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CASE REPORT

Proximal segmental ostectomy under standing sedation for treatment of open comminuted axially displaced fractures of the fourth metatarsal bone in two horses

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Summary

Two cases with open, comminuted, axially displaced fractures of the proximal third of the fourth metatarsal bone were referred to the University Equine Hospital Vienna. Due to concerns regarding the risk of injury to the suspensory ligament and risk of implant infection with an open configuration, surgical treatment with proximal ostectomy of the fractured fourth metatarsal bone was performed in both cases. Based on telephone follow-up, Case 1 was reported to be sound with no significant reaction at the surgical site 22 months following the procedure and Case 2 exhibited intermittent lameness, radiographically evident irregular new bone formation and some residual ultrasonographic changes of the proximal suspensory ligament 17 months after the procedure. Based on the results of this report, a proximal ostectomy facilitated by standing sedation and regional anaesthesia is a valid treatment option in cases of open, axially displaced fractures of the fourth metatarsal bone, minimising perioperative complications but not excluding long-term postoperative complications.

KEYWORDS
horse, open fracture, proximal ostectomy, splint bone, standing surgery

INTRODUCTION

A number of surgical and conservative treatment options have been described for open, comminuted fractures of the proximal third of the fourth metatarsal bone. However, each treatment option carries some risk for serious complications (Allen & White, 1987; Baxter et al., 1992; Bowman & Fackelman, 1982; Jackson et al., 2007; Jenson et al., 2004; Lescun, 2021; Mageed et al., 2018; Peterson et al., 1987; Sherlock & Archer, 2008). In cases with an unstable and displaced proximal fragment of the fourth metatarsal bone, open reduction and internal fixation using implants performed under general anaesthesia is the treatment of choice. Conservative management in these fracture configurations is generally not recommended (Jackson et al., 2007).

To date, all reported surgical procedures for the treatment of proximal splint bone fractures (i.e. excision of the distal fragment and associated fracture, complete excision of the fourth metatarsal bone, segmental ostectomy, internal fixation with plate or screws and internal fixation of proximal splint bone fractures using bioabsorbable screws) have been described under general anaesthesia (Allen & White, 1987; Baxter et al., 1992; Jenson et al., 2004; Mageed et al., 2018; Peterson et al., 1987). Moreover, the treatment of most proximal fourth metatarsal bone fractures with axially displaced fragments impinging on the suspensory ligament has not been specifically addressed. Due to the typically traumatic aetiology and open fracture configuration in this type of injury, it is important to consider the risks of general anaesthesia, in

particular recovery, and the potential for infection of any implants (Lescun, 2021; Sherlock & Archer, 2008). In the current case report, proximal segmental ostectomy using standing sedation and regional anaesthesia is described as a treatment option for open, unstable, axially displaced, comminuted fractures of the proximal third of the fourth metatarsal bone.

CASE PRESENTATION

History, clinical findings and diagnosis

Case 1

A 16-year-old Quarter Horse mare was referred to the University Equine Hospital Vienna for assessment and treatment of an open fracture of the left fourth metatarsal bone that had occurred 10 days previously, with a suspected traumatic aetiology.

On presentation to the hospital, the horse's vital parameters were within normal limits. A distal limb bandage was in place and the horse was 4/5 lame, based on the American Association of Equine Practitioners (AAEP) lameness scale. A 3 cm longitudinal laceration was present on initial examination over the proximal aspect of the fourth metatarsal bone, with moderate soft tissue swelling surrounding the wound. There was a small amount of serosanguinous discharge. Bacterial culture taken from the wound subsequently yielded *Streptococcus equi* subs. *zooepidemicus*. Aseptic arthrocentesis of the tarsometatarsal joint was attempted using ultrasonographic guidance but a sample could not be obtained, likely due to leakage of synovial fluid through the wound. An ultrasonographic examination of the surrounding soft tissues was limited due to gas artefacts. 500 mg amikacin was administered into the tarsometatarsal joint.

Radiography of the tarsus identified a comminuted, intra-articular fracture of the proximal third of the fourth metatarsal bone with a moderate proximal and axial displacement of one of the fragments (Figure 1).

Based on clinical and radiographic findings, the diagnosis of an open, comminuted, intra-articular, moderately axially and proximally displaced fracture of the proximal fourth metatarsal bone was made.

Case 2

A 13-year-old Missouri Foxtrotter gelding, used for recreation purposes, was presented to the University Veterinary Hospital Vienna for further assessment and treatment of an open, fourth metatarsal fracture of the left hindlimb following a kick injury that had occurred 14 days prior to presentation.

On admission to the hospital, the horse's vital parameters were within normal limits. The horse was 4/5 left hindlimb lame, based on the American Association of Equine Practitioners (AAEP) lameness scale. A 1 cm wound was evident on the lateral proximal aspect of the left metatarsus approximately 5 cm distal to the tarsometatarsal joint with moderate soft tissue swelling around the wound.

Radiography identified a comminuted fracture of the proximal third of the fourth metatarsal bone with a moderate axial displacement of the most proximal fragment (Figure 2). On ultrasonographic examination, an irregular contour of the surface of the fourth metatarsal bone was evident and several axially displaced fragments were visible, with corresponding hypoechoic areas in the suspensory ligament (Figure 3).

Thus, a diagnosis of an open, comminuted, axially displaced fracture of the proximal third of the left fourth metatarsal bone complicated by a traumatic proximal suspensory ligament desmopathy was made.

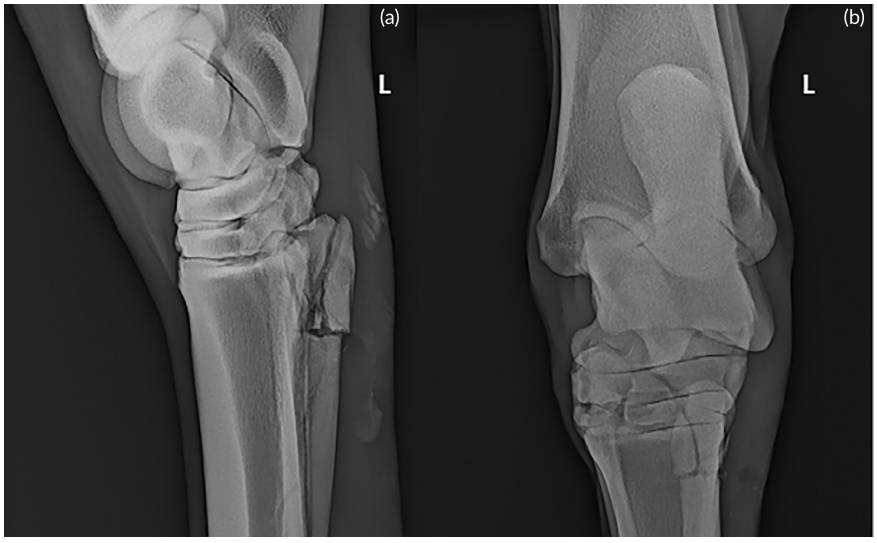

FIGURE 1 Radiographs taken on admission of Case 1. Lateromedial (a) and dorsoplantar (b) radiographic projections of the left proximal metatarsus showing a comminuted, intra-articular fracture of the proximal third of the fourth metatarsal bone with moderate proximal and axial displacement of the axial fragment.

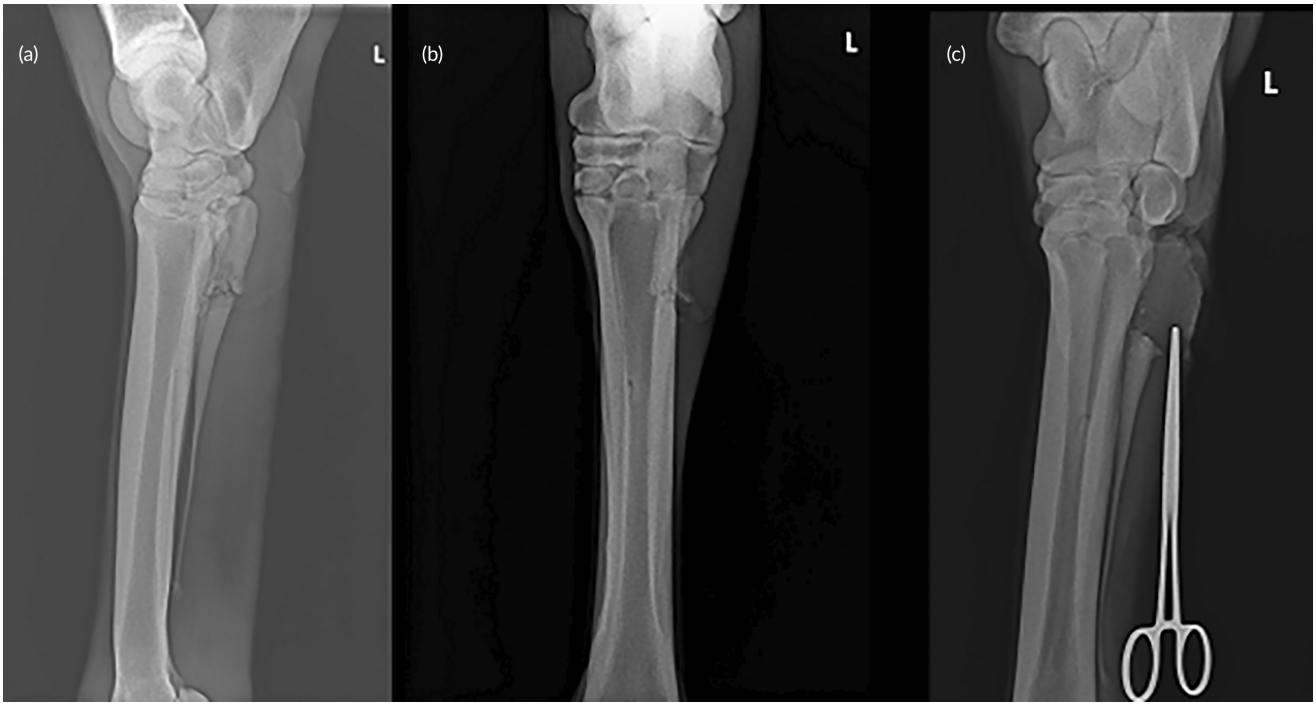

FIGURE 2 Pre and intraoperative radiographs of Case 2. Lateromedial (a) and dorsoplantar (b) radiographic projections of the left proximal metatarsus showing a comminuted and axially displaced fracture of the proximal third of the fourth metatarsal bone. (c) Dorsolateroplantaromedial radiographic projection of the left hindlimb immediately after proximal segmental ostectomy and before skin closure.

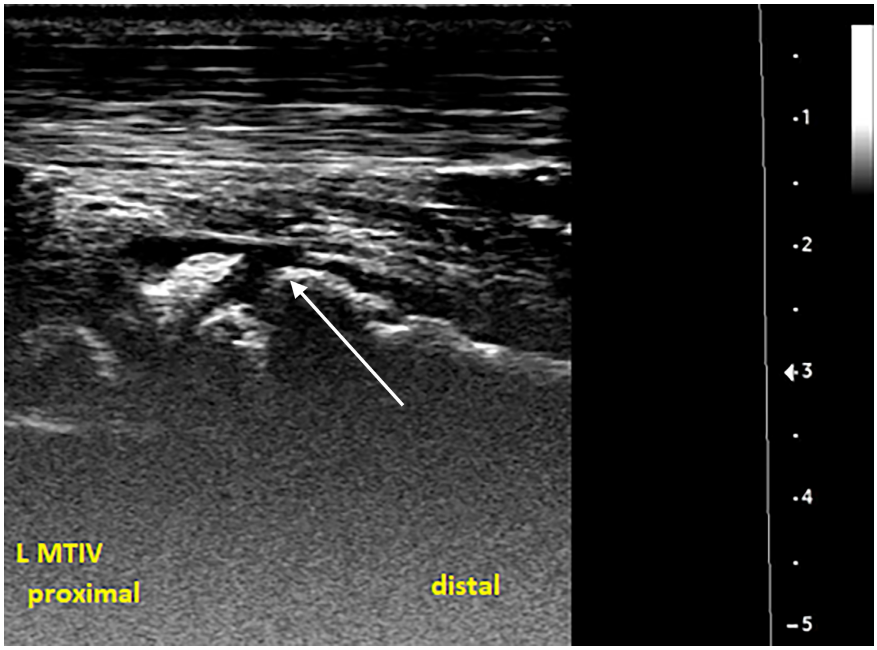

FIGURE 3 Ultrasonographic image of the plantar structures at the proximal metatarsus in Case 2 at admission. Longitudinal scan: proximal is to the left of the image, arrow: fracture site and axially displaced proximal portion of the fourth metatarsal bone with a corresponding lesion of the suspensory ligament.

Treatment

In both cases, wound assessment and initial local wound revision under standing sedation and local anaesthesia were performed at the time of hospital admission.

Based on axial displacement and instability of the fragment, surgical intervention was subsequently elected to remove the impingement of the axial fragment on the suspensory ligament.

Both cases were initially managed with local wound therapy, external stabilisation, box rest and medical therapy, with the aim of

decreasing local swelling and infection and to improve the viability of tissues preoperatively. Initial medical therapy was different in both cases. Case 1 received 8 days of antimicrobial treatment (sodium benzyl penicillin G [22,000 IU/kg bwt, i.v. q.i.d.] and gentamicin [6.6 mg/kg bwt, i.v. s.i.d.]) and non-steroidal anti-inflammatory medications (flunixin meglumine [1.1 mg/kg bwt, i.v. b.i.d.]). Case 2 received 14 days of non-steroidal anti-inflammatory medications (phenylbutazone [2.2 mg/kg bwt, p.o. b.i.d.]).

Surgical procedure

In both cases, the surgical procedure was performed using standing sedation and regional anaesthesia. For regional anaesthesia, a tibial and peroneal nerve block and a line block proximal to the surgical site was performed using 15 mL 2% mepivacaine per site. Sedation was administered through an 18 G intravenous jugular catheter, with detomidine hydrochloride (0.01 mg/kg bwt, i.v.) and butorphanol (0.01 mg/kg bwt, i.v.). Additional boluses of these sedatives were administered during the procedure to maintain an appropriate plane of sedation.

To ensure optimal access to the proximal third of the fourth metatarsal bone and the fracture fragments, an ultrasonographic examination of the area was performed immediately prior to surgery. An Esmarch bandage was placed proximal to the tarsus in both cases. The surgical fields were aseptically prepared in a routine fashion. Skin incisions were 10 cm long and located on the plantarolateral aspect of the proximal metatarsus, overlying the plantarolateral surface of the fourth metatarsal bone in both cases. Incisions extended from 1 cm distal to the fractured area to 1 cm proximal to the level of the tarsometatarsal joint. Blunt as well as sharp dissection was used to expose the fourth metatarsal bone and fracture fragments using Metzenbaum scissors, avoiding the neurovascular structures in the area. The proximal fourth metatarsal bone was transected from its ligamentous attachments with Mayo scissors and subsequently, all fracture fragments of the proximal part of the fourth metatarsal bone were removed. The proximal end of the remaining distal portion of the fourth metatarsal bone was rounded with a mallet and chisel and Luer bone rongeurs.

Intraoperative radiographs confirmed the complete removal of the fragments (Figure 2c).

At the end of the procedure, the wound was curetted and flushed with sterile lactated Ringer's solution. In Case 1, a Redon drain (P.J. Dahlhausen & Co GmbH) was placed in the wound, due to dead space that was created after the removal of the fragment and the communication of this space with the tarsometatarsal joint.

The surgical wound was closed in two layers. The fascia was closed with a simple continuous suture pattern using glyconate suture (Monosyn, Braun) and vertical mattress sutures were placed in the skin using polypropylene (Premilene, Braun), size 0 and 1, respectively.

Aftercare

A distal limb Robert Jones pressure bandage with focal pressure on the surgical site was placed for a total of 7 and 8 weeks and a negative pressure wound therapy system was applied for 2 and 1 weeks for Case 1 and Case 2, respectively, to improve wound healing. Antimicrobial (sodium benzylpenicillin G [22,000 IU/kg bwt, i.v. q.i.d.] and gentamicin [6.6 mg/kg bwt, i.v. s.i.d.]) and nonsteroidal anti-inflammatory (flunixin meglumine [1.1 mg/kg bwt, i.v. b.i.d.]) therapy were administered. Duration of antimicrobial treatment was in Case 1 8 days preoperatively followed by 7 days in the postoperative period and in Case 2 antimicrobial treatment was administered only postoperatively for 9 days. The drain in Case 1 was removed 4 days postoperatively; the supportive bandage was changed every 3–4 days and the thickness of the bandage was reduced after 4 weeks. Sutures were removed 14 days postoperatively. Stall rest was recommended for 3–4 weeks before the progressive introduction of in-hand walking. Repeat ultrasonographic assessment of the lesion within the suspensory ligament was advised 3 months postoperatively before increasing the exercise further.

Follow-up

In Case 1, radiography 1 month postoperatively showed areas of radio-opacity proximal to the distal remnant of the splint bone consistent with dystrophic mineralisation, but the horse was sound at walk (Figure 4). Based on a telephone conversation with the owner 22 months after the surgery the horse was not lame and the previous surgical site appeared unremarkable. The horse had progressively returned to its normal workload, starting with trot 3 months after surgery.

On repeat examination of Case 2 at 17 months postoperatively, intermittent mild lameness of the left hindlimb (1/5 based on AAEP scale) was evident. Palpation identified a small firm swelling at the level of the proximal third of the remaining segment of the fourth metatarsal bone. On repeat radiographs at this time, new bone formation was present at the site of the amputated proximal portion of the left fourth metatarsal bone, consistent with osteoarthritis of the tarsometatarsal joint. On ultrasound examination, there was evidence of new bone formation on the axial border of the amputated left fourth metatarsal bone impinging on the suspensory ligament, however, the suspensory ligament lesion appears smaller in comparison to the preoperative ultrasonographic images. Both imaging findings are a potential cause of lameness. At the time of repeat examination, the owner reported that the horse had been routinely ridden at walk; the owner was satisfied with the horse's progress and declined further diagnostics or treatment at that time.

DISCUSSION

The main reason to pursue surgical treatment in the reported two cases of open, unstable, axially displaced fractures of the proximal third of the fourth metatarsal bone was the displacement of the fracture fragments towards the suspensory ligament and the associated risk of impingement and/or damage to the suspensory ligament.

In reports favouring conservative management for open fractures of the proximal third of the fourth metatarsal bone, the problem of axial displacement of the proximal fragments has not been specifically addressed (Jackson et al., 2007; Jenson et al., 2003). However, in general, in cases of proximal splint bone fractures with an unstable proximal fragment, surgical treatment was recommended (Jackson et al., 2007).

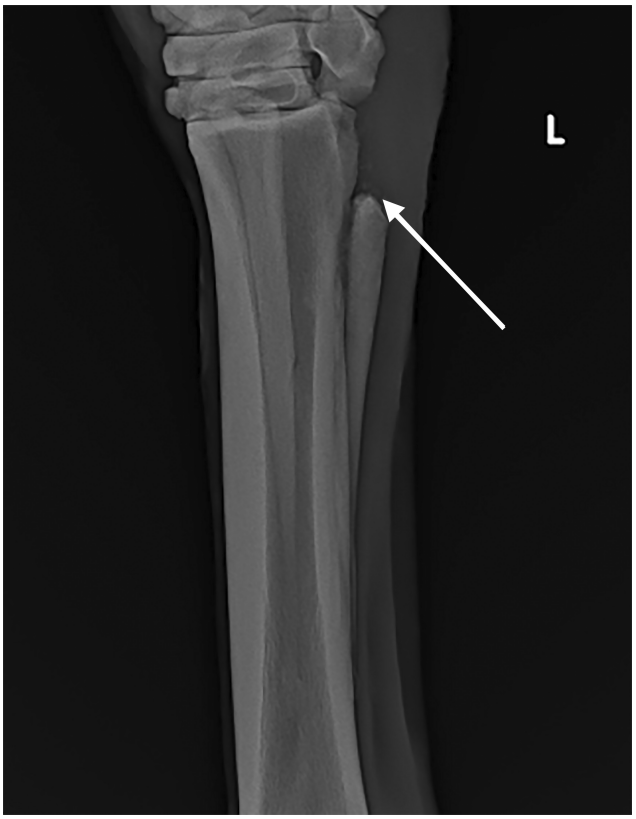

FIGURE 4 Dorsolatero-plantaromedial radiographic projection of the proximal metatarsus in Case 1, 1 month after proximal ostectomy. Arrow indicates minimal dystrophic mineralisation in the area proximal to the remaining distal portion of the fourth metatarsal bone.

Recently, there is a trend towards elective standing surgical procedures, with the aim to minimise perioperative complications and costs (Gasiorowski & Richardson, 2014; Rossignol et al., 2015; Russel & Maclean, 2006). The procedures described in this report were performed in standing, sedated animals to eliminate the risk of catastrophic injuries in recovery, which has been reported as a potential complication after treatment of traumatic fractures of the fourth metatarsal bone under general anaesthesia (Jackson et al., 2007; Jackson & Auer, 2019; Kälin et al., 2021; Sherlock & Archer, 2008).

Removal of a fractured fragment and the distal part of the fourth or second metatarsal bone with or without internal fixation of the proximal portion has been described under general anaesthesia with good outcome (Allen & White, 1987; Bowman & Fackelman, 1982). Since only the most proximal portion of the fractured bone was unstable and axially displaced in cases described in this report, surgical removal of the distal intact portion of the splint bone in addition to the fractured segment was not expected to provide any additional benefit.

Segmental ostectomy, removing only the fractured part of the bone was described as a less invasive alternative than the extirpation of the entire distal aspect of a fractured splint bone, but no cases of most proximal ostectomy have been specifically described (Jenson et al., 2004).

Another surgical option, that avoids the use of an implant, would be complete amputation of the fourth metatarsal bone (Baxter et al., 1992; Sherlock & Archer, 2008). The fourth metatarsal bone provides little axial support and is the only one of the vestigial metatarsal and metacarpal bones that can be removed without appearing to produce instability of the distal tarsus/carpus (Baxter et al., 1992;

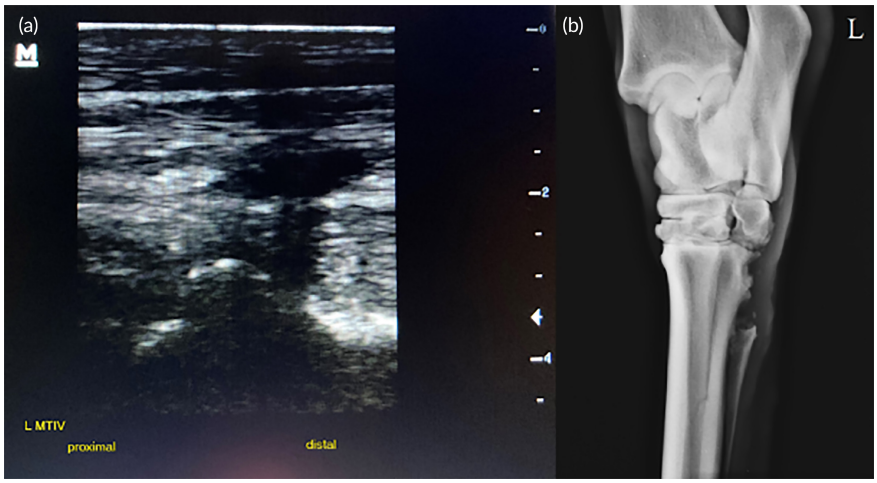

FIGURE 5 Ultrasonographic and radiographic images of the proximal metatarsus of the Case 2, 17 months after proximal ostectomy. (a) Longitudinal ultrasonographic scan of the plantar structures at the proximal metatarsus: proximal is to the left of the image, arrow: new bone formation/soft tissue calcification at the amputation site with a corresponding lesion of the suspensory ligament. (b) Dorsolateromedial radiographic projection showing moderate amount of irregular new bone formation at the ostectomy site and plantarolateral on the fourth metatarsal bone.

Lescun, 2021). In the two cases in this report only the proximal part of the fractured fourth metatarsal bones was removed, making the surgical incision smaller and the procedure less invasive when compared to complete fourth metatarsal bone extirpation.

In Case 1, minimal dystrophic mineralisation was present 1 month postoperatively (Figure 4) and, in Case 2, moderate heterogeneous new bone formation impinging on the suspensory ligament was present at the site of proximal ostectomy and plantarolateral on the fourth metatarsal bone 17 months postoperatively (Figure 5). Differential diagnoses for this localised region of multifocal radiopacities evident radiographically include soft tissue calcifications or a periosteal reaction at the ostectomy site (Sherlock & Archer, 2008). In retrospect, an oscillating saw could have been used for the ostectomies to elicit a less bony reaction at the site as this has been previously reported to be superior to the use of a mallet and chisel (Wienker, 2004). In Case 2 also, osteoarthritis of the tarsometatarsal joint developed, which was considered most likely to be consequent to a degree of articular instability (Jackson et al., 2007) caused by the initial injury; the removal of some axial support by extirpation of the articular surface of the fourth metatarsal bone; and/or as a consequence of entering the joint during surgery.

These complications have been previously reported after both conservative management and a variety of surgical treatment options in severely comminuted, displaced splint bone fractures (Jackson et al., 2007), therefore, this technique is not necessarily inferior, but greater numbers are necessary to further evaluate the frequency of this complication with this technique.

Furthermore, both cases were initially managed with local wound therapy, external stabilisation, box rest and medical therapy with the aim of decreasing local swelling and infection and to improve the viability of tissues preoperatively. The decision to provide preoperative antimicrobial treatment was based on clinical assessment of the level of wound contamination, the size of the wound and surrounding swelling as well as the involvement of intra-articular structures. In our cases, systemic antimicrobial treatment was quite extensive. Based on current recommendations for treating accidental wounds in humans, preoperative antimicrobial treatment should be focused more locally, instead of a prolonged course of systemic antimicrobials (Filius & Gyssens, 2002; Howell-Jones et al., 2005; Jørgensen et al., 2021). Based on these guidelines, proximal ostectomy might be more appropriately performed at the time of initial wound debridement, avoiding the need for prolonged preoperative antimicrobial therapy.

Surgical ostectomy of the proximal portion of the splint bone facilitated by standing sedation, as in the cases reported here, provides a less invasive surgical option compared to other previously reported treatment options and appeared to minimise perioperative complications, although the frequency of postoperative complications with this technique merits ongoing evaluation.

Performing the procedure standing rather than under general anaesthesia and using a less invasive surgical approach in comparison to other surgical techniques is expected to minimise the risk of peri-operative surgical complications.

CONCLUSION

In summary, proximal segmental ostectomy using standing sedation and regional anaesthesia of open, axially displaced fractures of the proximal third of the fourth metatarsal bone is a valid treatment option, which can be performed as an alternative to open reduction and internal fixation. The procedure was well tolerated by the horses and owners were satisfied with the outcome.

AUTHOR CONTRIBUTIONS

T. Vajs performed the drafting and revising of the manuscript. E. Haltmayer provided the clinical information, made significant intellectual contributions and reviewed the manuscript. Both authors have read and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

No conflicts of interest have been declared.

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ETHICS STATEMENT

This study did not require official or institutional ethical approval. The animals were handled according to high ethical standards and national legislation and a general consent form was signed at admission.

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