How to Perform Amputation of the Equine Limb Using a Caudal Flap Technique

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1. Introduction
Amputation of the equine limb has been performed for the past four decades.1–6 Previous reports indicate that, in cases where fracture configuration, impaired circulatory status, or sepsis render traditional means of limb repair hopeless, amputation should be considered as a viable option to euthanasia.1,2 As experience has been gained in surgical technique, and prosthetic designs have become routine, removal of the diseased limb can no longer be considered an abstract, controversial procedure. In addition, recent, high-profile cases of catastrophic limb failure in Thoroughbred racehorses have sparked an interest in the procedure from both the public and the insurance industry.a

In a previous report of 30 cases involving distal limb amputation, both a caudal flap technique and frog graft were used with good results.1 The frog graft technique can be used in cases where insufficient tissue is available for a caudal flap or in cases where frog chorium can be transposed as a local flap. The disadvantages in the frog graft technique include (i) graft failure and (ii) excessive growth of grafted frog, which can result in a poor-fitting prosthesis.1,b Unlike the human amputee, which will be non-weight bearing on the affected limb until the stump healing is complete, the equine patient must be able to weight bear immediately after surgery. The caudal flap technique provides an excellent opportunity for primary healing and rapid stump loading.

The purpose of this paper is to provide the equine surgeon with a step-by-step approach to removal of the limb with rapid return to function.

2. Materials and Methods
Case Selection
Amputation of the diseased limb has been routinely performed up to the level of the proximal metacarpus/metatarsus.1–6 The authors have performed amputations in horses ranging in age from 2 mo to 20 yr. Case selection should include horses with a temperament to allow sling recovery during anesthesia and cast changes. In addition, horses that undergo upper hind limb amputations should be expected to tolerate a rigid cast and prosthesis that immobilizes the hock. An important factor in selecting candidates for amputation is having owners and caretakers that are dedicated to the long-term maintenance of the horse. Owners should anticipate the equine amputee to perform without limita-
tions as a breeding or pasture animal. Breeding stallions should be expected to perform with either a forelimb or hindlimb removed, and broodmares can be expected to accommodate the weight associated with gestation.\textsuperscript{1,2,3} Pregnant mares have undergone amputation and delivered healthy foals.\textsuperscript{1} Horses up to 600 kg have been included in reported cases.\textsuperscript{1–6}

Contralateral limb laminitis is a universal concern in the non–weight-bearing patient and in the postoperative fracture patient. All amputee candidates are provided with frog support during the course of their injuries and immediately after surgery. Although traditional rationale would disqualify a horse as a candidate for amputation once laminitis has developed in the contralateral limb, one of the authors (T.P.V.) has had occasion to remove the original painful limb just to have moderate laminitis resolve in the contralateral limb. Therefore, one cannot always exclude horses as candidates with contralateral limb laminitis, although a careful case by case assessment should be made.

In selecting the level of amputation, every effort should be made to preserve the nutrient artery in the affected limb. Enough soft tissue covering on the caudal aspect of the limb should be intact and extend 2.5 times the width of the bone in a distal direction from the proposed site of amputation (Fig. 1). If insufficient soft tissue is available for a flap, another method such as a frog graft may be used.

Patient Preparation/Temporary Prosthesis

The patient is prepared for surgery in a routine manner. In all forelimb and hindlimb cases where the site of amputation is at or below the level of the fetlock joint, a transfixation cast is used in the immediate postoperative period. In hind limb cases above the fetlock, a cast will be applied to just below the stifle. A transfixation cast is not necessary in these cases because the angle of the hock will allow sufficient weight bearing on the cranial aspect of the tibia, thus requiring minimal loading of the stump until primary healing of the incision is complete. The temporary prosthesis in the upper hind limb cases will include four straps that incorporate into a titanium post (Fig. 2). This is coupled to a foot plate of 0.25-in stainless steel with borium. The forelimb and distal hindlimb cases incorporate an aluminum cup into the transfixation cast, which permits rotation of the limb while minimizing shearing stresses at the bone–pin interface (Fig. 3).

All horses are provided preoperative broad-spectrum antimicrobials, non-steroidal anti-inflammatory drugs (NSAIDS), and tetanus prophylaxis.

Surgical Procedure

The horse is placed under general anesthesia and is positioned in dorsal recumbency to allow access to the entire limb. The diseased portion of the limb is draped out of the surgical field. Neurectomy of the palmar/plantar nerves is performed at a level 4–8 cm proximal to the site of amputation and at least 2 cm of nerve is removed. Closure of the neurectomy sites is routine. In forelimb cases and distal hindlimb cases, two positive-profile 6.3-mm transfixation pins\textsuperscript{5} are placed at 30° divergent angles in the distal one third of McIII/MtIII (Fig. 4). A skin incision is

Fig. 1. Appearance of a preoperative limb with sufficient tissue for a caudal flap.

Fig. 2. Appearance of applied temporary upper hind limb prosthesis immediately after surgery.
made on the palmar/plantar aspect of the limb perpendicular to the long axis of the bone and distal to the site of amputation at a distance of 2.5 times the width of the bone at the amputation site. The incision extends in a cranial direction on both the medial and lateral aspects of the limb. Care should be taken to ensure that the medial and lateral aspects of the incision are symmetrical. As the incision reaches the middle of the limb, it is extended proximal to the site of amputation and then horizontal to complete the dorsal margin of the incision. Blood vessels are double ligated with absorbable suture and transected. The superficial digital flexor tendon, deep digital flexor tendon, and suspensory ligaments are sharply transected at the level of the caudal incision and are not separated from the skin and subcutaneous tissue. The extensor tendons are similarly transected at the skin margin on the dorsal aspect of the limb. The caudal skin, tendons, suspensory ligament, and vascular bundle are carefully dissected from the bone in a proximal direction to the level of the amputation (Fig. 5). In cases where the amputation is performed at the fetlock or pastern joint, the joint is simply disarticulated at this time. If the fetlock joint is the site of amputation, the sesamoid bones should be preserved to allow a bulbous stump end, which will prevent spinning and slippage of the permanent prosthesis. Cold fluids are used for irrigation during the amputation with an oscillating saw to prevent overheating of the cortical bone. Once
Aftercare

The horse is maintained on broad-spectrum antimicrobials and NSAIDS for 7 days. Two weeks after surgery, the horse is placed in a sling, and the cast is changed under IV anesthesia. Thirty days after surgery, the sling is again used, and the transfixation cast and pins are removed under IV anesthesia. Molding of the permanent prosthesis is done at this time. The healed stump can accommodate loading without risk of incisinal failure, and a simple cast/temporary prosthesis is applied. Once the permanent prosthesis is constructed (1–2 wk), the cast is removed with the horse standing, and the permanent prosthesis is applied (Fig. 8). The prosthesis is changed daily using a wool prosthetic sock. Care should be taken to ensure that the leg is dry and free of pressure sores at every cast change.
The horse can be turned out into a corral and resume controlled exercise.

3. Results

From 1986–2010, thirty four clinical cases of partial limb amputation using a caudal flap technique were reviewed. Twenty-two of the 34 cases were previously reported by the authors. Twenty-two horses (64.7%) survived at least 6 mo (mean, 31.1 mo). Age at amputation ranged from 2 mo to 13 yr (mean, 7.2 yr). Septic arthritis/tenosynovitis was the most common cause of amputation (53%). Chronic pain patients (n = 24) comprised a majority of the cases compared with horses with an acutely injured limb (n = 10). Of horses that survived, 7 were salvaged for sentimental value, 13 were broodmares, and 2 were breeding stallions.

4. Discussion

The goal of amputation is to remove an irreparably painful or unstable limb and return the horse to function as rapidly as possible. In restoring function, it is important to maintain comfort and promote primary closure of the stump. Unlike the human amputee, who will undergo several months of muscle atrophy and stump sclerosis, this is not a significant issue with the distal limb in the horse. Once stump healing is complete, the morbidity associated with amputation is minimal. As in humans, performing a high neurectomy facilitates a rapid return to comfort. Neroma formation did not develop in any of the cases in this study. Phantom pain, a poorly understood syndrome in the human, has been described in horses but did not develop in any of the cases in this study. Application of the caudal flap allows a firm, tough pad of tissue on which the horse can load. A transfixation cast can be used in cases including and below the fetlock joint to facilitate primary stump healing. As in humans, a high neurectomy provides comfort to the equine amputee and has not resulted in any significant complications. Morbidity associated with the catabolic state of the chronic pain patient can be decreased by recognizing the availability of amputation as a viable treatment option early in the course of managing the horse with a limb beyond repair.

References and Footnotes


Imex Veterinary, Longview, TX 75604.
Prolene, Ethicon, Somerville, NJ 08876.
PDS-II, Ethicon, Somerville, NJ 08876.
Procel Cast Liner, WL Gore and Associates, Flagstaff, AZ 86003.
Anderson Sling, CDA Products, Potter Valley, CA 95469.
Hanger Prosthetics and Orthotics, Sheridan, WY 82801.
Knit-Rite, Knit-Rite, Kansas City, KS 66105.