Maggot Debridement and Leech Therapy as Treatment of a Partial Digital Amputation Injury in a Dog

Alessio Vigani, DVM; Allison Schnoke, DVM; Antonio Pozzi, DVM, MS

Abstract: A 23-kg, 3-year-old spayed female boxer was admitted for evaluation of a traumatic partial amputation of the fourth digit of the right front limb. The injuries were self-induced by the dog trapping the legs under a metallic fence. The dog had multiple lacerations on both front limbs and a partial amputation of the right front digit. The dog otherwise appeared to be healthy. Methods and Results. The multiple lacerations were treated with repeated wet-to-dry bandages followed by non-adherent bandages on the established granulation bed. Epithelization of the numerous superficial skin lacerations was noted within 7 to 10 days. Initial management of the digital injury was unsuccessful. In spite of the aggressive medical and surgical treatment, the deep laceration progressively worsened. Serial attempts to debride the necrotic subcutaneous and muscular tissues failed to result in granulation. Maggot debridement was considered as a last resort of treatment following limited progress with tissue healing and the owner firmly declining the amputation of the digit. The treatment consisted of a single continuous application of sterile larvae over the open wound for 3 days to debride the necrotic tissues through the proteolitic action of maggot secretions, while sparing the surrounding live structures. When the complete maggot debridement was achieved, medical grade leeches were used for four consecutive applications 12 hours apart to control venous congestion. At the end of the treatment the wound was healed and completely re-epithelialized. Conclusion. Maggot debridement and leech therapy were used as alternative wound management of a nonhealing traumatic partial amputation of a digit in a dog. The treatment was safe, successful, and efficient for a difficult wound in a challenging anatomical location.

In dogs, laceration and partial amputation injuries of digits are common lesions resulting from crushing or digit-trapping accidents. The severity of the lesion depends on the anatomical location, level of contamination, extent of vascular injury, and presence or absence of deep tissue or orthopedic trauma. Because of their role as primary weight-bearing digits, third and fourth digital amputations may have a poorer prognosis than other digit injuries, and cause more significant gait abnormalities. For this reason...
numerous medical and surgical procedures, have been described in order to preserve or replace weight-bearing digits. Non-surgical treatments include autolytic or enzymatic debridement, wet-to-dry dressings, and negative pressure wound therapy (NPWT). Several surgical reconstruction techniques have also been reported, including local or distant flaps, free grafts, or digital pad transfers. Independently from the chosen type of management, negative prognostic factors attributed to failure of effective digital salvage are presence of infection, tissue necrosis, and inadequate circulation. Decreased availability of vital tissue and inadequate blood flow impede a successful surgical debridement and also prevent systemic or topical antibiotics from reaching the targeted site. These factors ultimately lead to further progression of necrosis, development of nonhealing wounds and a worse clinical outcome. 

In severe wound cases complicated by the presence of necrosis and infection, alternative forms of wound therapy have been successful when traditional medicine have failed. Among these alternative methods, biotherapy consists of using living organisms such as fly larvae for treating, for example, infected or sterile nonhealing wounds. The application of fly larvae (maggots) is referred to as maggot debridement therapy (MDT). Worldwide, another organism used for biotherapy, the leech, is considered standard of care for venous congestion after reconstructive plastic surgery. While the literature on use of biotherapy in human medicine is on the rise, there is a paucity of clinical reports in veterinary medicine. Application of MDT in veterinary medicine is more diffuse in large animals, in particular horses, compared to companion animals. A published survey of the use of maggot therapy by small animal practitioners described the treatment in two dogs, four cats and one rabbit over a 6-year period. A previous article reported the outcome of maggot-treatment of chronic bed sores and ulcers in rabbits. To the authors knowledge there are not reports presenting the combined use of MDT and leech therapy for digit injuries in small animals.

This case report describes the sequential use of maggots and leeches as treatment of a nonhealing, progressive, non-septic necrosis of a primary weight-bearing digit in a young boxer. The procedures, patient management, and outcome are discussed.

Case Report

A 23-kg, 3-year-old female spayed boxer was presented to the Ohio State University Small Animal Hospital Emergency Service for evaluation of multiple lacerations on both front limbs and partial amputation of the right front fourth digit. According to the owner, the injuries were self-induced by the dog trapping the legs under a metallic fence while playing with his playmate. On presentation, the dog was bright, alert, and no systemic abnormalities were identified. Multiple abrasions and lacerations were present on the right front limb up to level of the elbow. Approximately 60% of the girth of the fourth digit was involved with a 2 cm wide, 0.5 cm deep, severely contaminated laceration at the level of the proximal interphalangeal joint. The distal portion of the digit looked cyanotic and felt cool to the touch. Pain sensation was still present on manipulation.

The multiple abrasions were immediately treated with surgical debridement, and then by repeated wet-to-dry bandages followed by non-adherent bandages on the established granulation bed. A prophylactic broad-spectrum antibiotic was prescribed for 15 days. Epithelization of the numerous superficial skin lacerations was noted within 7 to 10 days. However, the initial management of the digital injury was unsuccessful. In spite of the aggressive medical and surgical treatment, the deep laceration progressively worsened. Due to the progression of tissue necrosis, venous congestion and infection, a tissue biopsy for bacterial culture was obtained. Both aerobic and anaerobic bacterial cultures resulted in no growth. Complete blood count and biochemical profile were within normal limits except for a moderate leukocytosis (WBC: 15000/mcL) with mature neutrophilia (PMN: 11000/mcL). Serial attempts to debride the necrotic subcutaneous and muscular tissues failed to result in granulation. The tendon of the common digital extensor, the proximal interphalangeal joint capsule and the ventral portion of the digit were preserved. The remaining vital tissue on the distal segment of the digit became insufficient for any further surgical intervention. Biotherapy with maggots and leeches was considered as a last resort of treatment following limited progress with tissue healing, and the owner firmly declining the amputation of the digit.

The first phase of treatment consisted of the continuous application of sterile larvae of the common greenbottle fly (Lucilia sericata) over the open wound for 3 days. The goal was to debride the necrotic tissues through the proteolitic action of maggot secretions, while sparing the surrounding live structures. When the complete maggot debridement was achieved, medical grade leeches were used for four consecutive applications twelve
hours apart. The goal of the leech therapy was to temporarily maintain blood drainage until complete revascularization of the digit occurred.

Sedation of the patient was needed for the maggot application. The confinement of the larvae within the lesion was critical for maximizing the effect of MDT and for avoiding complications. Under antiseptic conditions a wound-sized hole was cut out of self-adhesive hydrocolloid dressing that served as foundation for the “maggot cage.” We used a pre-manufactured dressing called Le Flap™ (Monarch Labs, Irvine, CA). The dressing was shaped to conform to the digit and the two adjacent interdigital spaces. The sterile maggots were then moved from their container to the wound, which had been previously isolated by the hydrocolloid pad (Figure 1). A total of approximately 30 larvae were transferred from the container by wiping them off the sides of the vial with a sterile saline-moistened swab. Directly after the transfer, the larvae were quickly covered with a piece of nylon netting affixed to the hydrocolloid dressing with the adhesive glue provided in the Le Flap dressing kit. The netting was finally covered with an absorbent air permeable pad of gauzes to maintain airflow to the larvae as well as to draw moisture and tissue debris from the wound. A bivalved fiberglass cast reaching the elbow was applied for preventing displacement of the “cage” during movement. A distal window on the cast allowed the three times daily changes of the top absorbent pad and re-evaluation of the wound. Maggots were left over the laceration for three days, free to move within the confinement dressing. An Elizabethan collar was maintained at all times to prevent direct patient interference.
On the third day of treatment we removed the dressing and disposed of the maggots. The dog was carefully inspected to ensure that no larvae had escaped. Wound granulation was sufficient to enable the secondary closure without any further debriding interventions (Figure 2). Horizontal pattern stent sutures were placed in order to relieve wound tension during the healing process. Twenty-four hours after the maggots were removed, the distal portion of the digit was still significantly swollen and congested, most likely secondary to both the inflammatory process and the inadequate venous return.

In an attempt to relieve the venous congestion and improve blood flow to the distal digit, four sequential applications of medical grade leeches were performed. Before each application the area was cleaned thoroughly with warmed heparinized saline to enhance vasodilation and promote ongoing bleeding. The area was not scrubbed with antiseptic agents that would impede the leech attachment. The skin surrounding the lesion was pricked with a hypodermic needle to encourage each leech to attach a targeted location. Each leech was gently picked up using standard exam gloves and the leech’s head was steered to the target spot on the skin. Two to three leeches at a time were applied (Figure 3). Once attached, each leech remained safely in place until fully distended (20–30 minutes). The leeches’ activity was monitored over the entire duration of the procedure to ensure that each leech had not migrated or detached prematurely. The prophylactic regimen of antibiotic was continued also for the entire duration of leech therapy. Giving that the therapeutic effect of leech application is continued also for the entire duration of leech therapy.

At the end of the treatment pain medications and antibiotics were discontinued and the patient was discharged. Sutures were removed ten days after application. At that time (4 days after the last leech treatment) the wound was healed and completely re-epithelialized (Figure 4). The degree of weight bearing on each digit was assessed with a pressure platform (TekScan®, Boston, MA) that allowed us to objectively measure limb function of both front limbs during consecutive strides. No statistical difference was found between the percentages of weight borne by each digit on the treated leg compared to the respective contralateral digits (Table 1). Three months later, telephone contact was made with the owner who reported that there were no residual wound problems, evidence of lameness, or other pain related behaviors.

**Discussion**

The efficacy of biotherapy in wound management has been demonstrated in both people and animals. Fly maggots have been known for centuries for their ability to debride wounds. Today, MDT is used in more than 20 countries worldwide and more than 2000 medical institutions. Greater than 30,000 patients have been treated successfully in the last 20 years. Lately, this treatment modality received the approval from the national health authorities of the United States, Great Britain, and Israel. In veterinary medicine examples of MDT are relatively rare, more commonly found in bovine and equine medicine. Our case report is the first describing the combined use of MDT and leech therapy in the attempt to prevent a digital amputation.

---

**Table 1. Data of Vertical Impulse during walk measured with Pressure Platform Gait Analysis (TekScan®, Boston, MA).** Measurements are shown in percentage of body weight born by each digital pad of both front legs. The results showed that the percentage of weight borne by the pad of the right front fourth digit (injured digit) is not statistically different from the one borne by the contralateral fourth digit. (injured leg [mean ± SD])

<table>
<thead>
<tr>
<th>Pad/Digit</th>
<th>Left front leg (mean ± SD)</th>
<th>Right front leg (injured leg [mean ± SD])</th>
<th>Difference between mean values (L-R)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacarpal pad</td>
<td>0.38 (± 0.11)</td>
<td>0.41 (± 0.23)</td>
<td>-0.03</td>
<td>0.80</td>
</tr>
<tr>
<td>Digital pad-2</td>
<td>0.88 (± 0.29)</td>
<td>0.94 (± 0.13)</td>
<td>-0.06</td>
<td>0.70</td>
</tr>
<tr>
<td>Digital pad-3</td>
<td>4.62 (± 1.09)</td>
<td>3.72 (± 0.55)</td>
<td>+0.9</td>
<td>0.15</td>
</tr>
<tr>
<td>Digital pad-4</td>
<td>6.98 (± 0.90)</td>
<td>6.44 (± 0.65)</td>
<td>+0.54</td>
<td>0.23</td>
</tr>
<tr>
<td>Digital pad-5</td>
<td>4.66 (± 0.32)</td>
<td>5.36 (± 0.79)</td>
<td>-0.7</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17.44 (± 1.44)</strong></td>
<td><strong>16.88 (± 1.54)</strong></td>
<td><strong>0.56</strong></td>
<td><strong>0.57</strong></td>
</tr>
</tbody>
</table>
The successful outcome without complications suggest that this combination of biotherapies may be beneficial in cases of complicated wounds unresponsive to surgical debridement and dressing.

In this case, MDT was delayed until surgical debridement and dressing was attempted. We suspect that the causes of failure of healing following the initial treatment included insufficient necrotic debridement and insufficient blood supply. Debridement of distal extremities wounds is difficult because of the functional structures that need to be preserved. Additionally, poor blood supply and scarce soft tissue predisposes these wounds to infection and healing complications. The application of maggots in infected digital wounds may allow to debride tissue that cannot be otherwise removed surgically or with other forms of wound therapy. The technique that we used to apply the maggot dressing is simple, readily available, comfortable for the patient. Medicinal maggots have multiple beneficial actions by secreting proteolytic enzymes and antimicrobial agents into the wound, and by raising the local pH to levels that inhibits bacteria. They produce a selective debridement of the necrotic tissue in virtue of the fact that their secretions are inactivated by contact with healthy tissue. It has also been shown that they directly stimulate wound healing promoting neutrophils activation and fibroblasts migration.

Minor complications of MDT occasionally reported by human patients ranged from the emotional discomfort of hosting larvae on the skin to the occurrence of moderate pain. In the case reported here the degree of pain associated with the wound, as assessed by the dog’s response to digital pressure on the digit, decreased significantly early in the treatment. The larvae did not appear to cause any irritation to the dog, which seemed unaware of their presence. As for many other complex bandaging techniques, the application of the larvae on veterinary patients requires sedation in order to sufficiently restrain the animal during the placement of the “maggots cage.” A significant advantage of this treatment compared to wet-to-dry dressing, is that a single sedation is needed for the initial application, while wet-to-dry dressing requires daily treatments in most cases. The maggot-cage remains in place until the end of treatment and then can be easily removed without sedation of the patient. Ammonia toxicity in animals naturally infested with very high numbers of fly larvae has also been reported. Therefore the size of the wound in relation to the size of the animal may be a determinant factor for the concentration of maggots per square centimeter. Large size wounds in small patients may have to be conservatively treated with a lower concentration of larvae. Further studies should evaluate the correct number of larvae necessary for application in animals.

The application of leeches for venous congestion in the distal extremities has not been previously reported in dogs but is commonly performed in people following skin reconstruction procedures. Following digital reconstructive surgery, skin-flap transposition, and free tissue transfer, there is often a critical need for adjuvant therapy in order to restore sufficient venous drainage. In conditions of limited or absent venous drainage, the blood must be removed and the pressure must be reduced in order to avoid tissue hypoxia and consequent necrosis. Venous congestion can be treated by relieving tension on the suture site, applying heparin-soaked gauzes, or making small tension releasing-incisions. In our case, we elected to use medicinal leeches to treat the postoperative venous congestion. The leech is able to decrease venous congestion in virtue of the components of its saliva including anti-thrombotic, thrombolytic, hypotensive, anti-inflammatory, and bacteriostatic agents.

A single organism attached to the skin of a host will actively withdraw approximately 5 mL (1 teaspoon) of blood. Further therapeutic benefit of leech therapy comes after the leech is removed, during which up to 50 mL of blood will continue to ooze for up to 48 hours. In human plastic surgery, leech therapy commonly consists of multiple postoperative leech applications to the area of interest over 3 to 6 days. This is usually the period of time that it takes the veins to regenerate such that the blood is no longer pooling within the surgical site. The application of leeches to the patient is relatively simple, but does require care. The number of leeches needed for a wound depends on its size and its clinical response to the treatment. The patient's skin must be cleaned thoroughly with gentle soap and water, and then rinsed with distilled, non-chlorinated water. A gauze barrier around the intended site will prevent the leech from wandering away from the site where its attachment is desired. It can be carried to the site by hand, or it can be placed within a 5 cc plastic syringe (plunger removed) and then applied to the wound site, containing the leech until it is attached. If the leech is reluctant to bite, it might be necessary to entice it with a tiny droplet of blood, drawn from the wound site with a needle prick. Once the leech is attached, it will likely remain safely in place until fully distended. It is important that the site...
be checked continuously to insure that the leech hasn’t moved. The leech will let go of the patient (host) when it is finished (usually within 30 minutes).

Complications following leech therapy are rare but worth attention. The most common complication following leech therapy is persistent and prolonged bleeding at the site of detachment of the leech due to release of anticoagulants. Thus particular attention has to be given to the blood loss in small sized patients. A well-padded, compressive bandage can be applied if bleeding is a concern. Infection by Aeromonas sp. is possibly the most worrisome complication of leech application in human medicine and prophylactic antibiotic therapy is recommended. The cost of biotherapy in veterinary medicine may represent a drawback to its use in veterinary practice. However, a study in human patients evaluated the cost of MDT compared with conventional hydrogel bandages, for the treatment of nonhealing ulcers. The cost of applying maggots was greater per day, yet the shorter hospitalization and smaller number of dressing changes resulted in a reduced overall cost.

**Conclusion**

In this report we presented the successful application of MDT and leeches in a difficult wound management case. While it is impossible to know if other therapeutic approaches would have given similar results, we concluded that this therapy was successful, inexpensive and well tolerated by the patient. Although the literature regarding biotherapy in veterinary medicine is severely limited, the diffuse anecdotal evidence of its efficacy in animals by both general practitioners and veterinary specialists seems to be promising for the production of a more consistent, scientific literature base.

**Acknowledgement**

We thank Dr. Jonathan Dyce and Dr. Katy Townsend from the Ohio State University for completing the TekScan® analysis.

**References**


30. Gursoy K, Kankaya Y, Uysal A, Kocer U. Dealing with the


23. Horobin AJ, Shakesheff KM, Pritchard DI. Maggots and


