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In 1982 he joined Dr Peter Rosedale's Newmarket practice, becoming a partner in 1984 and now senior and managing partner. An RCVS and European Specialist in Equine Surgery, his interests are in general and minimally-invasive orthopaedic and soft tissue surgery.

He was awarded the Centenary and the Chiron Awards of the BVA and the Richard Hartley Clinical Prize of the BEVA. He has lectured around the world on a variety of equine surgical topics and has had papers published on a number of subjects as well as several chapters in veterinary textbooks.

He was made an honorary professor of the University of Glasgow and an associate lecturer of the University of Cambridge. He is a past president of BEVA, BVA and WEVA, a Diplomate of the ECVS and a member of its board of regents. He is vice-chairman of SPANA and an honorary member of BEVA, BVNA and the BAEDT.
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Angular and flexural limb deformities in foals and yearlings

Part 1: Angular limb deformities

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Normal foals

Foals are born with soft, 'slipper-like', almost gelatinous hooves. However, within a few hours their feet will harden. In foals with correct limb conformation there is little need for major interference with the feet. It is common practice for good stud farms to call upon a farrier to assess and dress foals' feet on a regular basis. The first farrier contact, in normal circumstances, is at four weeks. By this time, mild angular deviations and other limb abnormalities of new-born foals, such as fetlock hyperextension as a result of flexor tendon laxity, will usually have improved. The hooves will require trimming before becoming overgrown and training can begin while the foal is small and receptive. The conformation and hoof shape should be constantly monitored throughout development.

Foals usually require foot trimming every four weeks. Even foals that are considered 'perfect' have slight deviations in distal limb conformation. Deviations are categorised into two types; *valgus* describes the deformity in which the limb distal to a joint deviates laterally to the proximo/distal axis of the limb (**Figure 1**), and *varus* in which it deviates medial to that axis.

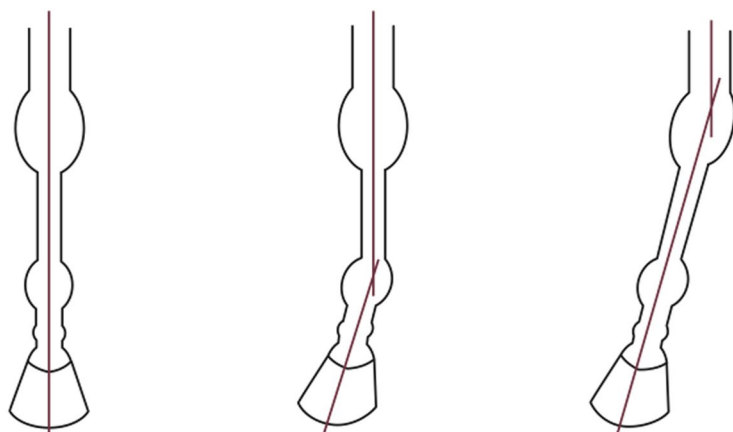
It is normal for newborn foals to have a slight (5°) carpal valgus conformation of their forelimbs. This distorts foot growth by pushing the hoof capsule laterally and shunting the medial bulb of the heel proximally. The medial hoof wall may also wear more than the lateral side. Trimming

is designed to restore normal foot balance by correcting such distortions. As the foal grows and its chest broadens, such mild deformities can self correct, thus improving conformation.

A foal's foot does not grow in the same manner as that of a mature horse, i.e., in a distal direction. It also widens and expands. Since most expansion occurs proximally, most foal hooves are tapered. As the distal hoof is relatively small, the weight bearing area is positioned dorsally. Correct trimming will enlarge this area and move it in a palmar/plantar direction. The feet of young foals of one to two months of age have a pointed shape. Trimming should encourage a more round or even square foot shape, to promote even break-over of the foot as it strides forward.

Aetiology of angular limb deformities

Angular deformities are either congenital in origin or acquired after birth. There may be a variety of causes of congenital deformities, including nutritional and hereditary factors, placentitis and intrauterine foetal position, although in most cases the cause is unclear. Incomplete ossification of the distal limb cuboidal bones, excessive joint flaccidity or uneven loading of the limb have also been suggested as a cause. Angular deformities can also be acquired due to excessive weight bearing on one limb because of a painful condition of the opposite fore- or hind limb, which usually results in an acquired



Line drawings showing (left) straight limb conformation and an approximate deviation of 15° deviation over the fetlock (middle) and carpus (right)

▲ **Figure 1.** A right foreleg, viewed from the front, showing valgus of the fetlock and of the carpus (Acknowledgment: Lewis C.R. Smith MRCVS, RosSDales Equine Hospital)



▲ **Figure 2.** Moderately severe bilateral carpal valgus in a young foal

varal deformity. Injury to a limb, such as a fracture, might cause an angular deformity of the affected limb (usually a valgus).

Assessment

As mentioned above, most foals are born with a mild forelimb valgal conformation, which disappears as the foal grows. However, some foals are born with a more severe angular deviation (**Figure 2**). These foals may be candidates for corrective foot trimming or other remedial procedures.

The first prerequisite is for accurate appraisal of the foal's limb conformation. This may prove more difficult than expected in a young and sometimes

uncooperative patient. The foal must be viewed while it is standing in a symmetrical manner, on a flat surface. It should be examined from in front, the side and from the rear. The foal should then be walked away from and then towards the examiner.

Each limb should be carefully picked up and flexed, with the examiner's hand grasping the cannon bone and attempting to hold it parallel to the radius or tibia by gently flexing the carpus or tarsus. It is important that the limb is not held tightly and that the distal portion remains relatively relaxed. A visual appraisal of the extent of deviation from axial alignment and the origin of the deformity may then be possible. At the same time the foot should be assessed

carefully for latero-medial imbalance. Any rotational deformity should also be noted. Such deformity is common and must be differentiated from angular deviation.

Having made a detailed clinical assessment of any axial malalignment and its origin, a more objective assessment should be made by creating an image of the area of interest. Thus dorso-palmar/plantar and latero-medial radiographic projections of this area should be obtained and compared with paired views of the contralateral fore-/hind limb.

It is essential to stand the foal as symmetrically as possible because radiological misinterpretation is more likely if the foal is positioned incorrectly. This is particularly important if the foal is sedated to carry out the examination. It is also of value to include as much of the limb proximal and distal to the suspected centre of malalignment on the radiographic image; using a long, rectangular or large plate is beneficial in this regard. By creating axial lines bisecting the adjacent long bones on a dorso-palmar/plantar projection (**Figure 3**) it is possible to determine the degree of angulation, but again this is open to misinterpretation, so care must be taken when doing this.

In some cases, a deformity may be simple, such as a mild fetlock varus or valgal deformity centred on the distal physis of the third metacarpal/tarsal bone. In others, however, there may be a complex deformity involving one or several joints, a physis or physes or even the diaphysis of the bone. It is essential that an accurate appraisal be made prior to attempting correction by whatever means.

A careful radiological assessment is particularly important in more severely affected foals where physal manipulation or other types of surgical management are being considered. However, it is also valuable to identify early, severe, performance-limiting conditions such as carpal or tarsal bone hypoplasia, or crushing of the immature bones. It is important to identify the presence of incomplete ossification (hypoplasia) of the cuboidal bones of the carpus (**Figure 4**) so that preservation of the integrity of these joints can be maintained. This can be done using a tube cast to support

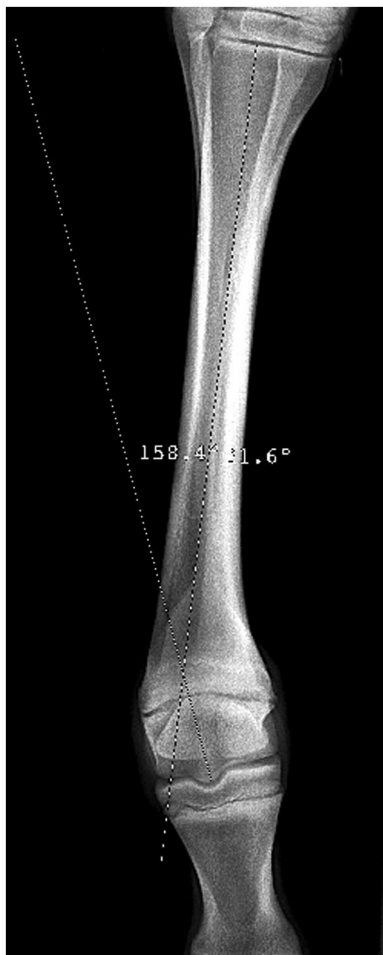


Figure 3. Dorso-palmar radiographic view of right forelimb of a foal with severe fetlock varal deformity, with lines created



Figure 4. Dorso-palmar radiographic views of hypoplastic carpal bones

the axial alignment of the limb until ossification occurs. If the condition is not identified promptly, irreversible crushing of the bones will result in severe degenerative joint disease and lameness. Other orthopaedic conditions, where corrective therapy may not be appropriate, should also be identified before time has been wasted and expense incurred.

Non-surgical treatment

Corrective trimming

The basis of trimming the foot of a foal with an angular limb deformity is the same as when dealing with a normal animal. It should be aimed at producing a correct foot with minimal latero-medial or dorso-palmar/plantar imbalance. In an ideal world, the coronary band should be equidistant to the distal border of the foot and the ground when viewed from in front. Although a tilted coronary band is a sign of foot imbalance, trimming aimed purely at levelling this line invariably leads to additional problems.

Where a mild angular limb deformity creates hoof capsular distortion, foot trimming should correct this and reduce uneven stress through the limb. For example, fetlock varus pushes the hoof capsule medially and wears the lateral hoof wall. This in turn compounds the problem by causing the toes to deviate inward, described as 'toe-in' conformation. In such cases, trimming of excessive medial hoof growth should be carried out every two weeks. The converse is true in valgus deformities, and a slightly 'toe-out' conformation develops, requiring trimming of excessive lateral hoof wall.

The guidelines for trimming for foals with angular limb deformities are:

- Fetlock deformities (foals up to 4 months of age)
 - The solar plane of the hoof should be at 90° to the long axis of the proximal and middle phalanges. This causes the limb to adopt a vertical position in the axial plane.
- Carpal valgus deformity (foals over four months of age)
 - The solar surface of the hoof should be trimmed at 90° to the long axis of the third metacarpal. The foot needs trimming to have a symmetrical shape, with rounding or squaring of the toe at 90° to the frog.

In normal circumstances, a foal's feet are assessed and trimmed every four weeks. However this should be increased to every two weeks in foals with minor deviations. It is better to bring the solar plane of the foot back into alignment more frequently than to 'overcorrect'. Overcorrection, (i.e. reducing the hoof capsule to an alignment of less than 90° to the long axis of the limb) will distort

the hoof without correction of limb alignment.

Using extension shoes in treating angular limb deformities

There is no doubt that severe foot trimming can adversely affect hoof development and may produce a twisted foot. It is not uncommon to note distortion of the coronary band and bulbs of the heel in foals or yearlings that have undergone radical hoof trimming on a regular basis to correct angular limb deformities. Whilst it is necessary to balance the foot in all cases of angular limb deformity, it is considered preferable to create more even weight bearing by means other than radical foot trimming.

The preferred method is to extend the weight bearing solar surface of the foot in the direction of axial alignment, i.e. with a varus deformity a lateral extension is used and conversely a medial extension when the deformity is valgus. To be effective, the ground surface of an extension must align on the same basis as the trimming described above. An extension readjusts the weight-bearing surface of the foot, and therefore the axial load of the limb, in the direction of the extension.

Extensions may be applied to the hoof by many methods. Originally they were made of metal and attached by nailing. This requires considerable skill and involves the risk of inadvertent injury to the sensitive structures of the foot. There are a number of manufactured glue-on foal shoes, which can be used as extensions and customised for individual animals. These have their disadvantages: either they are not easy to secure or they can constrict the hoof capsule causing contraction of the foot.

Acrylic or polymer urethane hoof repair materials can be bonded directly to the hoof and moulded to create the required extension (Figure 5). Acrylic undoubtedly creates the strongest bond to the hoof; however, its use is associated with irritant fumes, which some feel represents an unacceptable health hazard.

For this reason, the preferred method is the use of polymer urethane. It is very simple to apply and creates an effective extension.

The hoof must be thoroughly cleaned by trimming and rasping, and drying with a heat gun, or hair drier. Chemical cleaning agents such as acetone and polypropylene



▲ Figure 5. Medial acrylic extension shoe in a foal with a right fore fetlock valgus

must not be used as they prevent the successful attachment of urethanes.

Surgical treatment of angular limb deformities

The methods of correcting angular deformities can be split into techniques that attempt to stimulate growth at the physis on the concave side of the deformity, and those that retard it on the convex side, as well as correction by osteotomy.

Extracorporeal shock-wave therapy

Extracorporeal shock-wave therapy is a technique that has been used in the last few years as a non-invasive means of physal growth retardation. It seems to have a benign effect on affected foals and in mild and moderate deformities, particularly of the carpus and tarsus, has been effective. Now it is often the first course of action in mild cases.

Periosteal transection

This technique involves making a hemi-circumferential periosteal incision on the metaphyseal side of the physis on the concave side of the deformity. The aim is to release periosteal tension and to stimulate bone growth. The technique is benign and never causes overcorrection, but in recent years its efficacy has been called into question. The original technique involved making an extensive cut and required a general anaesthetic. This has been replaced in recent years with a much less extensive incision or by the use of shock-wave therapy, which can be performed under sedation.

Temporary transphyseal bridging

This technique involves the insertion of a screw, screws and wire, or a staple across the physis on the convex side of the deformity. The technique is effective and is used in foals when the deformity is more severe or when the time until functional physal closure is short (for example, when the fetlock is involved). The preferred technique is to use a single transphyseal screw (Figure 6).

The technique is performed under general anaesthesia. It can result in overcorrection, so careful post-operative monitoring is mandatory to ensure the implants can be removed just as the limb has become almost straight. This requires a second anaesthetic, therefore the procedure is reserved for cases where rapid or more extreme correction is required.

Osteotomy

'Wedge' or 'step' osteotomy, involving the removal of a section of bone, is seldom used but can be an effective means of treating more severe deformities. It involves carrying out an osteotomy on the diaphysis/metaphysis of the affected bone having carefully evaluated pre-operative radiographic images and decided upon a precise surgical plan. The limb is then repaired in its corrected alignment with a broad dynamic compression plate.

Management of the foal

Generally speaking, foals with angular limb deformities, irrespective of the origin or severity, should have restricted



▲ Figure 6. Transphyseal screw for fetlock varus

exercise. Foals with severe deformities, particularly where temporary transphyseal bridges have been inserted surgically, should be given complete box rest until limb straightening has occurred. This could take a few weeks. However, in those where periosteal releasing surgery has been performed, walking exercise in a yard or nursery paddock may be allowed fairly soon, once the incision has healed. In those which have only undergone a trimming procedure, or following shock wave therapy, exercise may be restricted to a nursery paddock or they may be turned out with other mares and foals.

Conclusion

The equine nurse can play a varied role in these cases; usually in managing operating theatres and peri-operative patient care, and with post-op bandaging. As previously mentioned, angular and flexural deformities are fairly common in the equine neonate, therefore these cases give many nurses the chance to develop skills in handling and nursing equine neonates. This is a challenge to be embraced as these young animals are naturally energetic.