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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.
Clin Tech Equine Pract 5:259-269 © 2006 Elsevier Inc. All rights reserved.

KEYWORDS ALD, assessment, varus, valgus, bench knees

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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doi:10.1053/j.ctep.2006.09.002

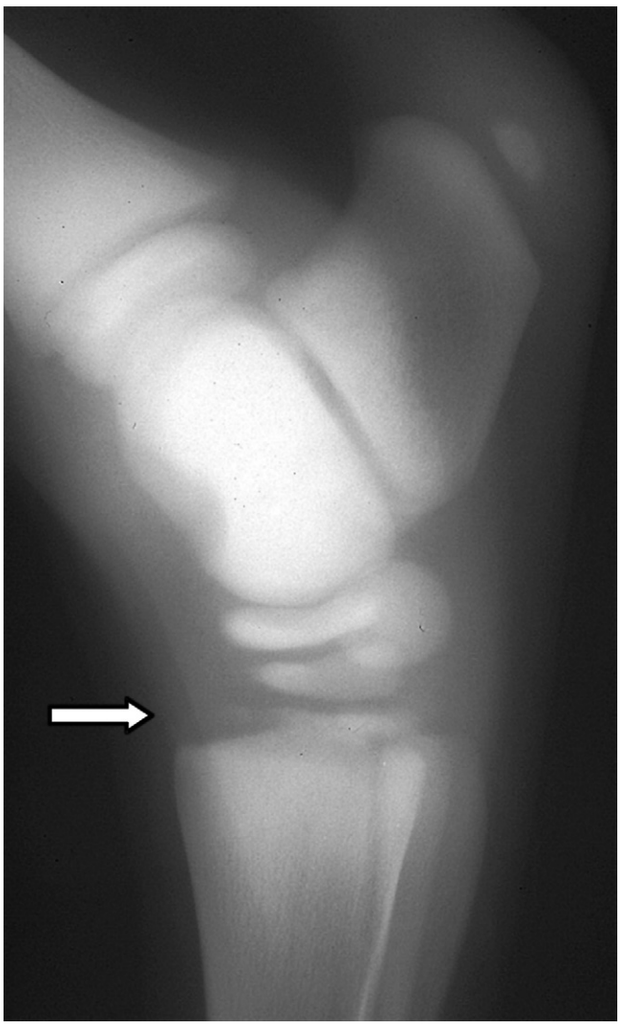

Figure 1 Lateromedial radiographic view of the tarsal region of 290-day-old fetus. Note the third and central tarsal bones are only rudimentarily ossified and the proximal epiphysis of MtIII (arrow) is not yet fused with the rest of the bone.

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

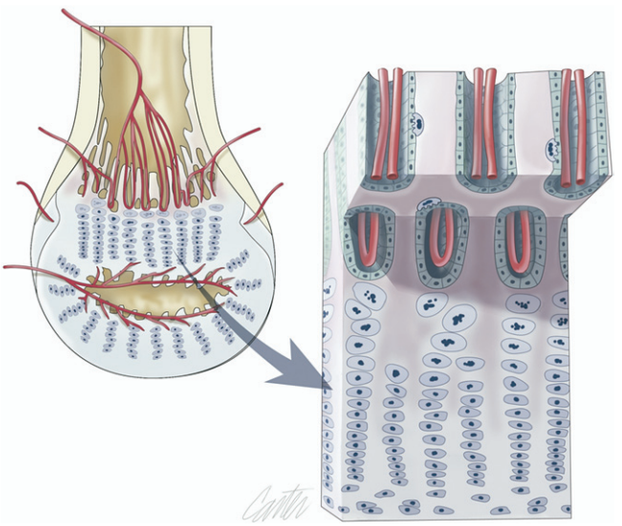

Figure 2 Drawing of the distal McIII with metaphysis, physis, and epiphysis. (Color version of figure is available online.)

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

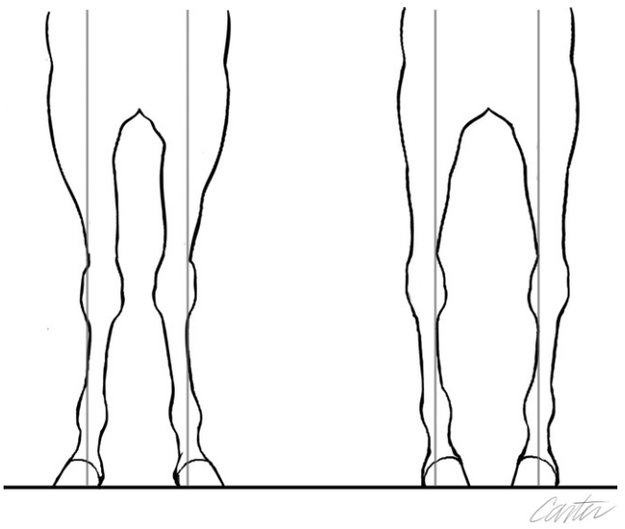

Figure 3 Drawing of a foal with a valgus deformity in the distal radius region (left) and a foal with a varus deformity of the same location (right).