Repair of chronic rupture of the insertion of the gastrocnemius tendon in the dog using a polyethylene terephthalate implant

Early clinical experience and outcome

M. A. Morton[1]; D. G. Thomson[1]; R. M. Rayward[1,2]; M. Jiménez-Peláez[1]; R. G. Whitelock[1]

[1]Davies Veterinary Specialists, Manor Farm Business Park, Higham Gobion, Hertfordshire, UK; [2]Current address: Coast Veterinary Referrals Ltd, Eastbourne, East Sussex, UK

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Summary
Objectives: Chronic degeneration of the gastrocnemius tendon results in scar tissue formation at the insertion of the tendon, and detachment from the calcaneus. In severe cases, excision of this tissue makes repositioning of the tendon to the calcaneus extremely difficult. A polyethylene terephthalate implant, used to aide repair by bridging gaps and allowing tissue ingrowth, was evaluated.
Methods: In this retrospective study, clinical records were evaluated to assess long-term outcomes and complications. The surgical technique is also described. The implant was sutured proximally into the gastrocnemius at the myotendinous junction, and secured into the calcaneus using an interference screw.
Results: The implant was used in 10 patients; of which seven returned to full function. Major complications, due to infection, were identified in two of the 10 patients. Minor complications occurred in five of the 10 patients. These were associated with external coaptation in three of the patients in the immediate postoperative period. One minor infection was reported. These all resolved without further complication. Long-term outcome was available in eight patients, with six of these eight dogs returning to normal exercise.
Clinical significance: This implant may be suitable for use in canine patients with severe gastrocnemius tendon degeneration. Ongoing evaluation is warranted.

Correspondence to:
Mark Morton Davies Veterinary Specialists
Manor Farm Business Park
Higham Road
Higham Gobion, Hertfordshire, SG5 3HR
United Kingdom
E-mail: mam@vetspecialists.co.uk

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Introduction

Chronic degeneration of the gastrocnemius tendon (type 2c lesion) is a well-recognized cause of lameness in large breed dogs (1, 2). Degeneration leads to scar tissue formation at the insertion of the gastrocnemius tendon. Elongation in the common calcaneal tendon mechanism results in a plantigrade stance and lameness. The superficial digital flexor tendon is not affected, but increased tension in the tendon causes hyperflexion of the digits, resulting in the characteristic 'claw' foot appearance.

Current repair techniques involve excision of fibrous scar tissue and reattachment of the gastrocnemius tendon to the calcaneus with or without augmentation (3, 6–19). A modified three-loop pulley suture pattern was found to be superior to a locking loop technique for reattaching canine tendon to bone (3). However a modified three-loop pulley using barbed polypropylene showed no benefit (4). Gap formation of greater than three millimetres significantly impairs canine tendon strength (5). Augmentation of repairs with a polypropylene mesh has been investigated, though gap formation still occurred (6). Other methods of augmentation include the use of semitendinosus muscle, small intestinal submucosa, fascia lata, peroneus brevis and longus tendons and bone plates (7–12).

To protect any repair, external coaptation is advocated, including the use of casts and splinted dressings, calcaneo-tibial screw and transarticular external fixation (3, 13–18). No significant difference in outcomes between transarticular external fixation, splints and casts following surgical repair of Achilles tendon ruptures has been found (19). Lister and others reported that immobilisation of the tarsal joint at a normal standing angle did not reduce strain in the common calcaneal tendon, though typically the joint is immobilised in extension (20).

The most commonly reported complications following repair of the common calcaneal tendon in dogs are associated with external coaptation, and gap

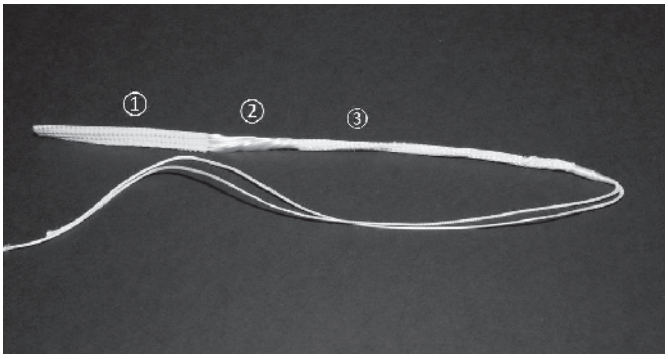

Figure 1 Image of the Canine CAT30 gastrocnemius implant (STIF, Chenove, France). The implant is comprised of the following three sections: (1) a flat proximal portion, (2) a central section containing open fibres, and (3) a cylindrical distal section. The string attached to the distal segment assists in placement of the implant in open ended tunnels, though it was not used in this technique. (Image courtesy of VetLig UK.)

formation, which will result in reduced long-term strength or ultimately failure of repair and recurrence (2, 5, 19). Experimentally, following sutured repair, gap formation occurs at loads that are significantly lower than normal weight bearing loads (3, 6).

Return to function relies on excision of all scar tissue from the gastrocnemius tendon to allow restoration of functional length. In many chronic cases, complete excision makes re-apposition of the tendon to the calcaneus difficult, if not impossible, due to contracture of the gastrocnemius muscle and the large gap that remains. If scar tissue is left *in situ* and sutured to the calcaneus, or if there is excessive tension on the repair, then gap formation or failure is much more likely.

In order to overcome the problems associated with gap formation and failure of repair, as well as potentially reducing the need for external coaptation, the use of a novel polyethylene terephthalate implant[a] was trialled. Biomechanical testing of this implant in canine cadavers found the strength of this repair to exceed that of suture alone and to be potentially suitable for canine patients (21). The human implant from which this canine implant was developed, has been successfully used to repair Achilles tendon injuries in human patients, significantly reducing the time to recovery when compared to conservative and other surgical management (22). It allows restoration of functional length despite the presence of a gap, and thereby counters the risk of gap formation. This retrospective study describes the surgical technique for implantation of this polyethylene terephthalate implant and our initial clinical experience and long-term outcomes.

Materials and methods

The clinical records of all patients with chronic rupture of the gastrocnemius tendon, treated at Davies Veterinary Specialists between 2009–2013 were reviewed to identify cases that had been treated with the polyethylene terephthalate implant. The implant was used in cases in which chronic degeneration had led to severe contracture of the gastrocnemius tendon and marked hyperflexion of the hock. In these cases, excision of all the scar tissue would not have allowed re-apposition of the tendon to the calcaneus. In order to be included in the study, all cases needed to have been re-examined, clinically and radiographically at least at six weeks following surgery, with additional clinical examinations or telephone conversations performed with clients as required. Long-term follow-up was also mandatory, at the least via telephone conversations with clients.

The implant used was based on a human implant[b] that was modified for canine patients. The implant was comprised of three sections: a flat proximal portion designed to be sutured at the myotendinous junction of the gastrocnemius; the central section containing open fibres, which can be placed at the tendon defect bridging gaps and allowing tissue ingrowth; and the cylindrical distal section, which is secured into the calcaneus using an interference screw (▶Figure 1)(23).

All patients were presented with a similar history; a variable period of pelvic limb lameness, a plantigrade stance in the affected limb, painful thickening at the insertion of the gastrocnemius tendon, and hyperflexion of the digits in the affected limb.

Perioperative care

All patients were premedicated with acetylpromazine[c] (0.02 mg/kg) and methadone[d] (0.3 mg/kg). Anaesthesia was induced with propofol and maintained with isoflurane in oxygen. Carprofen[e] [4 mg/kg] or meloxicam[f] [0.2 mg/kg]) were administered preoperatively. Intravenous amoxicillin with clavulanic acid[g] (20 mg/kg) or cefuroxime[h] (22 mg/kg) was also administered preoperatively and continued every 90 minutes during surgery. Postoperatively, methadone (0.3 mg/kg) was continued every four to six hours as required following pain assessment. The administration of non-steroidal anti-inflammatory drugs continued for two weeks and amoxicillin with clavulanic acid or cephalexin for seven to 10 days was prescribed for all patients.

Radiographic evaluation

Preoperative radiographs of both hindlimbs were obtained. Lateral and caudocranial radiographic views were collimated to include the tibia and tarsus. Similar postoperative radiography was performed to assess screw position (▶Figure 2).

a CAT30: STIF (Soft Tissue Internal Fixation), Chenove, France

b LARS (Ligament Augmentation & Reconstruction System), Arc sur Tille, France
c ACP: Novartis, Frimley, Camberly, Surrey, UK
d Physeptone: Martindale Pharma, Romford, Essex, UK
e Rimadyl: Zoetis, London, UK
f Metacam: Boehringer Ingelhein, Bracknell, UK
g Augmentin: GlaxoSmithKline, Brentford, Middlesex, UK
h Zinacef: GlaxoSmithKline, Brentford, Middlesex, UK

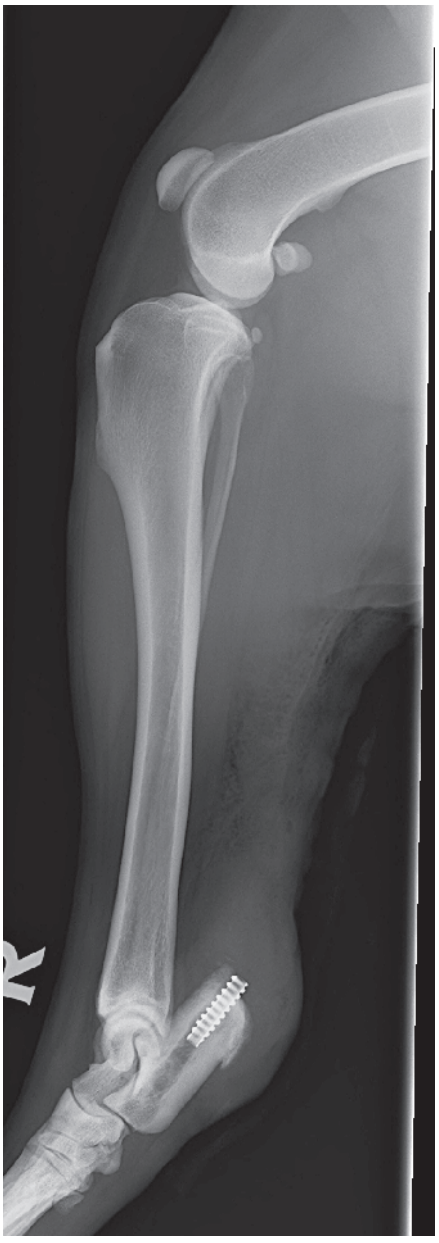

Figure 2 Medio-lateral postoperative radiograph. The interference screw is visible in the calcaneus.

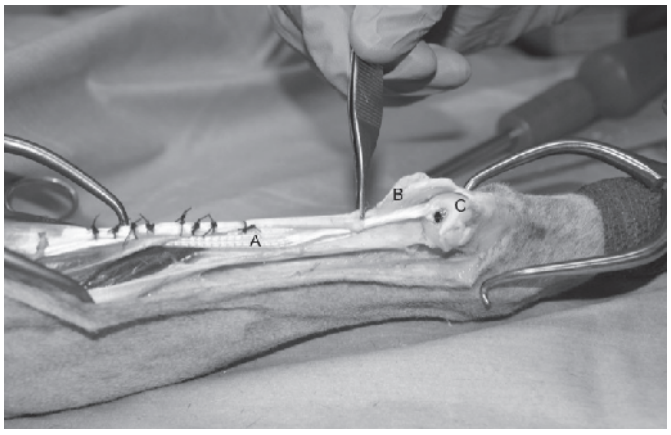

Figure 3 Implant shown in a cadaver specimen. A portion of the gastrocnemius has been removed to simulate excision of scar tissue. The forceps hold the 'healthy' portion of tendon, which cannot be apposed to the calcaneus. **A:** Indicates the proximal portion of the implant suture in place. Sutures begin at the myotendinous junction and extend to attach the proximal portion of the tendon. **B:** Marks the central section of open fibres bridging the simulated defect. **C:** Shows the interference screw securing the distal cylindrical portion of the tendon into the calcaneus.

Surgical technique

All patients were positioned for the surgery in sternal recumbency with the affected limb extended caudally and an adhesive iodine drape[i] was applied. A caudo-lateral incision was made extending distally from the gastrocnemius muscle to the lateral aspect of the calcaneus. The paratenon was incised. The presence of chronic scar tissue distally made it difficult to differentiate between the insertions of the gastrocnemius tendon and the combined tendon of the gracilis, biceps femoris, and semitendinosus. The lateral retinaculum of the superficial digital flexor tendon was then incised and the tendon luxated medially. At the calcaneus, the tendinous insertions were often incorporated within a mass of fibrous scar tissue. The abnormal tissue was excised to the level of normal tendon proximally. The bridging capacity of the implant allowed all abnormal tissue to be excised, even if this made apposition of the gastrocnemius tendon and the calcaneus impossible. The proximal section of the implant was positioned so that the free fibres were in the region of tendon deficit; no free fibres of the implant were allowed to enter the calcaneal tunnel to ensure adequate fixation. The flat portion of the implant was placed at the level of the myotendinous junction, sandwiched between the medial and lateral bellies of the gastrocnemius muscle and secured with eight, simple interrupted sutures of 3.5 metric polydioxanone[j]. The flat portion of the implant was cut shorter to aid positioning if required.

A 4.5 mm blind ending tunnel was drilled into the calcaneus beginning at the calcaneal tuber, entering the medullary cavity. The bone tunnel was made at least 30 mm deep to allow room for the implant and interference screw. The implant was tensioned and the distal end of the implant inserted into the tunnel. Flexing the stifle facilitated implant placement. In chronic cases, additional postoperative relaxation of the gastrocnemius muscle resulted in a slight increase in the functional length; this was considered when evaluating implant positioning. A hexagonal Kirschner wire[k] (2.5 mm diameter x 150 mm length) was then used to hold the implant in the tunnel, under tension, before it was secured in place with an interference screw[k] (5 mm diameter x 20 mm length). The screw was slid down the hexagonal Kirschner wire and inserted using the female screwdriver. The cannulation of the screw corresponded to the Kirschner wire. The screw was placed plantar or lateral to the implant (▶Figure 3).

Tension in the gastrocnemius mechanism was then evaluated. If inadequate tension was identified, the implant was repositioned proximally, (with the aid of stifle flexion), rather than by removing the screw. One or two positional sutures were

i Ioban: 3M, Bracknel, UK

j PDS II: Ethicon, Livingston, Scotland, UK

k STIF (Soft Tissue Internal Fixation), Chenove, France

placed between the remaining free end of the gastrocnemius and the calcaneus using 3.5 metric polydioxanone. This was to aid closure rather than provide strength. The paratenon, soft tissues and skin were then closed routinely.

A padded dressing incorporating a cranial splint[l] was applied in all cases. The dressing was replaced with a full fibreglass cast[m] after three to four days, which then remained in place for six weeks. The talocrural joint was fixed in extension in all cases. The cast was sculpted to minimise soft-tissue contact proximally. Postoperatively, strict rest, with only short lead walks, was permitted. The owners were advised to check the cast twice daily, and weekly assessments by the primary care veterinary surgeon were advised. Regular postoperative telephone reports were received from owners. All patients were re-evaluated (clinically and radiographically) at six weeks postoperatively when the cast was removed. All owners were contacted by telephone for long-term follow-up after at least twelve months for the purposes of this study. Previously defined criteria were used to assess outcomes and complications (24).

Results

Ten dogs satisfied the inclusion criteria. Follow-up was available for all dogs that had surgery using the implant during the time period of the study. The mean age of the patients was seven years (range: 2.0–11.0). Equal numbers of left and right pelvic limbs (n = 5) were affected. The mean body weight was 34.87 kg (range: 27.40 – 44.80 kg). Labrador (n = 5) and Dobermann (n = 4) breed dogs were most commonly affected, along with a cross-breed (n = 1). The surgical procedures were performed by several surgeons (MAM, DGT, RMR, MJP, RGW). Mean surgical time was 113 minutes (range: 90 –135 minutes).

Minor intra-operative complications were reported in three patients. In one case the hexagonal Kirschner wire twisted, then fatigued to failure, inside the interference screw during insertion. The screw could not be fully inserted as the Kirschner wire could not be removed. The screw was left protruding by only a small amount so revision was deemed unnecessary. In the other two cases, a small fissure was noted in the plantar aspect of the calcaneus following screw insertion. A 2 mm positional screw was placed from lateral to medial across the plantar aspect of the calcaneus to prevent propagation to a complete fracture. No further problems were identified.

Perioperative complications were reported in four cases. Minor complications associated with external coaptation were reported in three of the 10 cases. All of the complications resolved quickly following cast removal and replacement with a splinted dressing, which was changed on a regular basis and left in place for the remainder of the initial six weeks. Postoperative infections were identified in two of the 10 cases. Neither resolved with conservative management and implant removal was required. Both cases were then managed conservatively as the owners declined further surgical intervention.

Two minor long-term complications were encountered. One patient developed a discharging sinus near to the proximal end of the implant after approximately 180 days. This resolved with the administration of antibiotic medication and did not result in lameness at any time. No recurrence was reported at the time of long-term follow-up 875 days postoperatively. One patient was initially presented with chronic superficial digital flexor tendon contracture (secondary to the chronic gastrocnemius failure) resulting in hyperflexion of the digits. This did not resolve postoperatively despite the resolution of the plantigrade stance.

Long-term outcome was available in eight of the 10 cases. Mean follow-up time was 680 days (range: 454–943 days) Long-term follow-up was unavailable in two cases. One dog had died due to unrelated causes; the owner reported no complications and normal function at the time of death (177 days postoperatively). The other patient, the most recently treated patient (253 days), suffered a major complication (infection) postoperatively. Owner assessment of the eight dogs with long-term outcomes revealed that they all had an acceptable level of function with the majority (6/8) returning to full function (24). One dog with chronic superficial digital flexor tendon contracture, remained lame (grade 1/5) but could exercise at near to normal levels (25). Two patients, which had implant removal following postoperative infection, were managed with temporary external coaptation but did not require external support in the longer term. A moderate degree of plantigrade stance was present in both. The owners reported that this did not affect the quality of life of these dogs.

Overall, seven patients returned to full function and all these owners reported their dogs to be better than before surgery and rated the outcome as excellent. Three patients returned to an acceptable level of function. Five minor and two major complications were identified.

Discussion

This report describes a surgical technique, using a polyethylene terephthalate implant for treatment of chronic canine gastrocnemius tendon rupture and the outcome in a small number of patients. The breed and bodyweight of the dogs in our study population were consistent with previous reports (2, 3, 18, 19). The subjective assessment of outcome in our patients was similar to previous reports with between 60–78% of dogs returning to normal function though standardised assessment criteria were not used (7, 15, 19). Long-term comparison with previous studies is also difficult as these studies included patients with a range of common calcaneal tendon pathology from acute traumatic rupture to chronic degeneration of the gastrocnemius tendon. Our population only included patients with severe, chronic gastrocnemius tendon degeneration. In the authors' opinion, without this implant it would have been difficult to resect all the scar tissue in these patients and reattach normal tendon to the calcaneus using suture techniques.

Cast injuries are common in canine patients following common calcaneal tendon repair (26). Immobilisation of the hock by casting was considered necessary in all

l DynaCast Prelude: Smith and Nephew, Hull, UK
m Vetcast Plus: 3M, Bracknell, UK

cases. Other methods were considered. It was not possible to place a calcaneo-tibial screw due to the presence of the interference screw and the application of an external fixator frame was thought to increase surgical time and morbidity. Another study did not find a difference in outcome or level of complication between casting and external fixation following repair of Achilles tendon problems (19). The incidence of cast complications in our study was slightly lower than previously reported (19, 26). Both cases that suffered postoperative infection were presented initially with wound breakdown, possibly secondary to a cast sore.

We expect that with increasing experience with this technique, a reduced period of postoperative support may be possible, though previous biomechanical data have shown that some postoperative support is likely to be required (21). A splinted dressing changed on a regular basis may be preferable to a cast. Soft dressings may be less likely to rub, though require regular dressing changes. Minor cast complications do not appear to affect the long-term outcome. All external coaptation was removed after six weeks. This period of time is shorter than the seven to 10 weeks previously reported and may reflect the lower level of complication (19, 26). No complications were identified that a longer period of immobilisation would avoid.

Our mean surgical time compared favourably with that reported for suture repair with an external fixator (116 minutes) though it was longer than sutured repairs alone (65.5 minutes) (19). Surgical time should reduce as familiarity with the technique increases.

The intra-operative complications of iatrogenic fractures of the calcaneus were probably related to errors in the surgical technique. To ensure optimal positioning in the centre of the calcaneal tuber, we suggest that it is advisable to drill a pilot hole with a 2 mm drill bit or Kirschner wire. The surface of the calcaneal tuber has a slight angulation from lateral to medial. It is important to assess this on preoperative radiographs to ensure the correct drilling angle is achieved. This may reduce the risk of cortical penetration. The majority of screws were placed caudal to the implant. The medullary cavity of the calcaneus is narrower in a medial to lateral direction than from dorsal to plantar. In the case in which a calcaneal fissure developed, the screw was placed lateral to the implant. It appears that the narrower width of the calcaneus is less likely to tolerate the compressive forces of the interference screw against the implant so dorsal or plantar screw placement is advised. Failure of the hexagonal Kirschner wire probably occurred because the screwdriver was not in contact with the screw during insertion; the Kirschner wire tended to twist rather than insert the screw.

The major complication in this series was postoperative infection requiring implant removal. The potential for infection is always of concern when any implant, particularly a multifilament material, is used (27). Resection of the fibrous scar tissue requires extensive dissection, which may affect local blood supply. Precautions such as careful implant handling, and avoiding skin contact are advised. Following removal of scar tissue, the soft tissues should be closed around the implant to minimise dead space. It is anticipated that infection rates will reduce as the surgical technique becomes more familiar and surgical time reduces. The proposed benefit of this implant being a braided multifilament mesh over a monofilament implant is that it allows tissue ingrowth (23). We acknowledge the potentially increased risk of infection with this material, though we believe this risk can be justified in severely affected cases of chronic gastrocnemius tendon rupture. Delayed postoperative infection is a known complication with multifilament mesh type implants, with the increased surface area thought to promote bacterial adherence (28).

Assessing tension in the common calcaneal tendon mechanism can be difficult at the time of surgery due to contracture of the gastrocnemius muscle. Some lengthening of the gastrocnemius generally occurs postoperatively as the muscle relaxes. The authors suggest that the implant is fixed with enough tension to account for this, though in our experience patients appear to be able to tolerate a mild plantigrade stance postoperatively.

A major limitation of this study is its retrospective nature and the small number of patients involved. Continued assessment of this technique in a larger number of cases is recommended. Furthermore, several surgeons performed the surgical procedures, though the majority (8/10) were performed by or under direct supervision of the lead author (MAM). As with any new procedure, an improvement in outcomes would be anticipated as experience develops (29, 30). Further investigations would also benefit from more objective assessment of outcomes involving force platform testing and comparative studies.

The authors report that the surgical technique is straightforward although the complication of infection is of concern. Long-term outcomes were excellent in most of the cases, and the majority of owners reported that they were very satisfied with the outcome. This implant may be considered for repair in similar cases of chronic gastrocnemius degeneration when resection of scar tissue will leave a large gap.

Conflict of interest

The lead author has received payment from STIF with regard to publication of the surgical technique.

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