

# Bicipital Tendinopathy and Carpal Valgus Following a Distant Direct Thoracoabdominal Skin Flap in a German Shepherd with Necrotizing Fasciitis

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## ABSTRACT

A 4 mo old German shepherd dog was presented following an acute onset lameness and swelling of the thoracic limb. Clinical signs, surgical findings, and culture results were consistent with a diagnosis of necrotizing fasciitis. Initial management consisted of extensive surgical debridement, wound lavage, and bandaging. Surgical closure was achieved with an axillary fold flap and distant direct single-pedicle thoracoabdominal flap. Three mo later, following deterioration of the lameness that was associated with carpal valgus, carpal subluxation, and tendinopathy of the distal radial insertion of the biceps brachii tendon, a closing wedge pancarpal arthrodesis and tenotomy of the biceps brachii tendon was performed. We hypothesize that extensive soft tissue trauma and subsequent fibrosis and tendon contracture following soft tissue reconstruction contributed to the complications seen. To the authors' knowledge, this is the first report of carpal valgus deformity and biceps brachii tendinopathy following a distant direct skin flap and axillary skin fold flap.

(*J Am Anim Hosp Assoc* 2018; 54:226–230. DOI 10.5326/JAAHA-MS-6616)

## Introduction

Necrotizing fasciitis (NF) is a rapidly progressive, life-threatening bacterial infection of the fascial and subcutaneous tissues that requires prompt aggressive surgical debridement.<sup>1</sup> It often results in significant soft tissue trauma that requires an open-minded approach to reconstruction. This is particularly relevant to wounds of the distal limbs due to the limited local skin availability. The use of a distant direct thoracoabdominal flap has previously been described as a technique for skin reconstruction of distal thoracic limb wounds. The technique requires prolonged immobilization of the affected limb with the shoulder flexed and elbow extended adjacent to the thoracic and abdominal wall. The authors hypothesize that carpal valgus and biceps tendinopathy developed as a late complication in this case following utilization of the distant direct flap thoracoabdominal skin flap. This case report

describes the management of NF and the subsequent management of associated complications: carpal valgus and bicipital tendinopathy.

## Case Report

A 4 mo old entire female German shepherd dog presented at the primary care practice with lameness of the right thoracic limb. Initial physical examination findings included pain on manipulation of the carpus, pain on maximal elbow flexion, and 10/10 lameness.

On day 2, the right thoracic limb was markedly swollen, painful, and discharging through multiple sinuses, and treatment was initiated for a suspected cellulitis. Intravenous fluid therapy and antibiotics with potentiated amoxicillin<sup>a</sup> 20 mg/kg three times daily, metronidazole<sup>b</sup> 10 mg/kg twice daily, and marbofloxacin<sup>c</sup> 2 mg/kg once daily was instituted. Despite therapy, the cellulitis progressed to

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NF (necrotizing fasciitis)

Accepted for publication: June 22, 2016.

involve the ventral thorax and neck with concurrent clinical deterioration; the dog was subsequently referred.

Physical examination findings included depression and non-ambulatory right thoracic limb lameness. There was marked swelling of the right thoracic limb with necrosis of the skin extending from the right elbow to the dorsal aspects of the phalanges.

Extensive debridement and lavage of the wound was performed under general anesthetic. Bacteriology following wound lavage identified a mixed population of *Staphylococcus aureus*, *S. pseudintermedius*, and *Escherichia coli*. Sensitivity testing revealed combined resistance to ampicillin, cephalexin, and oxytetracycline and sensitivity to enrofloxacin, amoxicillin/clavulanic acid, cefovecin, and cefuroxime. Antibiosis with potentiated amoxicillin<sup>d</sup> 20 mg/kg orally *q* 12 hr was continued for a further 2 wk.

The wound was bandaged using a negative pressure wound therapy dressing followed by daily wet-to-dry bandage changes until a healthy bed of granulation tissue had formed (Figure 1).

Seventeen days after presentation, a combined axillary fold flap and thoracoabdominal single-pedicle distant direct flap were used to reconstruct the defect over the antebrachium and elbow (Figure 2). Staged release of the distant direct flap was performed initially with release of the abdominal skin from the level of the right metacarpus to the carpus on day 28 (10 days after initial surgery), followed 4 days later by release of the remaining skin flap.

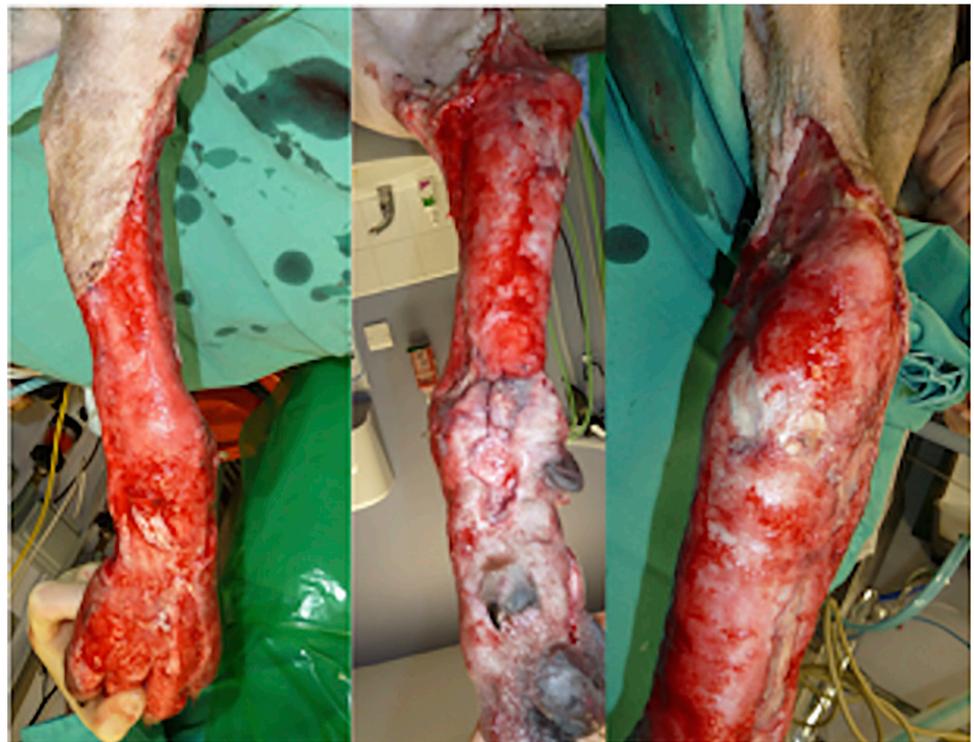
Two mo following initial injury, a 2-cm-diameter area of granulation tissue remained on the dorsal aspect of the paw of the right thoracic limb (digit 4); phalangeal filleting of digit 4 and dorsal transposition of the digital pad was performed. At this stage, there was a persistent thoracic limb lameness, carpal valgus, reduced range of motion of the carpus, and mild reduction in range of motion of the elbow in extension. Management at this stage consisted of strict rest.

Three mo after presentation, the dog presented with 5/10 right thoracic limb lameness, a valgus deformity of the right carpus, reduced range of motion of the carpus, and pain on examination of the elbow. Radiographs of the right carpus revealed medial subluxation of the radiocarpal bone (Figure 3). Due to financial limitations, management at this stage consisted of strict rest and physiotherapy.

Nineteen mo after initial presentation, the owners reported a reduction in exercise tolerance and suspected deterioration in lameness. On presentation, physical examination revealed progression of the carpal valgus and pain on manipulation of the elbow, with a grade 5/10 right thoracic limb lameness. A tight fibrous band was present on the cranial aspect of the elbow joint consistent with the radial insertion of the biceps brachii tendon complex. Pain was elicited on direct palpation of the tendon.

Computed tomography revealed mild radius curvus and moderate carpal valgus of approximately 20 degrees, with subluxation of the radiocarpal joint of the right limb. Ultrasound examination of the biceps tendon revealed a thick hyperechoic radial

**FIGURE 1** Wound of the right thoracic limb following debridement. (left to right): Cranial, medial, and caudal views of the right antebrachium.





**FIGURE 2** Clockwise from bottom left—postoperative image of an axillary fold flap; distant direct single pedicle thoracoabdominal skin flap; 3-mo follow-up examination with evidence of development of right carpal valgus.

insertion of the biceps brachii tendon in comparison with the contralateral limb.

Based on these findings, the decision was made to proceed with a pancarpal arthrodesis, arthroscopy of the right elbow, and tenotomy of the radial insertion of the biceps brachii tendon. Arthroscopy of the right elbow joint was unremarkable. A craniomedial approach to the elbow joint was performed to isolate the radial insertion of the biceps brachii tendon.<sup>2,3</sup> The tendon of the biceps brachii was cut at its insertion at the radial tuberosity, leaving the larger tendon still attached at the ulnar tuberosity. A medial closing wedge osteotomy



**FIGURE 3** From left to right: Dorsopalmar radiographs of antebrachium at time of initial injury; 3 mo later showing progression of carpal valgus; (center) postoperative view of closing wedge pancarpal arthrodesis performed 18 mo after initial injury; 8-wk follow-up dorsopalmar and lateral radiographs revealing progression of arthrodesis.

was performed in the distal radius to correct the carpal valgus, followed by pancarpal arthrodesis performed at the level of the antebrachio-carpal joint. The arthrodesis was subsequently stabilized with a 3.5/2.7 hybrid pancarpal arthrodesis plate (Figure 3).

Two wk following surgery, there was a moderate amount of discharge from the pancarpal arthrodesis site. Culture revealed a mixed growth of *Pseudomonas aeruginosa* and *E. coli*. As a result, marbofloxacin<sup>c</sup> 2 mg/kg orally once daily therapy was instituted. Two wk later, the discharge had resolved, and lameness had improved to 3/10 on the right thoracic limb.

On the last consultation, 2 yr following original presentation, no lameness was detected.

## Discussion

NF is a rare, rapidly progressive, fulminant bacterial infection of the fascial and subcutaneous tissue, which is potentially life threatening if not treated promptly with complete and extensive surgical debridement of the necrotic tissue.<sup>4,5</sup> The extensive debridement of wounds of distal limbs often requires a combination of skin reconstruction techniques to produce a successful outcome. This is in large part due to the lack of available skin in the distal limb of dogs and cats.<sup>6</sup> As a result, skin transplantation may be the only alternative for restoring normal function and cosmetic appearance.<sup>7</sup> There are several reported techniques available for transplantation of skin onto the distal thoracic limb, including free skin grafting, advancement flaps, axial pattern flaps, and distant direct flaps, each with its own advantages and disadvantages.<sup>8</sup> The successful management of a skin defect resulting from an *E. coli*-induced NF on the caudal thigh with a combination axial pattern flap and full-thickness free skin graft has been previously described.<sup>9</sup> Axial pattern flaps provide full-thickness skin coverage, and, because of the unique blood supply (direct cutaneous artery and vein), extensive segments of skin can be transferred in a single-stage surgery without the need for a delayed procedure. In dogs, the thoracodorsal flap has been used to cover defects down to the middle of the antebrachium and to a level 2 cm proximal to the carpus, when used in combination with skin stretchers.<sup>10,11</sup> However, there is a significant risk of partial flap necrosis associated with the thoracodorsal axial pattern flap, with a reported partial necrosis ranging from 2 to 53% of the flap surface in 7 out of 10 patients.<sup>10</sup> Because of the distal extent of the wound and risk of flap necrosis, this technique alone was deemed inappropriate in this case.

Full-thickness skin grafts can be used to repair extensive areas of skin loss, and in dogs they are primarily indicated to skin reconstruction of defects on the limbs. Graft acceptance relies on the presence of a fresh and healthy granulation bed and stabilization of the graft with bandages or vacuum bandaging.<sup>12</sup> A full-thickness skin

graft would potentially have been suitable in this case despite the risks of graft failure and reliance on postoperative bandaging.

In the case reported, we elected to perform a combination of an elbow skin-fold advancement flap in combination with a distant single direct thoracoabdominal pedicle flap.<sup>6,13–16</sup> These techniques allowed the provision of full-thickness skin coverage to increase padding over bony prominences and a high likelihood of flap survival.<sup>16</sup> The technique of distant thoracoabdominal pedicle skin flap has previously allowed 100% wound coverage in 10/14 animals with distal limb skin defects, and >95% skin flap survival was reported in 12/14 animals.<sup>6</sup> In addition, vascular supply through the pedicle eliminates the reliance on plasmatic imbibition required for survival of free skin grafts, allowing it to be used over poorly vascularized areas, such as over the elbow, where free grafts would likely fail.<sup>7</sup>

There are several disadvantages with distant direct flaps, including the necessity of immobilizing the limb in an abnormal position for 2–3 wk and the requirement for a two-staged release to improve flap survival by utilization of the “delay phenomenon.”<sup>6,7</sup> We hypothesize that prolonged immobilization required for the distant direct flap and severe cellulitis associated with NF resulted in a combination of flexor tendon and soft tissue contracture, which resulted in a biceps tendinopathy and carpal valgus.

Carpal valgus and radius curvus may have been consistent with premature closure of the distal ulnar physis, with interruption to the blood supply of the metaphysis and within the physis due to extensive soft tissue trauma resulting in alterations to the rate of bone growth.<sup>3,17,18</sup> However, in this case, there was no evidence of closure of the distal ulnar physis, as the length of the radius and ulna at the time of skeletal maturity were within 1 mm of each other. Focal retardation or premature closure of the lateral aspect of the distal ulnar physis may result in a carpal valgus without significant shortening of the ulna itself. The cause of the focal retardation is most likely due to the underlying soft tissue trauma. However, it is conceivable that maintaining the limb in position using a distant direct flap in a young dog may have resulted in abnormal pressure on a focal area of the distal ulnar physis, resulting in the carpal valgus.

Reports of dogs treated with a thoracic pedicle skin flap noted temporary lameness after the final release of the flap and attributed this lameness to joint contracture.<sup>6,7</sup> However, in each of the cases, the lameness resolved without further intervention. The authors suspect the young age of the dog at the time the procedure/initial trauma contributed to the orthopedic complications that subsequently developed.

The biceps brachii complex has a radial and ulnar insertion; the larger ulnar insertion of the tendon attaches on the ulnar tuberosity,

whereas the smaller radial insertion of the tendon attaches more distally at the level of the radial tuberosity.<sup>2</sup> Damage to the distal biceps tendon is believed to be a rare injury with a reported incidence of 1.2 cases per 100,000 patients per yr in the human literature.<sup>19</sup> These injuries in humans, and those reported in a series of greyhounds, typically were attributed to acute overloading of the tendon, which are in contrast to the case we present here.<sup>19,20</sup> We propose that the initial excessive tension on the radial insertion of the biceps tendon when the limb was apposed to the thoracoabdominal wall and continued growth during the period combined with fibrosis and contracture of the periarticular soft tissue caused the tendinopathy and ongoing pain. In the case reported here, it appears that the smaller radial insertion was solely affected, and this may be due to the position of the limb, with the greatest tension placed on radial component due to the more distal insertion point.

In humans with lateral elbow tendinopathies of the extensor carpi radialis brevis (tennis elbow), release operations or tenotomies have been performed to control recalcitrant pain.<sup>21</sup> Tenotomy of the ulnar insertion of the biceps brachii/brachialis complex of dogs has been described, and subsequent investigation found that tenotomy of the insertion of the brachialis did not alter stability of the elbow joint in a small-scale cadaver study.<sup>22,23</sup>

## Conclusion

In this case, transection of the smaller radial component of the biceps brachii tendon while maintaining the ulnar insertion maintained function of the biceps brachii complex, resulting in improvement in the level of pain, and was not associated with signs of instability. We surmised that tenotomy is therefore a viable option for treatment of similar cases with biceps tendinopathy.

This is the first report, to the authors’ knowledge, of a biceps tendinopathy and carpal valgus as a complication following a distant direct thoracoabdominal skin flap to treat a skin defect following necrotizing fasciitis. ■

## FOOTNOTES

- <sup>a</sup> Augmentin; GlaxoSmithKline, Uxbridge, Middlesex, United Kingdom
- <sup>b</sup> Metronidazole; Crescent Pharma, Overton, Hampshire, United Kingdom
- <sup>c</sup> Marbocyl; Vetoquinol, Lure, France
- <sup>d</sup> Noroclav; Norbrook, Corby, Northhamptonshire, United Kingdom

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