Case Report

Limb salvage and reconstruction following a zebra attack☆

Jacob T. Carlsona,⁎, James C. Yuenb, Matthew R. Smesc

a University of Arkansas for Medical Sciences, Department of General Surgery, 4301 W. Markham St., Little Rock, AR 72205, United States
b University of Arkansas for Medical Sciences, Department of Plastic Surgery, 4301 W. Markham St., Little Rock, AR 72205, United States
c University of Arkansas for Medical Sciences, Department of Vascular Surgery, 4301 W. Markham St., Little Rock, AR 72205, United States

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Animal bites are fairly rare events but can cause devastating traumatic injuries to the victim. In addition to the soft tissue, vascular, and orthopedic trauma inflicted by these occurrences, bite injuries also have the potential to introduce an inoculum of microbes, which may progress to an infection if not treated properly and expeditiously.

We present the case of a healthy male who sustained multiple bite wounds from a domestic zebra to his left upper extremity. This attack caused severe damage, including devascularization of the arm at the brachial artery, disruption of the distal biceps and brachialis, stripping of the forearm nerves, and shearing of the overlying soft tissue. The patient was taken emergently to the operating room for revascularization of the extremity utilizing a vein bypass graft. The soft tissue injuries were addressed with numerous irrigation and debridement procedures, during which coverage of the vein bypass graft was obtained using a variety of techniques, including skin flaps, musculocutaneous advancements, and the application of an acellular dermal matrix (AlloDerm) and a collagen-glycosaminoglycan matrix (Integra).

Wound cultures obtained intra-operatively during the irrigation and debridement procedures were notable for the growth of multiple microbes, including Rhodococcus spp., which have been documented to cause infection in immunocompromised patients. The patient in this case was treated with a prolonged course of antibiotics, and wound cultures negative for microbial growth were eventually obtained prior to final closure of his wound. The patient then underwent successful biceps reconstruction with a pedicled latissimus dorsi muscle transfer.

This case documents the extraordinary multidisciplinary approach provided in the salvage, management, and eventual reconstruction of a mangled left upper extremity that had sustained devastating traumatic injuries resulting from a rather unusual source.

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Introduction

Traumatic injuries caused by equine attacks are rare events with only 3–4.5% of such injuries resulting from bites [1]. In addition to the injuries that may result from these occurrences, bite wounds also carry the risk of transmitting infection. Pathogens reported to have been acquired via equine bites include Actinobacillus spp., Pasteurella spp., Staphylococcus spp., Streptococcus spp. including Group B Strep, Bacteroides fragilis, Campylobacter ureolyticus, Escherichia coli, Neisseria spp., Prevotella melaninogenica, Pseudomonas aeruginosa, and Yersinia spp. [1–3]. Infection with Rhodococcus after a bite injury has been described, although it

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⁎ Corresponding author.
E-mail address: jcarlson@uams.edu (J.T. Carlson).

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most commonly occurs in immunocompromised patients [1,4–6]. Just over 100 cases of Rhodococcus equi infection in humans have been documented in the literature [7]. We present the case of an otherwise healthy male who was attacked by a domestic zebra leading to injuries that necessitated limb salvage surgery as well as treatment of multiple infectious pathogens.

Case report

A 58-year-old right-handed male with no significant co-morbidities was working at a ranch when a domestic zebra bit his left upper extremity multiple times. Upon arrival to the hospital, he was hemodynamically stable and found to have a grossly contaminated 8 × 15 cm wound extending from the level of the mid-humerus through the antecubital fossa with muscle and tendon exposed (Fig. 1A). He demonstrated decreased active flexion of the elbow, thumb, and index finger and had no sensation in the median nerve distribution. No radial, ulnar, or palmar arch Doppler signals were detected. Computed tomography angiography (CTA) demonstrated an occlusion of the distal left brachial artery (Fig. 2).

He was taken emergently to the operating room for an attempt at limb salvage. After proximal and distal control were obtained, thrombus was removed from the proximal brachial artery as well as from the radial and ulnar arteries. The ipsilateral greater saphenous vein was harvested and placed in non-reversed fashion with end-to-end anastomoses proximally and distally (Fig. 1B). Revascularization of the extremity was achieved approximately 8 h after the initial injury. The distal biceps and brachialis were avascular and thus debrided. The median, radial, and ulnar nerves had been stripped, and the distal brachial artery and proximal ulnar and radial arteries had been degloved across the elbow. Skin flaps were advanced medially from the radial aspect of the forearm to cover the vein graft. Flexor compartment fasciotomy of the distal extremity was performed. A plaster cast was applied to maintain the elbow at 30 degrees of the flexion with the wrist extended slightly. At the end of the procedure, the patient had a palpable left radial pulse.

Fig. 1. A - Intra-operative photo of the patient’s left upper extremity depicts revascularization of the distal extremity (right) using an ipsilateral greater saphenous vein interposition graft. B - Pre-operative photo taken nine days after the zebra attack demonstrates that the interposition bypass graft (upper central portion of wound) remained exposed due to profound swelling of the extremity. C - Integra was utilized to provide coverage of the distal interposition bypass graft (center of photo) and remaining distal soft tissue defect (right) of the left upper extremity wound nine days after injury. D - Transfer of a pedicled left latissimus dorsi muscle was utilized to reconstruct the patient’s distal bicep, which restored 5/5 flexion strength at the left elbow.
Serial irrigation and debridement procedures were performed. Cultures obtained intra-operatively from the wound grew *Pseudomonas aeruginosa*, *Aeromonas hydrophila*, *Streptomyces* species, *Bipolaris* species, *Enterobacter cancerogenus*, and *Rhodococcus* species (Table 1), which were treated with antibiotics. The patient received four days of po amoxicillin/clavulanic acid (Augmentin), three days of IV piperacillin/tazobactim (Zosyn), fifty days of po voriconazole (VFEND), eleven days of IV cefepime (Maxipime),

Fig. 2. CTA obtained 6 h after the patient’s injury demonstrates occlusion of the distal left brachial and proximal ulnar arteries.

Table 1
Results of cultures collected from the left upper extremity wound intra-operatively at the time of the patient’s irrigation and debridement procedures following his initial injury.

| Operative day | Culture results |
|---------------|-----------------|
| POD 0         | No cultures obtained |
| POD 3         | Moderate *Aeromonas* spp. Moderate *Pseudomonas aeruginosa* |
| POD 4         | Moderate *Aeromonas hydrophila* Moderate *Pseudomonas aeruginosa* One colony Streptomyces spp. Few *Bipolaris* spp. |
| POD 5         | Few *Pseudomonas aeruginosa* Few *Enterobacter* spp. |
| POD 6         | Few *Pseudomonas aeruginosa* Few *Enterobacter cancerogenus* Few *Rhodococcus* spp. |
| POD 13        | Negative |
| POD 19        | Negative |
forty-eight days of po metronidazole (Flagyl), thirty days of po levofloxacin (Levaquin), and thirty days of po trimethoprim/sulfamethoxazole (Bactrim) (Fig. 3).

As swelling of the extremity increased, coverage of the vein graft provided by the fasciocutaneous flap was progressively lost. On postoperative day six, AlloDerm was used to cover the 1.5 cm distal segment of the vein graft. A negative pressure dressing and arm splint were applied to prevent displacement of the extracellular dermal matrix covering the vein graft.

On postoperative day nine, coverage of the vein graft was achieved by approximating muscle proximally and applying Integra over the distal vein graft and wound (Fig. 1C). Beginning one week later, portions of the Integra were trimmed to begin serial closure of the wound. On postoperative day 22, the remaining Integra was removed, and the wound was adequately approximated to provide complete soft tissue coverage of the vein graft.

Vascular labs obtained seven weeks after the injury demonstrated patency of the left brachial vein bypass graft (141 cm/s at the proximal anastomosis and 184 cm/s at the distal anastomosis) with no evidence of stenosis. Bilateral brachial (R 123 mmHg v. L 117 mmHg), radial (R 129 mmHg v. L 126 mmHg), and ulnar (R 120 mmHg v. L 128 mmHg) arm pressures and waveforms were normal.

Three months after injury, the patient reported persistent decreased sensation in his left hand in the median nerve distribution and demonstrated 5/5 strength in extension but only 3/5 strength in flexion of the elbow. Magnetic resonance imaging demonstrated an intact proximal biceps but no evidence of biceps muscle or tendon in the distal arm. The brachialis tendon was intact, but the muscle mass was significantly reduced. A nerve conduction study was consistent with left median nerve neuropathy with severe axonal loss.

Eight months after injury, the patient underwent transfer of his left latissimus dorsi to reconstruct the distal left biceps. The latissimus dorsi muscle was mobilized and tunneled with its pedicle through the axilla. Achilles allograft was used to reconstruct the distal biceps tendon. At his three-month postoperative visit, he demonstrated 5/5 strength in flexion of the left elbow (Fig. 1D).

**Discussion**

Bite wounds should be thoroughly cleansed to decrease the inoculum of bacteria introduced by the bite. This should be followed by wound exploration with careful inspection of tendons, blood vessels, joints, and bones, providing intervention as needed for each. Devitalized tissue should be debrided and the wound copiously irrigated with sterile normal saline. Closure of the wound depends on the depth and cleanliness of the wound [8]. Kose et al. describe a similar management of 24 patients who sustained equine bites. The soft tissue defects in these patients were addressed with a variety of reconstructive surgical techniques including simple wound closure with sutures, split-thickness skin grafting, full-thickness skin grafting, chondrocutaneous advancement flaps, reverse radial forearm flaps, and a pedicled groin flap [9].

*Rhodococcus equi* is typically susceptible to erythromycin, rifampin, fluoroquinolones, aminoglycosides, glycopeptides, and imipenem; is variably susceptible to cotrimoxazole, tetracycline, chloramphenicol, clindamycin, and cephalosporins; and resistant to penicillins. Treatment with broad spectrum antibiotics should be initiated at the time of diagnosis of *Rhodococcus* infection, and the regimen should be adjusted as susceptibility testing results become available [7]. Additionally, prophylaxis against tetanus and rabies is recommended in the management of animal bite wounds [8-9].

**Conclusion**

Equine attacks are infrequent events but can lead to profound injuries, as well as rare but potentially lethal infections. We present the case of a patient who was bitten by a zebra, which caused disruption of the left brachial artery, necessitating emergent surgical intervention to revascularize the distal extremity. Musculocutaneous advancements were utilized to provide coverage of an interposition bypass graft. Cultures obtained intra-operatively from the wound were significant for the growth of *Rhodococcus*, which typically infects immunocompromised hosts, as well as *Enterobacter cancerogenus, Pseudomonas aeruginosa,*

**Fig. 3.** The patient’s left upper extremity injury was initially treated with broad-spectrum antibiotics, which were adjusted once culture and susceptibility results became available. Post-Operative Day 0 corresponds to the day of injury and emergent revascularization procedure.
Aeromonas hydrophila, Streptomyces, Bipolaris. The surrounding soft tissue injuries were addressed with numerous irrigation and debridement procedures, and the patient was successfully treated with a prolonged course of intravenous and oral antibiotics. After soft tissue coverage of the wound was obtained, the left biceps was reconstructed using a pedicled latissimus dorsi muscle transfer, which restored flexion strength at the elbow and significant use of the extremity. This case documents the multidisciplinary approach utilized in the salvage of an upper extremity after an extraordinary and unique injury to provide exceptional functionality and a restored quality of life.

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