Arthrodesis of the tarsometatarsal joint, using type II ESF with acrylic connecting bars in four dogs

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Summary
Hyperextension injury of the tarsometatarsal joint (TMTJ) is a debilitating injury and arthrodesis of this joint is often the only procedure that can result in full return to function. Most surgical procedures described for arthrodesis of the tarsometatarsal joint necessitate the use of external, splint or cast, to protect the implants used from fatigue failure. This report describes the successful use of type II external fixator that spans the tarsometatarsal joint in four dogs with hyperextension injury of the tarsometatarsal joint. This technique enables the patient to bear weight on the limb immediately after surgery until bony fusion is achieved, without the need for an additional protecting splint.

Keywords
Arthrodesis, tarsometatarsal joint, external fixator

Introduction
Hyperextension injury of TMTJ is a relatively uncommon injury (5). Most common causes include motor vehicle trauma, jumping from a great height or when the dog is caught in a mesh fence while attempting to climb on it (2–5).

Dogs are usually presented with non-weight bearing lameness, pathology consists of disruption of the plantar fibrocartilage, plantar ligaments, dorsal ligaments, and collateral ligaments. In cases associated with severe trauma the instability is so great that the metatarsus is practically suspended by soft tissue (Fig. 1).

Treatment with coaptation is almost always unsuccessful; arthrodesis of the TMTJ is the treatment of choice, and can be successful even in large dogs (2–5). Several techniques have been described for arthrodesis of the TMTJ; they include pins and tension band wire, plates, linear external fixators and circular external fixators (1–4).

This paper describes the successful application of a type II external fixator, spanning the TMTJ to treat tarsal hyperextension injury in four medium-large breed dogs. This method is mentioned in a major veterinary orthopaedic textbook (5), however, the authors are unaware of publications which describe clinical cases.

Methods and results
Data was collected from the medical records of four dogs admitted to the author’s clinic with hyperextension injury of the TMTJ between October 2001 and October 2003. They were treated by arthrodesis of the TMTJ using type II acrylic external fixators. The signalment of the animal, type of injury, concomitant injuries, size and type of transfixation pins, time to healing and removal of frame, and results were recorded (Table 1).

Arthrodesis of the TMTJ was performed in all of the cases. The cartilage was debrided from the articular surfaces of tarsal bones 2, 3 and 4 and base of metatarsal bones 2, 3, 4 and 5. Depending upon the size of the dog, at least two IMEX centerface (IMEX™ Longview TX, USA) positive threaded profile pins of diameters 7/64” (2.8 mm shank, 3.5 mm threaded) or 3/32” (2.4 mm shank, 3.2 mm threaded) were used in the construct; the larger pin was inserted transversely through the 4th tarsal bone and central tarsal bone and the other pin was placed below the TMTJ, slightly distal to the base of the metatarsal bones. A smooth pin was inserted transversely through the distal aspect of the talus and calcaneus, and another was inserted distally to the pin inserted at the base of metatarsal bones. All of the pins were pre-drilled to reduce thermal damage and avoid pin loosening. Due to the curvature of the metatarsal bones, it is often impossible to pass the pins through all of them. An attempt was made to pass through at least three metatarsal cortices. The two pins proximal to the TMTJ, were cut to their final length on both the medial and lateral sides so that they were still long enough to

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Description of cases with tarsometatarsal joint luxation, treated by type II ESF with acrylic connecting bar.

Table 1

<table>
<thead>
<tr>
<th>No</th>
<th>Signalment</th>
<th>Injury</th>
<th>Transfixation pins proximal and distal to TMJ</th>
<th>Weeks until removal of frame</th>
<th>Results and follow up</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M, 4y, 24 kg, cross breed</td>
<td>TML, trauma unknown cause</td>
<td>proximal: 3/32 positive threaded, 3/32 smooth pin distal: 3/32 positive threaded, 3/32 smooth pin</td>
<td>16 weeks</td>
<td>Excellent</td>
<td>6 months post op</td>
</tr>
<tr>
<td>2</td>
<td>M, 4y, 25 kg, cross breed</td>
<td>TML, trauma unknown cause</td>
<td>proximal: 3/32 positive threaded, 3/32 smooth pin distal: 3/32 positive threaded, 3/32 smooth pin</td>
<td>17 weeks</td>
<td>Excellent</td>
<td>6 months post op</td>
</tr>
<tr>
<td>3</td>
<td>M, 3y, 21 kg cross breed</td>
<td>TML, HBC</td>
<td>proximal: 3/32 positive threaded, 3/32 smooth pin distal: 3/32 positive threaded, 3/32 smooth pin</td>
<td>20 weeks</td>
<td>Excellent</td>
<td>6 months post op</td>
</tr>
<tr>
<td>4</td>
<td>M, 2y, 29kg, Weimerenar cross</td>
<td>TML, HBC</td>
<td>proximal: 7/64 positive threaded, 3/32 smooth pin distal: 3/32 positive threaded, 3/32 smooth pin</td>
<td>20 weeks</td>
<td>Excellent</td>
<td>6 months post op</td>
</tr>
</tbody>
</table>

M: male; ESF: external skeletal fixators; TML: tarsometatarsal luxation; HBC: hit by car.

include an acrylic connecting bar of 20 mm diameter. All of the pins were notched to increase the surface area of contact with the acrylic connecting bar.

The stainless steel clamps and connecting bars were first mounted on the most proximal and distal transcortical pins, both laterally and medially, and tightened once the tarsometatarsal joint was manually compressed, thus maintaining alignment and ensuring compression. A cancellous bone graft was packed around the tarsometatarsal joints, and the skin was closed routinely. Acrylic was mixed, and poured into plastic tubing attached to the pins while still in a liquid state. External coaptation was not used post-operatively in any of these cases. The authors were instructed to restrict exercise for a period of eight weeks, at which time radiography was repeated to evaluate the progress of bony fusion and the pin-bone interface.

Technical problems were not encountered during the procedure in cases 1, 2 and 3; in case 4 postoperative radiographs revealed less than optimal tarso-metatarsal compression, however, the bone healed uneventfully. In all of the dogs, complete bone healing, detected by radiography, was achieved at the TMTJ by 16–20 weeks post-operatively. Following removal of the external fixator all dogs returned to normal preoperative activity, and achieved excellent healing. The four cases are summarized in Table 1.

Discussion

Conservative treatment of hyperextension injury of the TMTJ by cast or splint fixation is almost always unsuccessful (5), and arthrodesis of the TMTJ is considered the best treatment option (5). Several methods for arthrodesis of TMTJ have been proposed in the literature. These include intra-medullary pins combined with a tension band wire, intra-medullary pins combined with transfixation pins placed in cross pattern (5), dorsally-applied dynamic compression plate (DCP), and hybrid DCP applied on the lateral aspect of the inter-tarsal and TMTJ (1, 2, 4). Application of a DCP on the plantar (tension side) aspect of the tarsus and metatarsus, and thus acts as a tension band enabling compression of the joint surfaces was also described (5).

The use of circular external fixators (CEF) for arthrodesis of the tarsometatarsal joint was described recently (3). Although the final outcome was successful in all three of the reported cases, the authors describe substantial morbidity throughout the convalescent period, which included wire tract discharge in all three cases, and swelling of the distal limb. In two cases osteomyelitis developed, which necessitated revision of wires in two cases, removal of bone fragments, and treatment with multiple antibiotics.

The main advantage of CEF is its adjustability and inherent ability to adjust compression at the site treated. However, it is more complex to apply and maintain on the limb, and substantially more expensive than the method described in this report. The substantial differences in morbidity between the cases reported here and those treated by CEF (3) could be due to the superior axial stiffness of linear ESF circular compared to CEF. Consequently, a firm conclusion cannot be drawn due to the small number of cases reported here.

Linear External skeletal fixation for TMTJ arthrodesis, using a type II external fixator, and either acrylic connecting bars or rod and clamp systems is described in a veterinary orthopaedic textbook (5), however,
the authors are unaware of any publication which reports its clinical application. The advantages and disadvantages of the use of acrylic connecting bars in fracture fixation with ESF are well documented in the literature and also apply to the arthrodesis of joints (5). The main advantage of a linear ESF is its superior stiffness, therefore it does not require post-operative support by external coaptation, as is required by other methods. DCP plates applied dorsally or laterally, or hybrid plates applied dorsally, are not positioned on the tension side and thus external coaptation is required in order to protect them from fatigue failure before bony healing occurs. Additionally, Linear ESF allow easy access for open wound management, and place less foreign material directly into the traumatized area. It does not require specialized equipment, especially when one is using the acrylic system. When healing has occurred, the transcortical pins can be removed easily under a short anaesthetic procedure. External fixation systems need constant monitoring of the pin entry sites, and the animal needs to be restricted so that trauma to the apparatus is avoided. Strict exercise restriction should be imposed until bony fusion is achieved, similar to the other techniques listed. Furthermore, a splint or cast, which must be applied with all the aforementioned techniques, also requires constant attention (although for a shorter period), and complications associated with external splints or casts are well documented in the literature. These complications are rare, however, their occurrence may cause disastrous consequences if left unattended for just a few days.

External skeletal fixation can be used with either an acrylic connecting bar, or with a clamp-and-rod system. The use of the clamp-and-rod system might be limited by the size of the animal, since the two proximal pins placed transversally through the calcaneus and talus or fourth tarsal and central tarsal bone or more distally through the fourth tarsal and numbered tarsal bones, might be so close to each other that they will not leave enough space for the clamps. In a

small dog, an additional limitation might be the small diameter of the metatarsal bones, since positive threaded centerface pins are only available up to a size of 5/64” (2 mm) in diameter. Excessively large pin size may lead to weakening of the metatarsal bone and predispose it to fracture.

The cases presented here were of medium to large dogs, weighing over 25 kg, so that the size of the tarsus easily enabled the insertion of the proximal pins. Centerface positive threaded pins of different sizes were used in the tarsus and metatarsus and are described in Table 1. Distance between pins in the tarsus was dictated by the size of the tarsal bones.

In all four cases bony healing was achieved (Fig. 2) using this method and the dogs returned to pre-injury activity level. All of the patients were weight bearing throughout the convalescent period, and none showed morbidity that necessitated pin or frame revision. In case number 4, a technical error led to inadequate compression of the joint. However, healing occurred nevertheless. All of the owners were satisfied with the results and function of their pet.

In conclusion, the use of this method allows the surgeon to achieve a frame-bone construct, which is rigid enough to support weight until fusion of the TMTJ is reached, without the need for external coaptation.

References


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