EQUINE VETERINARY EDUCATION
Equine vet. Educ. (2009) **21** (12) 666-670
doi: 10.2746/095777309X479012

Original Article

A single screw technique compared to a two screw and wire technique as a temporary transphyseal bridge for correction of fetlock varus deformities

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Keywords: horse; transphyseal bridge; foal; angular; deformity; screw

Summary

A single screw technique is described as a temporary transphyseal bridge for the treatment of fetlock varus angular limb deformity in foals. This has been compared to tension band wiring with regards to rate of correction, cosmetic result and incidence of complications. The single screw was found to be an effective technique resulting in more rapid improvement of deviations in foals aged up to 5 months. Complications were minimal following both techniques and the final cosmetic result was better following single screw surgery.

Introduction

Angular limb deformities (ALDs) are axial deviations of a limb in a frontal plane (Dutton 1999) and are recognised to predispose to lameness (Ross 2003) and may result in aesthetic penalties at sale. Valgus refers to a lateral deviation and varus to a medial deviation (Auer 1991). Fetlock varus conformation is recognised to predispose horses to problems at the lateral aspect of the fetlock, such as lateral branch suspensory desmitis and fourth metacarpal bone injury (Ross 2003). Surgical correction is indicated in the foal if the degree of deformity is severe, not improving or worsening (Bramlage and Embertson 1990; Mitten and Bertone 1994). Fetlock varus or 'toe-in' conformation has been identified in 35% of Thoroughbred foals born in one study (Lowis 2005) and to account for 43–44% of ALDs undergoing surgery in other studies (Fretz 1978; Turner and Fretz 1978).

Angular deviations of the limb are amenable to correction by epiphyseal growth retardation using temporary transphyseal bridging (TTB) techniques, first reported in 1953 (Delananty and Gibbens 1953). Application of staples or 2 screws with tension band wiring (TBW) across the physis have been successful methods of TTB (Delananty and Gibbens 1953; Heinze 1964; Fretz 1978; Turner and Fretz 1978; Auer 1991), but complications include wound dehiscence, staple extrusion, wire breakage and poor cosmetic results (Fretz 1978; Turner and Fretz 1978). More recently, a single-positional screw (SS) technique as a TTB has been reported at the distal tibial, radial and metacarpal physis (Witte *et al.* 2004; Kay *et al.* 2005). This technique is reported to correct ALDs successfully with minimal complications and has given the impression of achieving superior cosmetic results (Kay *et al.* 2005).

This paper describes a SS technique for TTB on the lateral aspect of the distal metacarpus for correction of fetlock varus deviations. The rate of correction, cosmetic result and incidence of complications was compared with the more traditional TBW procedure performed on foals on the same farm, in the same year.

Materials and methods

Seventy-three lateral fetlock forelimb TTBs were performed on 40 Thoroughbred foals housed on the same Thoroughbred breeding farm, during the same breeding season. Of these, 54 were SS and 19 TBW; the age distributions for each technique are illustrated in **Table 1**.

Limb conformation was evaluated by the same author (A.R.A.) from age 2 weeks, at 1–2 week intervals. The

TABLE 1: Distribution of foals undergoing temporary transphyseal bridging in each age group

	<3 months	3–4 months	4–5 months
Single screw technique	5	30	19
Tension band wiring	7	10	2

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assessment was performed in the same way, with the same facilities, for each foal to give the assessment some degree of consistency. Post operative assessments were made blinded to the surgical technique used. The limb was evaluated at rest and during movement and a visual subjective grading system (0–4) was used to assess the severity of the deviations; 0 being a straight limb, 1 being <3° deviated, 2 being 4–7° deviated, 3 being 8–11° and 4 a severe varus deviation (>12°). Hoof trimming and hoof extensions were often performed as the first treatment after initial evaluation. Hemicircumferential periosteal elevations (HCPE) were performed on some foals with persistent deviations at age 2–4 weeks. Horses were considered candidates for TTB if they had at least a *Grade 2* deviation identified after age 6 weeks, or 6 weeks after a HCPE, or a persistent deviation that was not improving with conservative treatment. Each foal was considered individually and the age a TTB was performed was largely dependent on the severity of the deviation and its response to initial management techniques.

The foals were sedated with xylazine hydrochloride (0.7 mg/kg bwt i.v.). Anaesthesia was induced with a combination of ketamine hydrochloride (3 mg/kg bwt i.v.) and diazepam (0.1 mg/kg bwt, i.v.) and maintained with halothane in oxygen. Following induction treatment with ceftiofur (5 mg/kg bwt, i.v., q. 12 h), gentamycin (6.6 mg/kg bwt, i.v., q. 24 h) and phenylbutazone (2.2 mg/kg bwt, i.v. q. 24 h) was given for 48 h.

The foal was placed in dorsal recumbency and the limb secured in an extended vertical position. After presurgical scrub and preparation, a 20 gauge needle was placed on the lateral aspect of the distal metacarpus into the physis to identify its location. For the SS technique a 10 mm incision was made 10 mm proximal to the physis through the skin, subcutaneous tissue and periosteum. The periosteum was elevated for 5 mm on either side of the incision. A 5.5 mm drill sleeve was inserted between the periosteal flaps and a hole, 5 mm deep, was created using a 5.5 mm drill bit parallel to the physis. A sharp periosteal elevator was used to remove the proximal rim of the hole, which ensured that the screw head could be seated within the hole and beneath the perisoteum. A 3.2 mm drill sleeve was seated in this hole, angled at 70° to the physis and a 2.5 mm drill bit was used to create a hole 36–42 mm deep. The 70° angle ensured the distal end of the screw was positioned lateral to the sagittal ridge. The hole was measured with a depth gauge and subsequently hand-tapped and a 3.5 x 34–40 mm cortical bone screw was inserted (**Fig 1**). Intraoperative radiographs were initially undertaken to confirm correct screw placement but these were abandoned once each surgeon became familiar with the technique. A different rate of drill advancement could be felt in the different anatomical levels of the distal metacarpus, which allowed for an estimate of the length of the drill hole past the physis. The incision was closed in 2 layers with a simple continuous 3-0 polyglactin 910 in the periosteum and 2 or 4 simple interrupted 2-0 poliglecaprone 25 in the skin. The incision was then covered with sterile gauze swabs and the limb bandaged from the coronet to the carpus using sterile cotton wool wrapped with an elastic bandage.

The TBW technique is well described in the literature (Fackelman and Frolich 1973; Fretz 1978; Auer 1991). Briefly, 2 small incisions were made on either side of the physis, a 2.5 mm drill bit used to create a hole that was tapped and then 3.5 x 32–36 mm cortical bone screws inserted. A single 18 gauge figure of 8 cerclage wire was used to complete the TTB. The stab incisions were closed with a single cruciate suture of 3-0 polyglactin 910 in the subcutaneous tissue and one or 2 simple interrupted sutures of 2-0 poliglecaprone 25 in the skin. The incision was bandaged in the same way as the SS technique.

For the SS technique the horses were confined to a small stall (3.7 x 3.7 m) for 7 days, a large stall (7 x 4.5 m) for 7 days and then turned out to a small paddock. For the TBW technique the horses were confined to a small stall for 2 weeks, a large stall for 1–2 weeks and then turned out to a small paddock. The distal limb was bandaged for 14–21 days for the SS technique and until screw and wire removal for the TBW technique.

Horses were re-evaluated every 2 weeks following surgery. The TTB was removed once correction of the fetlock varus deformity had occurred, or growth was considered to have ceased due to physeal closure

Fig 1: Intraoperative radiograph to confirm the correct placement of a 3.5 mm single screw, angled at 70° to the physis.

denoted by radiography. For SS removal, horses were anaesthetised and positioned as for TTB placement. The site was clipped and prepared for surgery. Screw heads were located by probing a 20 gauge needle at the site of the previous skin incision. A 5–10 mm incision was made over the screw head, through the skin, subcutaneous tissue and periosteum and the screw was removed. Occasionally bone had formed over the screw head and a rongeur or curette was used to expose the screw head. Extreme care was taken to fully engage the screw driver to avoid stripping of the screw head. The incision was closed with one or two simple interrupted sutures of 2-0 poliglecaprone 25 in the skin. For removal of the TBW, the screws were removed through 2 incisions in a similar manner although the periosteum was not incised. The wire was removed through one of the stab incisions and the incision was closed as for the SS removal. The sites were covered in sterile swabs and limb bandaged with sterile cotton wool from the coronet to the carpus and then wrapped with an elastic bandage. The distal limb was bandaged for 12 days. Horses were confined to a large stall for 7–14 days and then turned out into a small paddock.

All foals were re-assessed at least 6 weeks after TTB removal for remaining fetlock varus deviations using the same grading system. Blemishes were also graded by 2 authors (B.L.R. and A.R.A.) on a scale from 0–3, (0: absent; 1: mild cutaneous thickening <1 cm diameter; 2: visible scar tissue <2 cm diameter or that protrudes <1 cm; and 3: excessive scar tissue >2 cm in diameter or scar tissue protruding >1 cm).

The SS technique was compared with the TBW technique with regard to speed of surgery, post operative complications, degree of deviation improvement, rate of deviation improvement and the final cosmetic appearance. Because this is a clinical retrospective study with subjective assessment of ALDs and blemishes, in-depth statistical analysis was not possible or appropriate.

Results

Surgery time for the SS technique from incision to suture placement was approximately 5 min compared with 15 min for the TBW.

The only complications seen with either technique were superficial skin infections, which occurred in 11 cases, of which 8 were SS and 3 were TBW (**Table 2**). These did not necessitate screw removal and there was no clinical or radiological evidence of bone infection. The infections were treated with a 3 day course of procaine penicillin (22,000 iu/kg bwt, i.m. q. 12 h) and all resolved without further complication. No post operative infections followed implant removal.

The average age at the time of TBW placement was 90.3 days (35–174 days) and 111.6 days (90–145 days) for the SS (**Table 2**). Surgery was performed on foals aged ≤145 days and the spread of ages when surgery was

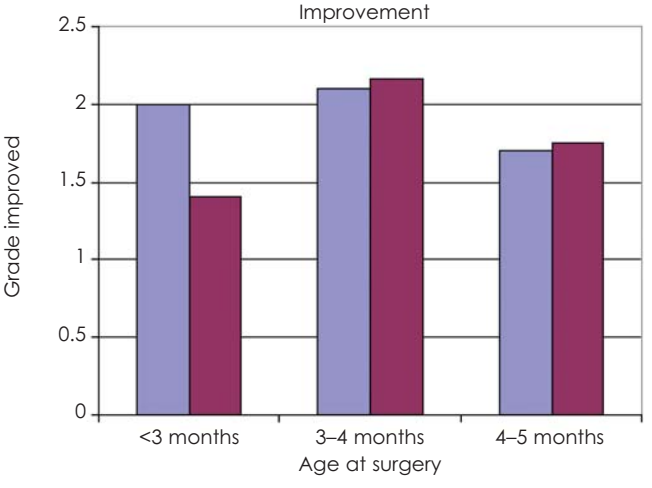

Fig 2: Grade of improvement seen in varus deviation following a TTB at different age groups. ■ = 1 screw; ■ = 2 screw.

TABLE 2: Average age of foal at surgery, length of time temporary transphyseal bridging (TTBs) were in left in place, improvement achieved and post surgical complications for each technique

	Average age at surgery (days)	Time before TTB removal (days)	Grade at surgery (1–4)	Final grade (1–4)	Grade Improved	Superficial infections (%)
SS	111.6	31.1	2.1	0.19	1.93	15
TBW	90.3	42.8	2.2	0.42	1.81	16

Fig 3: A foal with one SS (left) and one TBW (right). Note the different location and size of the cosmetic blemishes.

performed is outlined in **Table 1**. The SS was left in for 31.1 days (9–65 days) compared with 42.8 days (19–86 days) for the TBW technique (**Table 2**).

The average severity of the initial ALD was similar in both groups of foals (SS = 2.1, TBW = 2.2) but the final post operative deviation was less in the foals that had the SS (SS = 0.19, TBW = 0.42, **Table 2**). The SS technique resulted in an average grade improvement of 1.93 (0.5–3), which was better than the 1.81 (0.5–3) seen with the TBW technique (**Table 2**). Improvements were seen in foals undergoing surgery aged ≤145 days and foals aged >4 months still had an average improvement of 1.85 for the SS and 1.75 for the TBW (**Fig 2**).

The SS technique produced better cosmetic results; the average grade of the blemish was 1.4 (0–3) for the SS technique and 1.52 (0–3) for the TBW technique (**Table 2**). Where blemishes were present as a result of the SS, they were contained within a smaller area and further away from the fetlock joint (**Fig 3**).

Discussion

The results confirm that the SS technique is an effective technique for TBB of the distal metacarpus and appears to provide more rapid improvement of the ALD than the TBW technique. The SS technique required less time to improve the ALD even though it was placed later in life, when growth is reported to have slowed (Fretz 1978). This may be explained by the single screw causing immediate growth retardation compared with the dependence on an appropriately tightened wire for the TBW technique. Witte *et al.* (2004) noted that the rate of change using a SS technique at the distal tibia was related to the age of the foal and degree of deviation and they did not feel it differed from conventional TTB techniques.

The results of this study are flawed by the use of a subjective visual grading system for assessing the degree of deviation. Many reports advocate the use of preoperative radiographic assessment to identify pivot points near affected physes, the degree of deviation and morphological changes such as epiphyseal wedging and compensatory modelling (Pharr 1981; Barr 1995; Jansson 2005). However, a visual appraisal alone is used as a standard means of assessment by other authors (Bramlage and Embertson 1999; Whitte *et al.* 2004; Lowis 2005). Visual appraisal allows a rapid assessment of the limb both when standing and moving. An objective grading system is not used by the authors as it is difficult to achieve and prone to misinterpretation (Bramlage 1999; Dutton 1999). The authors believe the timing and decision for surgery should not be based on an absolute degree of deviation but after considering many factors including age, progression of the deviation, total limb conformation, presence of physeal dysplasia, and the dam's and sire's conformations. The decision to perform a TTB foal requires consideration of these issues with an understanding of normal physeal growth patterns as opposed to a single angle on a radiograph (Bramlage and Embertson 1999). Radiographic geometric measurements have been criticised in the evaluation of ALDs with regards to the requirement of long images and perfect positioning to get repeatable measurements (Bramlage 1999). The carpus and tarsus joints require radiography to identify cuboidal bone hypoplasia associated with ALDs but this is not necessary in fetlock joint assessment. Visual assessment was considered an accurate method for ALD evaluation and the decision to undertake a TTB.

It should be emphasised that the degree of ALD was not severe in many of these foals. It is the authors' experience that any tendency to 'toe-in' should be addressed at an early age as it will often worsen as the chest widens and the limb rotates in, consistent with reports from other authors (Bramlage 1999). In our hands, foals are subject to early and regular assessments with appropriate trimming or the use of hoof extensions and HCPE initially, prior to the decision that a TTB is required. It is therefore important that evaluations are repeated at regular intervals to identify how the deviation is changing as, in our experience, this is more important than the degree of deviation on a single examination. Hemicircumferential periosteal elevations were performed on some foals prior to TTB, but the authors do not believe this had any influence on the effectiveness of the TTBs. There was at least a 6 weeks delay between surgical procedures and TTBs were only performed on foals with varus deviations that had not improved following HCPE.

Improvements in fetlock varus deviations were achieved later in life than generally reported in the literature (Turner and Fretz 1978; Trostle and Hartmann 1992; Waagner von Mattriessen 1993; Mitten and Bertone 1994; Barr 1995; Lowis 2005). Our results show that improvements are possible in foals aged ≤5 months and we observed foals in the 4–5 month age bracket improving their deviations an average of 1.75–1.85 grades. The recent report of this technique by Kay *et al.* (2005) described metacarpal SS placement up to age 216 days with a similar average age at surgery of 94 days (compared with 91 days).

The SS technique described in this paper involves closure of the periosteum over the screw head. This is done to act as a barrier to infection, with this theory being supported by the lack of screw sepsis, but the presence of superficial sepsis. Secure closure of the subcutaneous tissue is also difficult at this location. Closure of the periosteum usually results in the formation of bone over the screw head. This can make removal difficult and a bone rongeur or curette is often needed to expose the screw head. Furthermore, the 3.5 mm screw heads can be easily stripped, also making removal difficult. Since this study the authors have undertaken a SS technique on >300 foals and now recognise a higher rate of infection at the time of removal than at implantation, potentially due to the greater tissue trauma required. Kay *et al.* (2004) reported screw breakage during screw removal in a number of

cases. We did not encounter this complication and we believe that removal of the proximal rim of bone from the 5.5 mm hole during implantation is important to prevent bending of the screw on implantation, potentially weakening the screw.

The SS technique was also used to reduce post operative aftercare and confinement. The technique is straightforward with a faster surgical time and less soft tissue trauma by avoiding placement of a screw through the collateral ligament. Despite less bandaging time and confinement for the SS technique, the incidence of post operative infections was similar between the 2 techniques. These infections were all superficial and the final post operative cosmetic appearance remained better for the SS technique. As a result of the reduced surgical trauma with the SS, and the covering of the implant with periosteum, foals that had SS were managed less intensively and this may have increased the rate of infection. This finding has resulted in re-evaluation of the post operative care. Stall confinement is now advised until suture removal at 16 days post operatively and limb bandaging for 21 days post operatively.

Initially there was concern that the SS TTB may cause a permanent transphyseal bridge due to complete physeal closure at the site where the screw passes through the physis and 'spot-weld' this area. However, this was not reported by Witte *et al.* (2004) when they used a SS at the tibial physis. It was thought that if it were to occur, it would be more likely and with worse consequences in the foals operated on earlier in life, so we used the TBW on the majority of foals aged less than 3 months. The SS technique was used in 34 limbs on foals aged 12–16 weeks, and over-correction was not identified. We now exclusively use the SS technique at the distal metacarpus, and have not identified any case of over-correction in over 300 limbs, including some foals undergoing surgery at age <4 weeks.

Direct comparisons have not previously been made between the effectiveness and the end results of different TTB techniques. These findings have been helpful to illustrate differences between the SS and TBW techniques. In summary, the SS technique resulted in greater subjective improvements in varus deviations of the fetlock than seen with the TBW, and at a faster rate. Improvements in deviations were achieved in foals aged ≤145 days. The SS TTB is an easier technique with a shorter surgery time, reduced aftercare requirements and with better cosmetic results.

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