How to Aid the Correction of Angular Limb Deformities in Foals Using Physeal Stimulation

Christopher M. Colles, BVetMed, PhD, HonFWCF, MRCVS

Stimulation of the physeal growth plate offers an effective, practical, and economic treatment for foals with angular limb deformities. The treatment can be carried out under sedation at an early age, and it leaves no detectable signs after treatment. Author's address: Avonvale Veterinary Practice, Ratley Lodge, Ratley, NR Banbury, Oxfordshire, OX15 6DT, UK; e-mail: chris.colles@avonvalevets.co.uk. © 2008 AAEP.

1. Introduction
Angular limb deformity is a well-recognized problem in a small but significant number of foals. It is generally accepted that most cases will correct themselves with time or with careful corrective trimming and shoeing carried out before closure of the relevant growth plates. A small number of cases, however, will not straighten with conservative treatments, and some corrective technique is required to prevent a significant conformational defect in the adult horse. Heinze described the surgical technique of physeal stapling to correct limb deviations from the carpus. Alternatively, Auer and Martens described the technique of periosteal transection and periosteal stripping, and this has currently gained widespread usage. In 2001, Read et al. suggested that surgical correction of angular limb deformity is not necessary. This was based on the results of surgery carried out on a small number of animals in an experimental model where all the limbs, whether treated or not, straightened over time. However, experienced clinicians still maintain that a number of clinical cases do not correct themselves adequately. They continue to use surgical techniques to encourage limbs to straighten, because limb deviations in the adult horse have serious orthopedic and financial consequences.

Auer and Martens suggested that angular limb deformity occurred as a result of the periosteum on one side of the distal limb failing to lengthen adequately to allow the limb to grow evenly, which results in the bend in the limb. The theory behind periosteal transection was that sectioning the periosteum removed the restriction to growth. Although this theory is interesting, there is no evidence that the periosteum does, in fact, prevent bone growth. It is possible that the surgery results in inflammation and that this inflammation stimulates more rapid growth in the adjacent area of the physis. This paper reports on the adaptation of the technique of periosteal striping to one of physeal stimulation in a series of clinical cases.

2. Materials and Methods
Cases Selected
Case selection was on clinical grounds; experienced clinicians selected foals with limb deviations that they considered were not correcting naturally. In all cases, the foals had received corrective trimming...
Table 1. Physes Stimulated Using Each Technique, With Maximum and Minimum Deviations Measured for Each Physis in the Group Before Treatment

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Foals</th>
<th>Distal Radius</th>
<th>Distal Mt3</th>
<th>Distal Tibia</th>
<th>Distal Mt3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1 (19°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>7 (5–20°)</td>
<td>18 (5–16°)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>(2 stimulated twice)</td>
<td>1 (5°)</td>
<td>3 (5–8°)</td>
<td>3 (5–7°)</td>
</tr>
</tbody>
</table>

and subsequently, shoeing of the feet for at least 2 wk. “Shoeing” took the form of some type of lateral or medial extension to the foot to encourage straightening. This “shoeing” was either a metal plate nailed or taped to the foot or in younger animals, the application of some form of “artificial hoof” to the hoof wall to form an extension. Foals were selected for treatment if they showed continuing deterioration of the condition or had failed to show any response to corrective trimming and shoeing over a 2-wk period. Consideration was given to their age and the time remaining before closure of the relevant physis. All cases were then referred to the author, who reassessed the cases, ensured that adequate corrective trimming and necessary shoeing had been correctly used, and confirmed the deviations radiographically. In three cases, further conservative treatment was given. In only one of these cases did further treatment result in satisfactory resolution of the condition and therefore, physeal stimulation was not subsequently needed. All the cases were between 2 and 25 wk old, and further information regarding the cases is given in Table 1.

Surgical Techniques

Because the concept of physeal stimulation gradually evolved, three different surgical techniques were employed. The first seven cases were treated under anesthesia, and the 13 cases in group C were treated under sedation. Because owners had to be willing to try a new form of treatment rather than the accepted methods, it has taken time to collect a series of foals for research.

Group A

In the first case only (in 1991), the foal was under general anesthesia and prepared for periosteal strip over a distal radial physis as described by Auer and Martens.2 The operation was carried out as normal, but before closure of the surgical incision at the end of the procedure, the end of a No. 11 scalpel blade was introduced into the physis as a means of creating some inflammation at the site. A single stab incision was made. Clinical assessment after surgery convinced the clinicians that the response was quicker than what was normally expected.

Group B

In the six cases between 1992 and 1998, the foals were treated under general anesthesia, and the area of the limb over the distal radial physis on the concave side of the bent limb was prepared for surgery. Instead of a periosteal strip, a small vertical incision was made through the skin and subcuticular tissue to the periosteum. The pointed end of a No. 11 scalpel blade was then introduced into the physis, and the distal end of the blade was moved in a dorsal and palmar direction to create a “fan-shaped” incision ~7 mm deep in the physis. The skin incision was closed, and dressings were applied. The foals received post-operative antibiotic cover of Procaine penicillin (20 mg/kg) and tetanus antitoxin (3000 IU) for 3 days. In all cases, corrective trimming of the feet had been carried out before surgery, and this was continued unaltered after surgery. In all cases, recovery from anesthesia and surgery was uneventful. Little response was seen for 3–4 days, but subsequently, rapid straightening of the treated limb was seen. In this series, one case underwent stimulation in both forelimbs (one medial and one lateral stimulation), and one case underwent physeal bridging in a severely deviated limb with physeal stimulation in the contralateral limb. In all cases, a satisfactory straightening of the limbs was achieved.

Group C

In 13 cases, foals were treated under sedation (1999–2006) using romifidine at ~5 mg/100 kg bodyweight, IV and butorphanol tartrate at 5 mg/100 kg, IV. With a single handler holding the foal, the concave side of the affected joint(s) was clipped and scrubbed for surgery. For the distal metacarpal/tarsal physes, a small infusion of local anesthetic under the skin was found to be necessary (prilocaine hydrochloride at 10 mg/ml). For distal radial and distal tibial physes, local anesthesia was not found to be necessary. Surgical sterility was maintained throughout the procedure. The physis was located by palpation, and it was usually immediately distal to the most marked bony prominence at the end of the metaphysis. A 1.2-mm diameter and 40-mm long (18-g, 1.5-in) hypodermic needle was then introduced into the physis. If correctly positioned, this passed into the physis with minimal resistance between 5 and 10 mm. If resistance was met, the needle was repositioned to ensure correct entry into the physis. The needle was withdrawn to the level of the periosteum but not through the periosteum, and it was reintroduced a number of times to make

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the “fan-shaped” series of punctures in the dorsal/palmar plane. The point of the fan was at the periosteum, which caused as little periosteal damage as possible. Then, the foals received antibiotic cover using Procaine penicillin (20 mg/kg) and tetanus antitoxin (3000 IU). The “surgical” site(s) were bandaged for 24 h.

In four cases, the technique was carried out bilaterally on the distal radial physes, and three of these also required stimulation of a distal tibial phys. Two cases with distal radial physeal stimulation required stimulation a second time. In three cases, one distal radial physes and one distal metatarsal physes were stimulated. In one case, the left distal radial (lateral stimulation) and left distal metacarpal (lateral stimulation) physes were stimulated at the same time. A total of 33 growth plates in 20 foals were treated.

3. Results

All the cases were assessed and radiographed by the author before physeal stimulation was carried out. Subsequent to treatment under anesthesia (groups A and B) and treatment of the first two cases in group C (cases 1–9), the foals were kept at the practice until the limbs had straightened. They were reassessed radiographically at 3 wk and then monitored clinically on a daily basis. Cases 10–20 were treated at their own farms or treated at the practice and returned to the farm the same day. These cases were reassessed at their farms by the author at weekly intervals after treatment until satisfactory straightening was seen. In all cases in all three groups, no effect was seen for 3–4 days, and then, rapid improvement of the angular deformity was seen over the next 7–10 days. There was no obvious difference in response to the three treatment methods.

In three severe cases, the limbs did not show sufficient response after the first stimulation. Correction of the deviation slowed down and stopped ~3 wk after treatment. The procedure was carried out a second time in all cases using the same technique. Similar delay and satisfactory response were subsequently seen; all three cases were of the distal radial physes.

4. Discussion

Controlled clinical trials of treatment of limb deviations in commercially raised foals are very difficult to arrange. There are frequently strong human emotions surrounding foals, making calculated, scientifically controlled studies difficult to apply. There are also financial and legal complications if cases of limb deviation are not treated and the mature animals subsequently show poor limb conformation. This trial was necessarily protracted, because owners were reticent to try a new technique of treatment when there were already treatments available that were tested and proven effective. It was not until treatment was possible under sedation rather than general anesthesia that owners were more forthcoming.

Read et al. carried out a study using an experimental model and concluded that limb deviation is always a self-correcting problem. Angular limb deformity was induced surgically in 10 foals using transphyseal bridging to cause bilateral limb deviations for the experiment. In each horse, one limb was then treated using periosteal transection, and the contralateral limb was left untreated. All the limbs straightened, and no significant difference was seen between the limbs in the mature horses at the end of the experiment. The authors concluded that transection was not necessary and that all deviations are a self-correcting problem. Although most experienced equine clinicians believe that most limb deviations can be treated conservatively, they also believe that some cases do not correct themselves without surgical interference. This is confirmed by the small but significant number of adult animals seen with limb deviations of varying severity. Therefore, it seems reasonable to question whether this was a suitable experimental model. Arguably, the fact that the control limbs all corrected themselves indicates that the model was not satisfactory or that an insufficient number of animals was involved.

The weight of clinical experience suggests that invasive treatment is required in a select group of foals. There are two techniques currently being widely used.

Transphyseal Bridging

This technique relies on stopping growth on one side of the physis, and it has two disadvantages. First, general anesthesia and the use of an implant, which is a relatively invasive surgery, are required. This must be followed by a second anaesthetic to remove the implant. The cost and risk of two anesthetics and surgical implants must be taken into consideration when assessing the need for surgery. Second, it also has the disadvantage that in a few cases, after removal of the implant, the limb continues to grow asymmetrically; the limb can “overcompensate,” which can result in a limb deviating in the opposite direction. Nonetheless, many clinicians, including the author of this paper, still use this technique for some severely deviating limbs.

Periosteal Stripping

The technique of periosteal stripping has the advantage that foals virtually never “overcorrect” after treatment. Additionally, only one anesthetic should be needed, and the surgery is quick and uncomplicated. There is considerable owner pressure placed on clinicians to ensure that foals grow with straight limbs, and there are severe financial penalties for young stock being sold with limb deviations. For this reason, it is likely that many foals have undergone general anesthesia and periosteal stripping when not strictly neces-
sary rather than risk the limbs not straightening. In a number of cases, it is possible to detect some new bone formation at the site of surgery in the adult horse, presumably because of periosteal damage stimulating new bone to form. This new bone formation and the requirement for general anesthesia are the principle disadvantages of this technique. Ethically, however, this technique is relatively easy to justify.

The technique of physeal stimulation described above appears to be a satisfactory alternative to periosteal stripping. As the technique evolved, it was shown that perfectly satisfactory results were obtainable using the technique described for group C, which was less invasive than that for groups A and B. It was also carried out without the need for general anesthesia. The technique is quick and simple to perform under sedation, and it can be carried out on any physis where uneven growth is seen. To date, it has resulted in no long-term evidence of surgical interference, because minimal periosteal damage is inflicted. Foals show no signs of pain or discomfort after 24 h, and normally, no pain response is seen at all, which makes post-operative analgesia unnecessary. Several physes can be stimulated simultaneously, and repeat stimulation after 21 days was not a problem in two of the foals in this series. The potential for osteomyelitis or an infected physitis after treatment must obviously be recognized, and strict aseptic technique must be used. The risk, however, is no greater than with periosteal stripping, and in this series of foals, no complications of any sort have been seen. This series did not include an untreated control group of foals, but by its clinical nature, it was not possible. All the patients had been assessed by at least two experienced clinicians before undergoing treatment, and all had undergone corrective farriery before treatment with no straightening of the limb deviation being detected clinically. In all cases, it was considered that some form of more radical treatment was needed based on clinical grounds.

Trials have been conducted using shockwave therapy on the convex side of the physis in limb deviations. The author understands that this has a satisfactory result in most cases, but to be effective, it does require the use of several treatments under sedation.

In conclusion, it was considered that physeal stimulation, using a hypodermic needle in standing sedated foals, was a satisfactory technique to stimulate more rapid growth in part of a physeal growth plate. Stimulation on the concave side of a limb deformity offers a simple and cost-effective method to aid the straightening of deviated limbs.

References and Footnotes


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