Short and long-term outcome following surgical stabilization of tarsocrural instability in dogs

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Canine, tarsocrural, tibiotarsal, talocrural, instability, luxation

Summary
Objectives: To evaluate the outcome and complications following surgical stabilization of canine tarsocrural luxations.

Methods: Medical records of dogs which were surgically treated for tarsocrural joint instability between February 2007 and June 2014 were reviewed. Surgical technique, complications and long-term outcome (via questionnaire and Canine Brief Pain Inventory) were assessed.

Results: Twenty-four dogs (26 joints) were included. All injuries were traumatic. All joints had associated fractures; malleolar in 21/26 limbs (13/26 medial). Eight joints had internal fracture fixation and transarticular external skeletal fixator, six had external fixator alone, four had prosthetic ligaments with external coaptation, and four had prosthetic ligaments with external coaptation. Two joints had pantarsal arthrodesis and two primary ligament repair. Complications occurred in 24/26 limbs giving 45 distinct complications; 16 were minor, 29 major, and 31 complications were external fixator associated. Prosthetic ligaments were significantly associated with major complications (p = 0.017); five out of eight required subsequent removal between 105–1006 days. Cost was significantly associated with major complications (p = 0.017) and soft tissue wounds (p = 0.03). Long-term lameness was seen in nine of 14 dogs. There was no association between pain severity (p = 0.3) and pain interference scores (p = 0.198) when comparing stabilization methods.

Clinical significance: Complications are common; however many are external fixator related. Prosthetic ligaments are significantly associated with major complications. Regardless of technique, a degree of ongoing lameness is likely.

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Introduction

The tarsocrural joint is formed by the tibia, fibula, talus and the calcaneus (1). Tarsocrural instability is an uncommon distal limb injury in dogs generally involving fractures of one or more of the bones contributing to the joint, varying degrees of ligament impairment, or a combination of both (1–5). The tarsocrural joint is particularly prone to fractures and shear injuries due to the paucity of soft tissue protection in this area (2, 6, 7). Injuries commonly occur following road traffic accidents, resulting in skin, muscle, ligament, and bone injury (1, 2, 7).

The anatomy of the tarsus is complex, often making diagnosis and management challenging (1, 3, 8, 9). Initial management of tarsocrural instability aims to limit further damage to the articular surface and supporting soft tissue structures, allowing restoration of anatomical joint alignment with stability to facilitate healing (3, 10, 11). Treatment modalities include combinations of primary ligamentous repair, prosthetic ligament reconstruction, external coaptation, transarticular external skeletal fixation, arthrodesis, and amputation (1–5, 7, 10, 12–15). Management with external coaptation alone can be inconvenient, poorly tolerated, and may result in coaptation associated soft tissue injuries (16). Some injuries of the tarsocrural joint are too extensive to be successfully reconstructed, leading to arthrodesis in order to maintain limb function (1, 2). Arthrodesis with a plate or external fixator may also be used as a salvage procedure if other methods of stabilization have failed (1, 2, 7).

To date, no studies compare treatment outcomes following surgical stabilization of tarsocrural joint instability in dogs. The purpose of this study was to retrospectively evaluate the outcome and complications following surgical stabilization of canine tarsocrural luxation/subluxations. In addition, the study aimed to evaluate differences in functional outcome as assessed by owner questionnaire.

Material and methods

Medical records of dogs with tarsocrural joint instability treated surgically between February 2007 and June 2014 were re-
viewed. Tarsocrural instability was defined as palpable instability at that joint level, then confirmed as loss of articulation between the talus and the tibial cochlea on survey or stressed radiographs (Figure 1). The following information was gathered for each patient: signalment, injury, cause of injury, concurrent fractures, presence of soft tissue wounds, duration of hospitalization, number of follow-up examination visits, complications, cost of treatment, and stabilization method.

The luxations and fractures were stabilized with internal fixation when appropriate. Primary collateral ligament repair was attempted if possible when instability was attributable to ligament damage. Complications were categorized as minor or major. Minor were defined as those not requiring additional surgical treatment. Major were those requiring further surgical treatment. Soft tissue wounds were divided into minor or major. Minor included superficial abrasions and puncture wounds. Major included all wounds other than superficial abrasions and puncture wounds.

Final outcome of each dog was assessed by owner questionnaire consisting of two sections: section one assessed owner satisfaction, ongoing medication and long-term complications. In section two, owners assessed long-term function and pain using a validated client questionnaire; the Canine Brief Pain Inventory (CBPI) (17, 18). The CBPI assesses owner perception of pain severity and pain interference. The pain severity questions were scored on a scale of 0 (no pain) to 10 (extreme pain). The pain interference questions i.e. how much pain interfered with the dog’s normal function, were scored on a scale of 0 (completely interferes) to 10 (no interference). The responses to these questions were averaged to generate the pain severity and pain interference scores (17, 18).

Commercially available statistical software programmes\textsuperscript{a,b} were used to perform all statistical analyses. Data were assessed for normality using the Shapiro-Wilk test. Associations between the presence of wounds, major complications, minor complications, fractures, non-tarsal injuries, soft tissue injuries, presence of an external skeletal fixator, and the final cost of treatment were assessed using the Mann-Whitney U test. The same associations were assessed in relation to hospitalization time. Fisher’s exact test was used to determine associations between the stabilization type and presence of complications. The Kruskal-Wallis test was used to compare pain severity and pain interference scores between treatment groups. Treatment groups were allocated as shown in Table 1. Pain interference and severity score association with talar fractures and wounds was as-

\begin{table}
\begin{tabular}{|c|c|c|c|}
\hline
Fixation group & Number of CBPI completed & Median pain severity score & Median pain-interference score \\
\hline
Plate pantarsal arthrodesis & 2 & 4.85 & 3.00 \\
TESF alone & 3 & 2.3 & 3.00 \\
Prosthetic ligament placement & 4 & 2.00 & 4.15 \\
Internal fracture fixation with TESF & 4 & 2.0 & 1.7 \\
Primary ligament repair with TESF & 0 & X & X \\
Primary ligament repair with internal fracture fixation & 1 & 0.00 & 0.00 \\
\hline
\end{tabular}
\end{table}

\textsuperscript{a} IBM SPSS Statistics for Windows, Version 21.0: IBM Corp, Armonk, NY, USA
\textsuperscript{b} GraphPad Prism version 6.00 for Windows: GraphPad Software, San Diego California USA

\[ TESF = \text{transarticular external skeletal fixator}, \text{CBPI} = \text{Canine Brief Pain Inventory}, X = \text{No CBPI questionnaires completed.} \]
sessed with the Mann-Whitney U test. Association of weight and complication development was assessed using t-test. A p <0.05 was considered significant.

Results

Twenty-four dogs with surgically managed tarsocrural joint instability met the inclusion criteria. Age on presentation ranged from 10 months to 10 years 10 months (median: 4 years 11 months), and weight ranged from 10 kg to 43 kg (mean: 27 kg). Breed and sex distribution are outlined in Appendix 1 (Available online at www.vcot-online.com).

All recorded injuries were traumatic in origin; 13/24 dogs sustaining a road traffic accident, four out of 24 developed an injury whilst running and three out of 24 fell from a height. The remaining known causes included being trodden on and limb entrapment. Suspected trauma was reported in one dog and in another the cause of the injury was unknown. Concurrent non-tarsal injuries were present in nine of 24 dogs, including superficial soft tissue wounds, tibial fracture, femoral fracture, metatarsal fractures, coxofemoral luxation, partial lung collapse, stifle laceration, pneumothorax and stifle shear injury.

Two dogs had bilateral instability following road traffic accident, giving 26 joints stabilized (15/26 left, 11/26 right). Of the 26 tarsocrural joints, instability was medial in 15/26, lateral in five of 26, and bilateral in six of 26. All dogs had fractures associated with the tarsocrural joint, typically malleolar fractures in 21/26 limbs; 13 medial, and eight lateral malleolar fractures. The remaining five joints had talar fractures. Tarsal soft tissue wounds were present in 12/26 limbs of which eight out of 26 were shear injuries.

Eight joints had internal fracture fixation and a transarticular external skeletal fixator, six had a transarticular fixator alone, four had prosthetic ligaments with a transarticular fixator (Figure 2), and four had prosthetic ligaments with external coaptation. Two tarsocrural joints were stabilized by plated pantarsal arthrodesis. Two had primary ligament suture repair, one with a transarticular fixator, the other with malleolar Kirschner wire and tension band repair followed by coaptation. Total hospitalization time ranged from four to 33 days (median 10 days). Fixators were applied in 19/26 limbs, and placement duration ranged from 17–96 days (median 47 days).

Complications

Complications occurred in 24/26 joints, with some joints having multiple complications, giving a total of 45 distinct complications (Appendix 1: available online at www.vcot-online.com). Of these distinct complications 16 were minor and 29 major including pin breakage, implant failure, sequestrum formation, implant migration, implant infection, and septic arthritis. All 19 joints with a fixator placed developed a complication directly attributable to the fixator, accounting for 31/45 complications (9/31 minor, 22/31 major). Fixator-associated complications included pin tract infection in 11/19 joints, pin failure and loosening in 14/19, and one dog formed a sequestrum at the tibial pin insertion leading to euthanasia. Non-fixator attributable complications occurred in 10/26 joints and half of these were minor complications related to casting or bandaging (Appendix 1: Available online at www.vcot-online.com). Following exclusion of complications directly attributable to the fixator; there was no significant association between the use of plated pantarsal arthrodesis (p = 0.63) or internal fracture fixation with development of (non-fixator-associated) complications (p = 0.31). Placement of a transarticular fixator was not a significant risk factor for the development of complications (p = 0.12) not related to the fixator itself. There was no significant association between shear injury and development of complications. Interestingly, the use of a transarticular fixator alone was protective against developing all other complications which were not fixator-associated (p = 0.035).

Figure 2  A) Postoperative dorsoplantar and B) mediolateral radiographs of the tarsocrural joint of dog 18 showing placement of three 2.7 mm screws with washers and fiberwire as prosthetic ligaments medially. A distal fibula fracture was stabilized with a 1.2 mm Kirschner wire and a 1 mm figure-of-eight tension band. A modified type II external skeletal fixator was placed to immobilize the joint.
Eight limbs were stabilized with prosthetic ligaments; six using multifilament fiberwire and two with monofilament nylon-leader-line. The two joints stabilized using nylon and three of the six joints stabilized using fiberwire developed major long-term complications due to infection and required implant removal. Four of five infected prostheses also developed clinical joint instability, which was absent prior to implant infection. Owners reported swelling or sinus tract formation from 105–1006 days postoperatively (median: 156 days) (Figure 3). Placement of prosthetic ligaments was significantly associated with postoperative complications (p = 0.017) compared to limbs which had no prosthetic ligaments placed when fixator-associated complications were excluded. Two dogs, (numbers 1 and 19) required revision surgery following implant removal after prosthetic ligament infection. Both dogs had prosthetic ligament removal and subsequent stabilization with a transarticular external skeletal fixator in dog 1 and plated pantarsal arthrodesis in dog 19 (Figure 3). The two dogs (numbers 7 and 10) with no complications were stabilized by both fiberwire prosthetic ligaments combined with postoperative coaptation and plated pantarsal arthrodesis respectively. Total cost of referral treatment was significantly increased if major complications occurred (p = 0.017), or tarsal soft tissue wounds were present (p = 0.03). No significant association was seen between cost of treatment and development of minor complications, the presence of non-tarsal soft tissue injuries, fixator placement or the presence of non-tarsal fractures. Similarly the development of major or minor complications and soft tissue injuries had no significant association with hospitalization time. Patient weight was not associated with development of minor (p = 0.86), major (p = 0.27), or non-fixator related complications (p = 0.73).

**Owner questionnaire**

Fifteen of 24 owners provided questionnaire responses at a median postoperative time of 54 months (range: 7–94 months) (Appendix 2: Available online at www.vcot-online.com). Six dogs were lost to long-term follow-up and four were deceased at the time of data collection. Of the deceased dogs, one owner responded. Owners rated the success of surgery as excellent in eight of 15 dogs, good in three of 15, satisfactory in one of 15, and poor in three of 14. Owner impression of their dogs overall quality of life and satisfaction with their dogs treatment is shown in Appendix 2 (Available online at www.vcot-online.com). Ongoing lameness or stiffness was noted in nine of 14 dogs with seven of these dogs being treated with long-term non-steroidal anti-inflammatory drugs. Activity levels following surgery were reported as very active in three of 15 dogs, active in six of 15, average in four of 15, and inactive two of 15 (Appendix 2).

**Canine Brief Pain Inventory** Mean postoperative pain severity scores and pain interference scores are shown for all patients with available CBPI in Appendix 2 (Available online at www.vcot-online.com). No significant association between pain severity (p = 0.3) or pain interference score (p = 0.198) were identified when comparing surgical stabilization techniques. No significant association between pain severity (p = 0.164) or pain interference (p = 0.77) score was identified when comparing dogs with and without talar fractures. Similarly, no association was seen when comparing dogs with and without major wounds, (p = 0.494) and (p = 0.29) respectively.

**Discussion**

Canine tarsocrural instability leads to severe loss of limb function. All our patients were managed surgically, whereas in hu-
mans the question of surgery versus conserva
tive treatment for ankle fractures re
mains controversial and is influenced by 
the specific injury combination (19, 20). 
The difference in approach between 
human and veterinary patients may in part 
lie in the plantigrade nature of the human 
pes with its inherent mediolateral stability, 
whereas the canine digitigrade stance con
tinually loads the tarsocrural support 
structures in the stance phase. Human pa
tients are also more amenable to resting for 
extended periods. There are several surgi
cal stabilization techniques available, how
ever assessment of long-term outcome and 
surgical complication rate were not pre
viously available in dogs. Whether human 
or veterinary, treatment aims are to re
establish anatomical reduction of the talus 
in the ankle mortise and maintain joint sta
bility (19). Generally, results following re
duction of human ankle fractures appear to 
be good, although post-traumatic arthritis 
has been described in 10% of patients des	pite anatomical reduction (21). This study 
showed that there is generally a reasonable 
outcome following a variety of surgical tech
iques in canine patients; however a degree of permanent lameness is expected 
regardless of fixation type, and minor com
plications are very common.

In this study, several surgical methods of 
stabilization were used; however all in
cluded tarsocrural joint reduction with im
mobilization. Many had reduction and im
mobilization alone using a transarticular 
elemental fixator. Fixator application 
alone is well documented in canine shear 
juries, in one study, six out of seven ca
nine distal limb shear injuries were stabil
ized with a transarticular fixator (7). The 
aim of joint stabilization is to provide suf
cient support until the periarticular tissues 
including the ligaments and joint capsule, 
can heal and fibrose sufficiently to provide 
stability. We found that clinical results from 
transarticular fixator stabilization alone 
were similar to ligament repair or pros
thetic ligament placement in addition to 
temporary immobilization. A small 
number went straight to salvage with pan
tarsal arthrodesis, which has previously 
been advocated for salvage of severe tarsal 
juries in both dogs and cats (5, 22). Inter
estingly, regardless of the method chosen,
long-term outcome was similar, with a large portion of dogs suffering postoper
ative complications and long-term lame
ness. Transarticular external skeletal fixators are a well-documented joint immobiliza
tion technique (2, 7, 10, 11, 13, 23, 24). We 
found that fixators were used extensively in 
these injuries as either a sole-fixation de
vice or as adjunct immobilization to pro
tect a primary repair. The fixator compli
cation rate was 19/19 in the present study 
with pin tract infection in 11/19 and im
plant failure in 14/19 limbs. Previous trans
articular fixator studies reported variable 
rates of complications ranging from 14% to 
71% (7, 10). The current study findings in
dicate a higher overall chance of compli
cations; however this could relate to re
cording differences, or perhaps this loca
tion is particularly vulnerable due to the 
high loads placed upon a joint-spanning 
frame. The alternative method of immobili
zation was coaptation, which can save on 
ina-rotate surgical time and hence cost, al	though continued dressing changes with 
coaptation should be considered (23). 
Following exclusion of fixator-associated 
complications when comparing fixation 
groups in the six dogs that had fixator 
placement as their only stabilization, there 
was a significant reduction in non-fixator-
associated complications. This probably re
flects the fact that 50% of non-fixator com
plications were coaptation related. Overall, 
the immobilization method appears to af
fect the complications seen. We suggest 
that fixators may still be preferable as al
though the complication rate was high, 
they are generally manageable and self-
limited following frame removal, and al
though in our small coaptation group no 
major complications developed, it has been 
previously documented that coaptation has a 
63% risk of causing soft tissue injuries 
(16). The ultimate choice of immobiliza
tion however should be based on clinical 
experience on an individual patient basis.

Some dogs had prosthetic ligament 
placement in addition to tarsocrural reduc
tion and immobilization. Prosthetic liga
ments have been described for medial and 
lateral collateral ligament replacement in 
dogs and cats, and they can be an effective 
way of maintaining range of motion while 
providing stabilization (3, 12, 15, 25). Use 
of prosthetic ligaments however was sig
ificantly associated with severe long-term 
complications, occurring up to two and a 
half years following placement. Previous 
studies have shown the high potential for 
complications with up to 50% infection 
rate with braided material and their use has 
been advised with caution (2, 13). In the 
current study, monofilament prostheses 
also required removal due to infection. Im
portantly, increasing antimicrobial resis	ance in small animals in conjunction with 
the increased cost of treatment associated 
with surgical site infections makes pros	hetic ligament use questionable given the 
high rate of infection and comparable cli
cal outcome when they are not used (26, 
27). Therefore, given the increased risk of 
complications with prosthetic ligaments, 
the authors would suggest using them with 
extreme caution, and warn owners of the 
potential for late complications developing. 
Four of five dogs that developed implant 
infection also developed clinical joint insta
bility, which was not present prior to infec
tion and may indicate that prosthesis use 
reduces long-term periartricular fibrosis de
velopment, or infection development can 
subsequently reduce soft tissue stability. 
Overall, the emphasis should be on strict 
aseptic technique if prosthetic ligaments 
are used.

Primary repair of ruptured collateral 
ligaments is also possible and can result in 
 excellent outcomes. There were no compli
cations directly attributable to ligament re
pair, and again, the clinical outcome was 
not hindered by their usage. Therefore, if 
the injuries present allow, attempting direct 
ligament suture repair remains an option, 
although a monofilament absorbable su	ure is recommended. This repair would 
duly need to be protected by either a fixator 
or coaptation. Plated pantarsal arthrodesis 
was performed in two dogs as the primary 
treatment and in another following initial 
stabilization failure. Previous studies docu
menting outcome following pantarsal ar	throdesis in 40 dogs showed an overall com
plication rate of 75% with a major compli
cation rate of 32.5%. A high proportion of 
these were soft tissue related, including 
catastrophic plantar necrosis associated 
with injury to the dorsal pedal or perforat-
ing metatarsal arteries. A minor complication rate of 42.5% was shown, frequently caused by prolonged external coaptation (4). In the current study, owner questionnaire results are only available for two dogs following plate pantarsal arthrodesis and one dog following primary ligament repair, thus making group size too small to infer substantial conclusions.

Long-term owner questionnaire results showed that nine of 15 dogs were active to very active following surgery with 11/15 owners rating surgical success as good to excellent. Owner satisfaction with treatment was similarly high compared to those reported previously for both tarsocrural instability and shearing injuries (2, 7, 11, 28). Overall owner satisfaction with surgery was high regardless of surgical stabilization type and in spite of the high complication rate. Nonetheless, nine of 15 dogs were reported as having long-term lameness or stiffness by their owners with half receiving long-term non-steroidal anti-inflammatory drugs. This discrepancy could reflect owner counselling at the outset of treatment as to the severity of the injury sustained and the possibility of complications. The alternative to stabilization in many of these cases would be arthrodesis or amputation, and whilst many dogs showed signs of ongoing lameness post stabilization, this may be felt to be a relatively good outcome compared with the alternatives. In other studies, osteoarthritis was documented in 81% of canine joints evaluated following tarsal shear injury, with 23.5% of canine patients suffering long-term lameness (2). Additionally, periarticular fibrosis and post-traumatic osteoarthritis are likely to be a cause of ongoing lameness.

Five dogs with prosthetic ligaments required implant removal; however only two of these owners completed the questionnaire. Overall success of surgery was rated as excellent following revision surgery in one dog which had a subsequent pantarsal arthrodesis using a transarticular fixator. The other dog had its prosthetic ligament removed and plated pantarsal arthrodesis performed, but further long-term implant associated infection was ongoing at the time of data collection (Figure 2) and surgical success was rated as poor (19). Overall, there is an indication that the long-term outcome following implant infection may be guarded, and while dogs can recover, the risk of ongoing infection should be considered prior to choosing any revision stabilization method. Only dog 15 had a long-term pain and severity score of zero. This excellent outcome could be attributable to the nature of the injury sustained and does indicate that full return to function can be achieved.

Inherent limitations of this study include its retrospective nature, use of owner questionnaire and lack of objective gait analysis. Multiple surgeons contributed cases over the study period, which inevitably creates variation in case management and record-keeping. A variety of injury combinations were seen resulting in tarsocrural injury, however due to the small numbers, further stratification was not possible. Multivariate analyses were not performed due to the small number of dogs in the study, and any benefit with regard to surgical technique requires further prospective studies, including objective force plate analysis with increased case numbers. Owing to our small sample sizes, our statistical analyses were inherently at risk of type two statistical error.

Our study findings confirmed that tarsocrural fractures and luxations are complex injuries to manage. Temporary joint immobilization is essential, and can be successfully used alone or in combination with direct ligament repair or internal fixation of fractures or both as appropriate. Transarticular external skeletal fixators remain the authors’ preferred method of immobilization, however fixator complications are guaranteed. Placement of prosthetic ligaments is significantly associated with infection-related complications that typically require further surgery to extract the prosthesis, and these problems can occur over a protracted time frame. The authors therefore would counsel against using prosthetic ligaments as part of the surgical management. Whatever the method of fixation, owner satisfaction appears high, the clinical outcome is reasonable, but a degree of ongoing lameness appears likely. We suggest that owner education is paramount, as expectations for full return to normal function must be managed due to the low proportion of dogs returned to pre-injury status. Given the large case variability, ultimate choice of stabilization must be made on a patient by patient basis with consideration to our findings.

Conflict of interest
The authors have no conflicts of interest for this paper to declare.

References