Canine distal hindlimb soft tissue sarcoma – a novel approach to surgical defect closure
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Keywords
Canine, reconstruction, distal crus, sarcoma

Summary
A 10-year-old, male, neutered whippet was presented with a soft tissue mass located on the medial aspect of the distal right tibia. The mass was 4 cm in diameter and of two months duration. Recent biopsy by the referring veterinarian, prompted by noticeable enlargement, identified the mass as a soft tissue sarcoma. Staging assessments did not reveal any evidence of metastases. Marginal excision was performed. The resultant defect was closed primarily by the creation of a bipedicle flap on the distal caudo-lateral aspect of the crus to enclose the Achilles tendon separately, leaving a defect between the Achilles tendon and the tibia. Postoperative management entailed support dressings and exercise restriction. Complete wound healing was attained three weeks postoperatively with excellent return of function. No recurrence was noted at eight months post-resection.

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Vet Comp Orthop Traumatol 2011; 24: 84–88
doi:10.3415/VCOT-10-05-0072
Received: May 12, 2010
Accepted: August 15, 2010
Pre-published online: November 19, 2010

Introduction
Soft tissue sarcomas (STS) are a heterogeneous group of mesenchymal tumours that constitute 15% of all skin and subcutaneous tumours in the dog (1). Many STS have overlapping histological characteristics which make it often more practical to treat them as a group due to their similar biological behaviour (2–5). Soft tissue sarcomas are typically characterised as locally invasive and pseudo-encapsulated with a tendency to recur locally (1, 3, 6). Metastatic rates of up to 20% have been recorded for these tumours, and haematogenous metastases to the lungs tend to predominate, although regional lymph node metastases do occur (1, 6, 7).

Wide surgical excision is the treatment of choice for soft tissue sarcomas (1). Adjunctive radiotherapy can be used in cases of incomplete excision (8). Local recurrence rates of six percent to 60% have been reported for cases with wide surgical excision, and 15% to 60% for cases where surgery was combined with adjuvant therapies (4, 6, 9–14). Due to the limitations on attainable surgical margins with STS of the distal extremities, a multimodal approach or amputation are usually required (15).

This report describes a case of STS on the distal hindlimb of a dog where the neoplasm was marginally excised and the resultant challenging defect was closed via a novel technique.

Case history
A 10-year-old, male, neutered Whippet was presented with a soft tissue mass, 4 cm in diameter, located on the medial aspect of the right hindlimb. The mass was located between the distal tibia and common calcaneal tendon (Fig. 1). It was first noted two months previously, but veterinary attention was sought due to recent marked size increase. An incisional biopsy by the referring veterinarian identified the mass as a low-grade STS and wide excision was advised by the pathologist which prompted referral.

Physical examination revealed the mass to be adherent to the overlying skin, but no adherence to the skin on the lateral aspect, the common calcaneal tendon, or the deep digital flexor tendons could be appreciated. Three-view thoracic radiography did not reveal any evidence of metastasis. The results of the haematological and biochemical analyses were both within normal limits.

The dog was premedicated with acepromazine (0.02 mg/kg), methadone (0.3 mg/kg), and carprofen (4 mg/kg). Anaesthesia was induced with propofol (4 mg/kg) and maintained with sevoflurane and oxygen.

Marginal excision involved resection of the overlying attached skin and dissection along the tumour’s visible extent. Dissection demonstrated involvement of the caudal saphenous artery, the caudal branch of the common calcaneal tendon, and the distal digital flexor tendons (Fig. 2). These were ligated and...
transected at the proximal and distal extent of the tumour (Fig. 3). Following resection, the defect was closed using simple interrupted 3–0 polypropylene skin sutures. A bipedicled flap was created by making an incision in the skin and subcutis overlying the lateral aspect of the distal crus, between the common calcaneal tendon and the distal tibia, preserving the caudal branch of the lateral saphenous vein and the superficial branch of the cranial tibial artery. Because the creation of the skin flap involved merely an incision in the lateral skin and no dissection, separate surgical instrumentation for creation of the flap was not deemed necessary. Construction of this flap was very similar to constructing a bipedicled advancement flap in that a parallel releasing incision was made along the longitudinal axis of the defect. The difference was that the width of the flap in this case was not determined by the size of the defect, but rather the circumference of the common calcaneal tendon and the location of the associated vascular structures. The flap was also not advanced in this case, negating the need for undermining, but rather encircled around the mid-body of the common calcaneal tendon (Fig. 4). This was then followed by apposition of the cranial skin edge of the lateral incision to the cranial skin edge of the medial defect, enclosing the distal tibia. Lastly, the proximal and distal extent of the defect was closed (Fig. 5). Histopathological assessment of the excised STS showed it to be of intermediate grade and well demarcated. Neoplastic cells were present within a millimetre of the proximal and distal margins, in close proximity to the caudal saphenous artery and its satellite nerve and vein. Local recurrence was mentioned to be a possible complication.

Postoperatively, supportive dressings were applied and exercise was restricted for two weeks. Carprofen at 2 mg/kg were dispensed for twice daily administration for five days. The skin sutures were removed 14 days postoperatively, but minor delayed wound healing was evident as granulation tissue in the distal 3 mm of the wound. Daily cleaning with a 0.02% chlorhexidine digluconate solution resulted in uneventful healing a week later. Following complete wound healing, external beam radiation was recommended but declined. Three weeks postoperatively, veterinary assessment revealed an intermittent slight lameness. The eight-month postoperative re-evaluation did not reveal any signs of sarcoma recurrence and the limb function was normal.

**Discussion**

This case report describes the marginal excision of a STS that left a defect too large to close by simple primary closure. Primary closure involved utilising a novel technique whereby a bipedicled skin flap was created to close the common calcaneal tendon separate from the structures overlying the distal tibia. The technique resulted in an excellent functional outcome with minimal complications after a follow-up period of eight months.

The adequacy of surgical margins has been identified as a prognostic indicator for local recurrence, therefore surgical margins of 3 cm lateral to the tumour and one fascial plane deep have been recommended (1, 9). These margins are generally not attainable on the distal extremity unless the limb is amputated (15). It is accepted in the human literature that multimodal limb-sparing treatment of STS of the extremities deliver results comparable to those obtained by amputation (16). Veterinary literature has also recently started to challenge the notion that wide surgical excision of STS is always necessary (3). A recent study published a local recurrence rate of 10.8% following marginal resection as sole treatment of low-grade STS of canine extremities (15). In the light of this information, the owner’s reluctance to amputate, and the STS’s low-grade attributed by inital biopsy, marginal excision was performed in this case.

Due to owner preference, postoperative radiotherapy was not utilised in this case despite the fact that it has been shown to be a viable adjuvant therapy for STS (4, 6). However, low local recurrence is reported even with microscopically incomplete margins without adjuvant therapy, and furthermore, the inherent low metastatic rate of these neoplasms would suggest that surgical excision alone is relatively safe (2, 15). Although not deemed necessary in this case because of the lack of need for dissection, the use of separate surgical instruments for the creation of the bipedicled flap would...
have been academically more correct. Even when utilising postoperative radiotherapy, further seeding of tumour cells should be avoided (17). An important reason being that at least 3 mm of the circumference of the limb have to be spared of radiotherapy so as to allow for lymphatic drainage (4). If the seeding were to have taken place along the whole circumference of the limb, recurrence could be promoted. Possible explanations for the variance in tumour grade between the incisional and excisional biopsies include the subjectivity of tumour grade assessment, varying levels of pathologist expertise, and the inherent heterogeneity of the tumour itself making an incisional biopsy less representative of the tumour as a whole compared to an excisional biopsy (18).

Intra-operative anatomical considerations included the effects that the resection of the caudal saphenous artery and its satellites would have upon the circulation and innervations of the distal limb. The remaining function present in these structures was questionable. However, because no suspicion of their involvement existed preoperatively, their function was not specifically assessed. Due to the location of resection, arterial supply to the mid-body of the common calcanean tendon was compromised, although collateral supply from the musculotendinous junction and calcanean attachment was considered likely (19). Anastomoses of the deep plantar arch and the perforating dorsal metatarsal artery would have ensured continued arterial supply to the plantar aspect of the pes and collateral venous drainage would have been facilitated by the caudal branch of the lateral saphenous vein (20). Transection of the distal tibial nerve proximal to the tibiotalar joint did not result in any loss of sensorimotor function on the plantar pes, which could only be explained by the communicating branch of the distal caudal cutaneous sural nerve supplying a sensory and motor component to the tibial nerve distal to the level of transection (21).

Postoperative complications have been confined to mild delayed wound healing in this case. Although not observed, adhesion formation secondary to wound healing, between the common calcanean tendon and the bipedicle flap, was a consideration. Its
functional significance was questionable however, considering the skin’s elasticity. In order to minimise local inflammation and adhesion formation, subcutaneous sutures were not used in this case (22–25). A possible long-term complication that should be kept in mind is an Achilles tendinopathy due to a compromised blood supply. Some owners may find the hock defect aesthetically unacceptable, and therefore, owners need to be informed preoperatively of the outcome’s appearance. Catching the hock defect on foreign objects is a potential hazard about which the owner needs to be vigilant.

Other alternatives for closure of defects on the distal crus include distant pedicle skin flaps, mesh-free skin grafts, strip- or punch-free skin grafts, microvascular-free skin grafts, reverse saphenous conduit flaps, rotational skin flaps after tissue expansion, genicular artery axial pattern flaps, and closure by secondary intention (26). Distant pedicle flaps provide durable, full-thickness skin and adnexa of cosmetically acceptable appearance and have the advantage of a high flap survival rate. Disadvantages of this closure technique include the need for several days of limb immobilisation and for a second flap releasing procedure (26). Mesh free skin grafts have a high success rate and a good cosmetic appearance if not expanded. These grafts conform and adhere to irregular surfaces, and can be placed on exudative or bleeding wound beds since the meshing allows drainage (27). However, limb immobilisation and regular bandage changes do mean that the aftercare is fairly intensive. Graft preparation also needs to be meticulous and can be time consuming (28). Strip- or pinch-free skin grafts are easy to perform and lend themselves to closure of smaller wounds with an irregular surface and low-grade infection. These grafts are difficult to immobilise after implantation and are susceptible to traumatic wear. The cosmetic outcome of this technique is poor because of epithelial scarring and sparse hair growth (27). The involvement of the plantar branch of the medial saphenous artery and its vena by the STS, and the specialised training and equipment required for the transfer of a microvascular axial pattern flap made it an unfavourable option (29). The reverse saphenous conduit flap could have been rotated and sutured to a bridge incision or tubed into the defect. Survival rates of these flaps are high if the vascular tree are preserved by ensuring the width of the flap extend 0.5 to 1cm past the cranial and caudal branches of the saphenous artery (30). This minimum flap width makes it a less desirable option in a whippet with minimal surplus skin at the level of the distal medial thigh. Tissue expansion techniques are associated with minimal complications and are technologically not demanding, but multiple surgeries are required and the staged expansion results in a delay of 14 to 20 days before wound closure (31). The genicular artery axial pattern flap was another closure option with a reasonable flap survival rate, but was decided against due to the limited skin availability in this dog (32). Healing by second intention was considered a last resort due to the long duration of intensive wound management necessary and the complications that could result from reduced mobility secondary to wound contracture.

The chosen wound closure technique in this case allowed complete primary closure of the defect with a reasonable cosmetic outcome. The need for a second procedure, specialised equipment and training, delayed wound closure, demanding wound management and dressing changes, limb immobilisation, skin availability, and prolonged hospitalisation were circumvented by utilising this technique. This case illustrates an uncomplicated technique with minimal complications that could be utilised to allow primary closure of a defect on the distal crus where skin availability is limited.

References

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