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Medial Bone Plating for Management of Type V Central Tarsal Bone Fractures in Six Dogs

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Abstract

Objective The aim of this study was to report the surgical technique and outcomes of dogs with type V central tarsal bone (CTB) fractures stabilized with a bone plate applied to the medial aspect of the tarsus and metatarsus.

Study Design This study was a retrospective review of dogs with type V CTB fractures diagnosed with computed tomography and stabilized using a medial bone plate. Follow-up included clinical examination and radiography 8 to 10 weeks postoperatively and/or a long-term owner questionnaire.

Results Six dogs were identified. All fractures occurred during exercise without external trauma and all dogs had additional tarsal fractures. Five dogs returned for clinical follow-up; all had no or mild lameness and evidence of fracture healing on radiography. A suspected surgical site infection occurred in one dog and resolved with medical management. Suspected contact between the plate and medial malleolus in one dog, and loosening of a talar screw in another, were identified, though not treated. Five owners completed the questionnaire, a median of 88 months postoperatively. No further complications were reported, limb function was reportedly acceptable, and all owners were very satisfied with the surgery.

Conclusion Medial bone plate stabilization of highly comminuted CTB fractures resulted in evidence of fracture healing, and a low incidence of complications in six non-racing dogs.

Keywords
- fracture
- central tarsal bone
- tarsal
- dog
- bone plate

Introduction

Central tarsal bone fractures have been previously classified into five types[1] and are primarily recognized in racing greyhounds, although they also occur in non-racing animals.[2–4] Types I to IV comprise specific configurations of slab fractures, whereas type V is defined as a severely comminuted and displaced central tarsal bone fracture.[1] In a recent study involving central tarsal bone injuries in non-racing dogs, type V fractures were the most common configuration and were identified in 22/32 cases.[4]

While good outcomes following stabilization with one or two bone screws are reported for type I to IV fractures, the outcomes with this management strategy for type V fractures are poor.[5] Disappointing outcomes are also seen with non-surgical management and external coaptation,[5] potentially due to the loss of the medial tarsal buttress. Alternative options for type V fractures include partial tarsal arthrodesis, which has been reported recently,[4] or spanning the central tarsal bone with a bone plate. The latter has been recommended in orthopaedic texts[6,7] but, to the authors' knowledge, there is no published literature on the technique or outcomes.

The purpose of this case series was to report the surgical technique and outcomes for dogs with type V central tarsal bone fractures diagnosed with computed tomography (CT) and treated with a bone plate applied to the medial aspect of

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the tarsus and metatarsus without arthrodesis of the intertarsal or tarsometatarsal joints.

Materials and Methods

Clinical records between 2010 and 2018 from Willows Veterinary Referral Service were reviewed to identify dogs with type V central tarsal bone fractures diagnosed with CT that were stabilized using a medial bone plate. Data extracted from the records included signalment, history, clinical examination findings, CT findings, surgical technique and the results of follow-up examinations and radiography.

Computed tomographic scans were acquired under sedation or anaesthesia with a 16 slice multidetector unit (GE Brightspeed; General Electric Medical Systems, Milwaukee, WI, United States) using a 0.625mm slice collimation. Images were reviewed following multiplanar reconstruction by a board-certified radiologist and the attending board certified surgeon.

For surgery, dogs were anaesthetized using standard anaesthetic protocols overseen by board certified anaesthetists. All dogs received intravenous potentiated amoxycillin (Augmentin, GlaxoSmithKline, Brentford, UK) or cefuroxime (Zinacef; GlaxoSmithKline, Brentford, UK) at anaesthetic induction and every 90 minutes thereafter until the end of surgery. Meloxicam (Metacam; Boehringer Ingelheim, Berkshire, UK) or carprofen (Rimadyl; Zoetis, Surrey, UK) were also administered perioperatively. Limbs were clipped and aseptically prepared for surgery according to hospital protocol.

Fracture stabilization was performed following a medial approach to the tarsus.[8] In many cases, the skin incision was made on the dorsomedial aspect of the tarsus to ensure the incision was not located directly over the implants. Majorly displaced bone fragments were reduced digitally or using bone reduction forceps prior to bone plate application. In cases with a substantial dorsal slab fracture, and at the surgeon's discretion, a dorsoplantar lag screw was placed across the central tarsal bone to maintain reduction of the dorsally displaced bone fragment. The bone plate extended from the medial aspect of the neck of the talus, to the medial aspect of the proximal third to half of the second metatarsal bone, bridging the central tarsal bone and restoring tarsal alignment. The proximal metatarsal screw(s) engaged multiple metatarsal bones. In some cases, a bone screw engaged the central tarsal bone through the plate. Anatomic reconstruction of the bone fragments and debridement of the articular cartilage from the intertarsal and tarsometatarsal joints were not performed. Following lavage, routine layered closure was performed, and an adhesive, absorbent dressing was placed (Primapore; Smith & Nephew, Hertfordshire, UK). All surgeries were performed by board certified surgeons.

Postoperative radiographs were obtained to ensure appropriate alignment and implant placement, and, in 5/6 cases, a padded dressing was placed for up to 5 days to limit postoperative swelling. Dogs were discharged between 2 and 5 days postoperatively; owners were instructed to administer non-steroidal anti-inflammatory drugs in all cases and antibiotic medication at the surgeon's discretion. Owners were instructed to confine their dog to a crate or small room and restrict their exercise to short lead walks for 8 weeks. Follow-up examination and radiography were recommended 8 weeks postoperatively; exercise thereafter was dictated by clinical progress and radiographic evidence of healing. Long-term follow-up was obtained via a telephone questionnaire; owners were asked 10 questions regarding complications and functional outcome (►**Appendix A**, available in the online version).

Results

Six dogs with type V central tarsal bone fractures diagnosed with CT and stabilized using a medial bone plate were identified (►**Appendix Table 1**, available in the online version). There were five sighthounds (2 ex-racing Greyhounds, 2 Greyhound Crosses and 1 Whippet) and a Hungarian Vizsla. Median weight and age were 26 kg (range: 14.2–31.3 kg) and 58.5 months (range: 39–127 months) respectively. There were five male dogs (3 neutered) and one female neutered dog. All fractures occurred during exercise without any significant external trauma. Three left limbs and three right limbs were affected. Five dogs were non weight bearing on presentation and one dog, with a modified Robert Jones dressing in place, was mildly lame.

Computed tomographic scans revealed a comminuted fracture of the central tarsal bone in all cases with collapse of the medial aspect of the tarsus. Fractures mostly comprised several small bone fragments interposed between two or three larger bone fragments (►**Fig. 1**). When present, displacement of the major fragments was dorsal, medial or a combination of both. All dogs had concurrent fractures to the fourth tarsal bone and ►**Supplementary Fig. S1** (available in the online version) had an avulsion fracture of the fifth metatarsal, fractures of the second and third tarsal bones and a small calcaneal chip fracture. Fourth tarsal bone fractures were primarily composed of small chip fractures at the distodorsal bone margin, although small fractures at the proximoplantar aspect were also present in one dog.

Surgeries were performed between 2 and 12 days after injury. All dogs had a medial bone plate applied extending from the talus to the second metatarsal (►**Fig. 2, Appendix Table 2**, available in the online version). A locking compression plate (LCP [DePuy Synthes; Zuchwil, Switzerland]) was used in the five dogs over 20 kg (2.7 mm in 4, 2.4 mm in 1) and a 2.0/2.7 mm veterinary cuttable plate (Veterinary Instrumentation, Sheffield, UK) was used in ►**Supplementary Fig. S2** (available in the online version), a 14 kg Whippet. Median number of screw holes was 7 (range: 6–10) and median number of screws was 5.5 (range: 4–8). Only two locking screws were used, each in a separate dog; one was placed through the most proximal plate hole into the talus, and the other engaged the central tarsal bone through the plate. Three dogs had a separate dorsoplantar central tarsal bone screw to maintain reduction of a dorsal slab fragment, and three dogs had a mediolateral central tarsal bone screw placed through the plate. One of these screws was placed through the central tarsal bone and into the fourth tarsal bone. In ►**Supplementary Fig. S3** (available in the online version), no screws engaged the central tarsal bone.

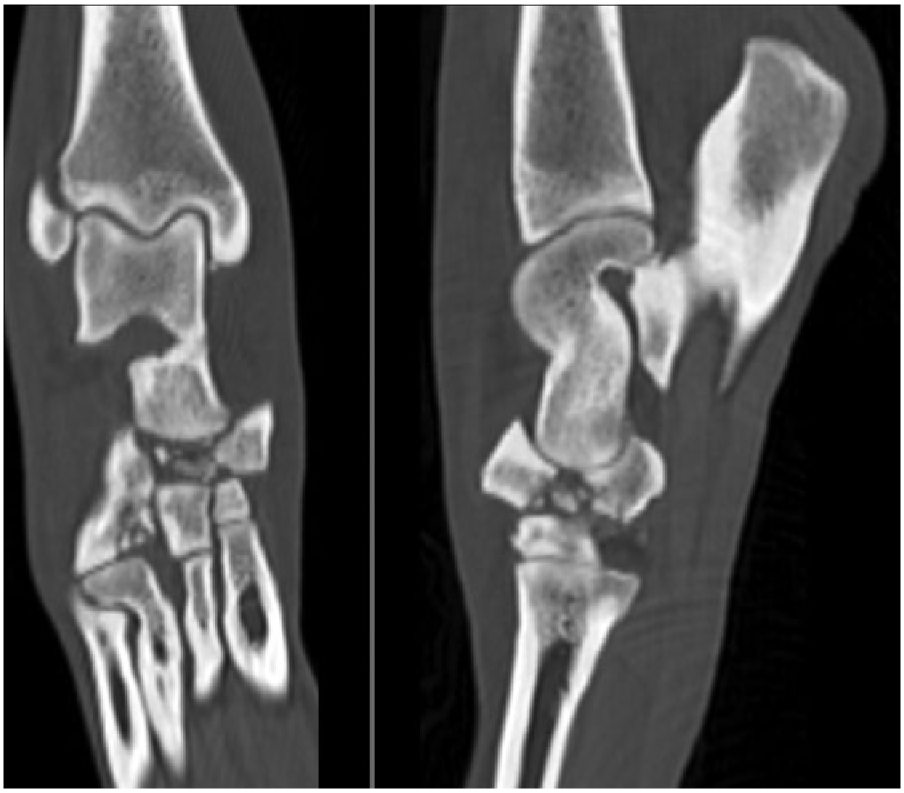

Fig. 1 Frontal (left) and parasagittal (right) computed tomographic images from Case 3, a 5-year-old Greyhound Cross, with a comminuted central tarsal bone fracture. There are two major fracture fragments, displaced medially and dorsally, with multiple smaller fragments interposed. There is collapse of the joint space with subsequent varus deformity.

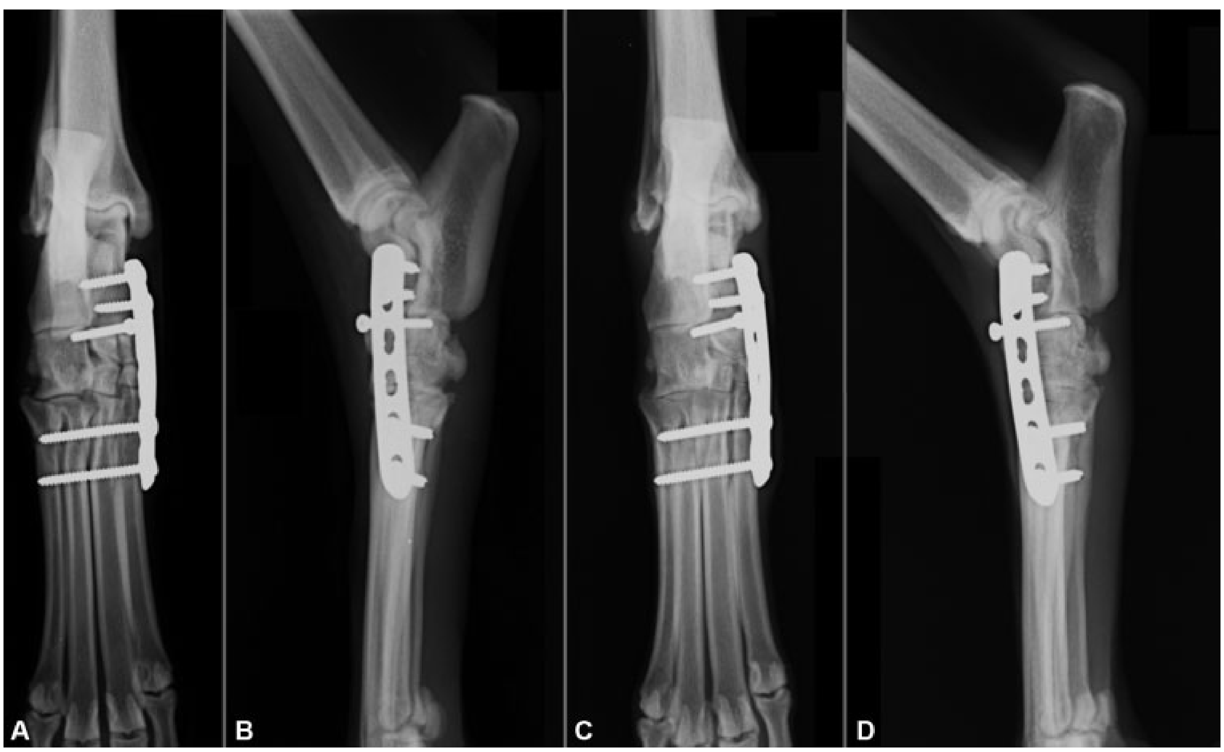

Fig. 2 Immediate postoperative (**A** and **B**) and 8-week follow-up radiographs (**C** and **D**) from Case 3, a 5-year-old Greyhound Cross, with a central tarsal bone fracture stabilized using a medial six hole, 2.7 mm locking compression plate and a 2.4 mm dorsoplantar screw. Healing of a fracture line is evident on the dorsoplantar projection and there is narrowing of the intertarsal and tarsometatarsal joints.

Five dogs had two screws in the talus and one dog had three. Between two and five screws were placed across the metatarsus. No intraoperative complications were reported, and postoperative radiographs demonstrated acceptable alignment and implant placement in all cases.

All dogs received clinical and/or long-term follow-up (►**Appendix Table 3**, available in the online version); five dogs returned for clinical assessment a median of 8 weeks postoperatively (range: 8–10 weeks). At clinical follow-up, two dogs had no lameness, two dogs had a very mild lameness and the remaining dog was not lame at walk but was intermittently lame at trot. Follow-up radiography demonstrated no change in tarsal alignment and evidence of fracture healing in all dogs. New bone bridging the centrodistal joint was identified in two dogs and narrowing of the intertarsal and/or tarsometatarsal joints was seen in 4/5. The avulsion fracture at the base of metatarsal V in ►**Supplementary Fig. S1** (available in the online version) had healed, although loosening of a talar screw was also detected. Following discussion with the owner, the loose talar screw was not removed. ►**Supplementary Fig. S3** (available in the online version) had a change in contour of the craniodistal aspect of the medial malleolus which was presumed to be related to contact with the bone plate during hyperflexion of the hock. Greater stand-off between the proximal aspect of the plate and the talus was seen in this case compared with the other dogs.

One complication that received treatment was encountered. ►**Supplementary Fig. S4** (available in the online version) presented 9 days postoperatively with acute severe lameness and pitting oedema around the surgical site. Analgesia was continued and a 6-week course of cephalexin (20 mg/kg per os twice a day) was administered. Lameness was reported to improve within 3 days of starting medical management and did not return following cessation of antibiosis. At follow-up 10 weeks postoperatively, no lameness was noted at walk, although intermittent lameness was present at trot. This dog represented at our institution for an unrelated condition 18 months postoperatively; no lameness on the operated limb was reported by the owner or detected on orthopaedic examination. The dog was euthanatized at this time due to the unrelated disease and, consequently, the owner was not contacted for long-term follow-up.

The owners of five dogs completed the questionnaire, a median of 88 months postoperatively (range: 16–95 months, ►**Appendix Table 2**, available in the online version). ►**Supplementary Fig. S2** (available in the online version) x0029; was not returned for clinical follow-up; the owner reported good limb function over the telephone 8 weeks postoperatively and completed the questionnaire 73 months after surgery. The owner of ►**Supplementary Fig. S4** (available in the online version) was not contacted for long-term follow-up as their dog was euthanatized at our institution 18 months after surgery for unrelated reasons. Of the five dogs for which the questionnaire was completed, two were deceased at the time of the questionnaire having died 8 months and 5 years after surgery, and 9 and 26 months prior to the questionnaire. Cause of death in both cases was unrelated to the fracture. No complications were reported after clinical follow-up and no dogs were reported to be stiff after exercise nor required exercise restriction or ongoing analgesia. ►**Case 3** was reported to have mild lameness in cold weather and mild stiffness after rest was reported in ►**Supplementary Fig. S5** and ►**Supplementary Fig. S4** (available in the online version). Four out of five owners judged their pets to have an excellent quality of life; ►**Supplementary Fig. S1** (available in the online version) was assigned a fair quality of life due to concurrent medical conditions. All owners were very satisfied with the surgical procedure.

Discussion

This article reports the use of a bone plate applied to the medial aspect of the tarsus and metatarsus for the management of type V central tarsal bone fractures in six non-racing dogs. Minimal lameness was seen at clinical follow-up and, in the longer term, owners reported a return to normal activity without need for ongoing analgesia.

In these cases, we spanned the central tarsal bone with a bone plate to restore the medial buttress and allow fracture healing. One text has suggested the bone plate be applied to the dorsal aspect of the tarsus with screws placed into the talus and third tarsal bone.[6] A dorsally positioned plate is theoretically well suited to resist lateromedial bending. However, bone stock for implant placement is limited by the trochlea of the talus proximally and small proximodistal size of the third tarsal bone distally. This limitation may result in the use of undersized implants and/or the use of a single bone screw on one or both sides of the fracture. We elected to apply the bone plate to the medial aspect of the tarsus to increase the available bone stock for screw placement both proximally and distally.

Locking compression plates were used in most cases, though predominantly with cortical screws. The veterinary cuttable plate has closer hole spacing than a comparably sized LCP which was felt to be beneficial in facilitating placement of two screws in the talus when used in the smallest dog in this series.

Central tarsal bone fractures are articular in nature, yet the surgical technique described here does not adhere fully to the principles of either articular fracture stabilization or arthrodesis. Anatomic reconstruction of these highly comminuted fractures was impossible and thus a bridging construct was created to provide relative stability and permit secondary bone healing. The benefit of placing screws into the central tarsal bone is unclear and it is likely that bridging the central tarsal bone with restoration of tarsal alignment would be sufficient for bone healing and return to acceptable function.

Despite the bone plate bridging the talocentral, centrodistal and tarsometatarsal joints, the articular cartilage was not debrided, and a bone graft was not used. The primary goals of surgery were osteosynthesis and restoration of the medial tarsal support not joint fusion and, as such, efforts were made to minimize disruption to the fracture site to promote bone healing.

Fracture callus bridging the centrodistal joint, as identified in this series, has previously been seen following screw stabilization of central tarsal bone fractures, with complete ankylosis reported 4 to 6 months postoperatively.[3,5] This finding has not been associated with lameness nor prevented a return to racing.[3,5] Similarly, in our patients where the centrodistal, talocentral and tarsometatarsal joints were immobilized by the bone plate, discomfort and lameness were not identified. Ankylosis is expected following immobilization of the low motion joints and is associated with good function.[3,5] Proximal metatarsal screws engaged multiple metatarsals in our cases, and it is not known whether engaging just metatarsal 2 would affect the functional outcome.

A suspected surgical site infection was the only complication that received treatment in this series, and this was resolved with medical therapy. One study has reported a major complication rate of 25% for dogs with central tarsal bone fractures or luxations managed with partial tarsal arthrodesis, and a major complication rate of 15% for dogs with type V central tarsal bone fractures treated with partial tarsal arthrodesis, screw stabilization, external skeletal fixation, external coaptation or conservative management.[4] Complications for each management strategy were not specifically reported but generally included implant failure, surgical site infection, wound dehiscence and sores secondary to external coaptation, with bandage sores reported in 9/29 cases.[4] We elected not to use external coaptation postoperatively and no implant complications requiring treatment occurred, suggesting that plate stabilization can be used without external support for the management of these fractures.

Previous reports of type V central tarsal bone fractures have shown poor outcomes following external coaptation and/or stabilization with one or two bone screws.[5] In the present report, all dogs were reported to have returned to a normal level of activity without need for ongoing analgesia, with all but one dog reported to be free from lameness. The two dogs reported to be stiff after rest were approximately 12 years old at the time of questionnaire and it was not possible to determine if this was associated with their previous tarsal injury. Alternative suggested surgical treatments include removal of the small fracture fragments followed by reconstruction with multiple lag screws, or placement of screws and washers to buttress the small bone fragment.[9] To the authors' knowledge, there is no published literature documenting these techniques or their outcomes.

All dogs in the present report were middle aged or older companion animals and as such, the owners' expectations for function will be different to those of an owner of a racing greyhound. It is unknown if application of this technique to a competition animal would result in a successful return to racing and further investigation in this area appears warranted. Furthermore, long-term follow-up was dependent on owner assessment and no objective outcome measures were recorded.

Limitations of this study primarily relate to the retrospective design, low number of cases, short duration of clinical follow-up and reliance on owner assessment rather than objective outcome measurements. Despite these limitations, medial plate stabilization was associated with acceptable outcomes for the management of comminuted central tarsal bone fractures in a small population of non-racing dogs.

Authors' Contributions
Tim Easter, Jonathan Pink and Alexis Bilmont contributed to conception of study, study design, acquisition of data and data analysis and interpretation. Bill Oxley contributed to acquisition of data and data analysis and interpretation. All authors drafted, revised and approved the submitted manuscript.

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Conflict of Interest
None declared.

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