stimulates osteogenesis and bone maturation. Lack of sufficient amounts of this hormone has been associated with defective ossification of the tarsal bones in foals.\textsuperscript{2}

Angular limb deformities also occur in foals that were born with relatively straight legs. Usually the deviation becomes evident within the first few weeks of life. In some cases, a mild congenital deformity exists but is not recognized by the owner until the condition worsens. Even a mild congenital deformity can cause asymmetric compressive forces within the joint and result in uneven bone growth.\textsuperscript{2} A mild congenital deformity can be exacerbated by excessive exercise, poor conformation and improper nutrition.\textsuperscript{1,5,6}

Trauma should be considered in every case of acquired limb deformities. Direct trauma to the growth plate can lead to premature closure of one side of the physis. As the normal side of the physis adds to long bone growth, a progressive limb deformity is the result.\textsuperscript{2} In other cases, trauma or lameness in
one leg will cause the foal to carry more weight in the unaffected limb. This abnormal weight bearing places stress on the growth plate and results in an acquired deviation.\textsuperscript{1,5,6} Excessive exercise is also thought to cause trauma to the cartilage of the growth plate. Some foals with mild deformities respond well to stall rest and decreased exercise.\textsuperscript{2,5}

Improper nutrition has also been implicated in the complex etiology of angular limb deformities. If a foal is overfed, the excess weight can traumatize the cartilage and initiate or accentuate an angular limb deformity.\textsuperscript{6} An imbalanced diet has been linked to osteochondrosis in some cases. Improper levels of calcium, phosphorus and the trace minerals in the foal's diet can alter the growth of cartilage at the physis and result in an acquired limb deviation.

Many foals are born each year with angular limb deformities caused by laxity of periarticular support structures. This type of deviation usually has a history of being present since birth and the practitioner will notice no radiographic abnormalities in a limb that can be manually reduced.\textsuperscript{4} Mild deformities of this type tend to be corrected spontaneously as the foal develops increasing tone in the muscles, periarticular ligaments and tendons. It is also recommended in these cases to restrict the foal's exercise so as to avoid compressing the growth plate in an uneven manner.\textsuperscript{2} In more severe cases of joint instability, a splint or cast should be applied to the leg to support the limb and prevent development of a skeletal origin limb deformity.\textsuperscript{2} The cast or splint should be removed in ten to fourteen days and the limb should be re-evaluated. Often this length of time is sufficient for the strengthening and maturation of soft tissues and hypoplastic carpal bones.\textsuperscript{4}

In cases where limb deformities are caused by asynchronous long bone growth, a variety of surgical techniques may be considered as treatment options. Transphyseal bridging using either screws and wire or staples on the convex side of the limb is thought to temporarily arrest the growth in the affected area. The concave side of the limb continues to grow and eventually the limb is straightened.\textsuperscript{2} Once the deformity is corrected, the bridging device must be removed to avoid overcorrection.\textsuperscript{2,4,6} Transphyseal bridging can only be effective in correcting a deviation if there is sufficient growth potential in the growth plate. For example, the distal radial physis shows radiographic closure at 22 to 36 months of age. However, most of the growth occurs between birth and eight months.\textsuperscript{2,4} If the physis is bridged after that time, very little correction will result. The optimal time to insert a transphyseal bridging device across the distal radial physis is between two weeks and four months of age.\textsuperscript{4}

Both staples and screws and wire procedures have been used as a means of bridging the physis to correct an angular limb deformity. With the stapling technique, a stainless steel staple is seated into the bone so that the legs of the staple are the same distance from the physis.\textsuperscript{2,5} The stapling procedure has an advantage in that a smaller skin incision can be made and the surgery is easier as compared to placing screws and wire. However, the results of the stapling technique are often not as cosmetic due to difficulty in removing the staples or premature extrusion of the staple.\textsuperscript{2,6} It often takes longer for the stapling method to achieve correction because the staple cannot be tightened to compress the physis as is possible with screws and wire. The staple may also spread after placement, decreasing its ability to compress the physis.\textsuperscript{2,4,6}

When bridging the physis with screws and wire, one screw is placed above the growth plate and another screw distal to the physis. Eighteen gauge cerclage wire is then used to connect the screw in a figure eight fashion.\textsuperscript{2,5} The screw and wire technique requires a slightly longer surgical time and better surgery skills but also offers several advantages over the stapling procedure. Each screw is placed independently which allows better adaptability to anatomic variations. The wire can be tightened to achieve immediate compression of the physis and earlier correction of the deformity may result. Another advantage is ease of implant removal. In many cases screws can be removed via stab incisions using short acting general anesthesia.\textsuperscript{2,4,6}

In the early 1980's, a hemicircumferential transection of the periosteum and periosteal stripping technique was developed for treatment of angular limb deformities. In contrast to transphyseal bridging, this procedure is done on the concave side of the affected leg. A vertical skin incision is made just proximal to the physis and the subcutane-
ous tissues are dissected away to expose the periosteum. The periosteum is then incised horizontally and vertically to form an inverted "T" shape in the periosteum. The periosteum is then undermined in all directions using a periosteal elevator. It is theorized that incising the periosteum releases the tension across the growth plate. Following surgery there is an increased rate of growth at the surgery site which is thought to be caused by changes in the blood supply to the physis.

Periosteal transection and stripping has several advantages as compared to transphyseal bridging. This surgery is simple, fast and does not require use of implants and the specialized instruments to handle them. The cosmetic results of this surgery are better than with use of implants. There is also a decreased likelihood of post operative infection. Another advantage of this procedure is that no implants are used so in most cases foals with angular limb deformities only undergo one surgical procedure. Overcorrection of the deformity is usually not a problem. In cases of severe deformities or in foals who are approaching the age of growth plate closure, periosteal transection and stripping may be repeated if necessary or combined with transphyseal bridging to accelerate correction.

**Conclusion**

In the past, angular limb deformities were treated with either stall rest or transphyseal bridging. Many foals with severe deformities were euthanized before treatment was even attempted. If combined with early and accurate diagnosis, periosteal transection and stripping can provide veterinarians and horse owners alike a more practical means of achieving a successful outcome to a very common problem.

**References**


