Medicinal Leech Use in Microsurgery

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CME Continuing Medical Education

PHYSICIANS HAVE USED the medicinal leech (*Hirudo medicinalis*) for centuries. Indeed, the etymology of the word *leech* shows it is a derivative of the Anglo-Saxon term *laece*, meaning *physician*. The earliest recorded use of the medicinal leech was depicted graphically in ancient Egypt (1567–1308 BCE), and written records date to 200 to 130 BCE. Their use has varied substantially over the past 3500 years, with indications ranging from treatment of sexually transmitted diseases to tuberculosis, kidney disease, and arthritis. Their use waned until the 1960s, when they were used to salvage tissues that were endangered from venous congestion[1] after replantation.

LEECH BIOLOGY

Of the more than 700 species of leech, *H. medicinalis* is the most widely used in medicine. Leeches have suckers on both ends of their body. The caudal sucker is larger and is used for crawling and attachment, whereas the cephalad sucker is narrow and tapered and is used for feeding. The mouth contains 3 jaws each with 60 to 100 pairs of teeth, and it creates the typical Y-shaped bite. Feeding can be stimulated by topical application of a glucose/saline solution or blood. Leeches feed at temperatures between 33°C and 40°C. Therefore, the tissue must be warm[2] to have the leech latch on to the tissue.

Leech saliva contains a variety of active biochemical compounds. The most well-known, hirudin, is a polypeptide that Haycroft isolated from leech salivary glands in 1884. It is a potent natural anticoagulant[2] that acts as a direct inhibitor of thrombin. It does not require antithrombin III and blocks the final step of both intrinsic and extrinsic clotting cascades.[2] By contrast, heparin inactivates thrombin through an antithrombin III—dependent mechanism. Hirudin is not inactivated by platelet factors or other antiheparin proteins, nor does it affect platelet function, because it has no immune-mediated ability to activate platelets. It can inactivate thrombin already bound to a thrombus, thereby preventing clot propagation. Taken together, these properties make it a highly useful anticoagulant that can be used in patients with antithrombin III deficiency, as well as in patients who are at risk for heparin-induced thrombocytopenia.[3]

Leech saliva also contains hyaluronidase, which increases tissue permeability. This allows other secretions (a histamine-like vasodilator to increase local blood flow, various proteinase inhibitors, as well as calin and apyrase, both of which are thought to inhibit platelet aggregation) to penetrate local tissue better. Another salivary protein binds to collagen and inhibits collagen's interaction with von Willebrand factor, thereby inhibiting platelet aggregation. The presence of a secreted local anesthetic has been posited as well.[2]

The obvious benefit of leeches is that they help relieve venous congestion by removing excess pooled blood physically from congested tissue. This occurs both actively, a direct result of the leech bite and blood meal, and passively after detachment of the leech. Removal of excess blood from engorged tissue reduces the capillary filling pressure and allows arterial capillary beds to reperfuse.[4] Conforti et al.[5] demonstrated that the average blood meal volume of the medicinal leech was 2.45 mL in a porcine model, whereas passive blood loss averaged 2.5 mL, with 90% occurring in the first 5 hours. The amount of active and passive blood loss during a single leech bite varies and is related to the length of leech starvation, leech size, and concentration of secretions. Laser Doppler imaging revealed that increased flap perfusion localized to a 1.6-cm-diameter circle around the bite (approximately 2-cm area), indicating that multiple leeches might be needed for adequate decongestion of larger flaps.[5]

CURRENT USE

In 1960, Derganc and Zdravic reported a series of 20 pedicled flaps compromised by notable venous engorgement. Using 3 to 6 leeches at a time on the most congested portion of the flap, and repeating this 2 to 3 times over an unspecified time period, they were able to

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completely salvage 70% of their flaps.[6] In a case series and meta-analysis, de Chalain[7] reviewed 108 cases in which leeches were applied to replants, free-tissue transfers, and pedicle flaps for an average of 4.2 days for venous congestion. The survival rate was 83% in 89 uninfected cases.[7]

Leech use has also been described in distal digital replantation when venous repair was technically impossible. Foucher and Norris[8] reported on their series of digital replantations distal to flexor digitorum superficialis insertion and found a 68.1% survival rate in digits performed without vein repair.[8] In 2004, Tuncali et al.[9] reported on 2 cases of class IIC ring avulsion injury (arterial supply intact, venous drainage disrupted) in which they were unable to perform a venous repair. Both patients received 4 to 6 leeches per day for 7 to 10 days and both recovered "excellent" function of the replanted fingers.[9]

EDUCATIONAL OBJECTIVES

- Discuss the history of the use of the medicinal leech.
- State the biomechanical compound in leech saliva responsible for anticoagulation.
- Discuss the factors that affect the amount of active and passive blood loss during leech therapy.
- State the role and outcome of leeches in venous congestion following tissue transfer.
- Describe the main complication following leech therapy.

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COMPLICATIONS

The main complication of leech therapy is infection. The reported incidence ranges from 2% to 36%. Several bacterial species have been identified. The most common is *Aeromonas hydrophilia*, which lives symbiotically in the leech digestive track and aids in the digestion of ingested blood. *Aeromonas* has a high affinity for muscle tissue, and deep infection may resemble clostridial infection with the production of local gas. Infection after leech therapy can cause septicemia, local tissue damage and flap failure, prolonged hospital stay, the need for additional antibiotics, and even death.[10] Severe infections should be treated with aggressive debridement and high-dose antibiotics. Reported flap survival in infected cases is less than 30%.[7] Antibiotic prophylaxis for the duration of leech therapy is recommended with ciprofloxacin,[10] although culture and sensitivities of leech secretions at individual institutions can help guide the appropriate selection of antibiotic prophylaxis if necessary.

Other complications include excessive blood loss requiring transfusion, scarring from leech bites, local hypersensitivity reaction, and anaphylaxis. Relative contraindications for leech therapy include arterial insufficiency, immunosuppression, opposition to blood transfusion (as with Jehovah's Witnesses), prior allergic reaction to leeches, and the inability to cooperate with leech therapy for psychological reasons.[7]

RECOMMENDATIONS

Based on the available literature, we recommend applying one leech per 2 cm^2 of congestion. Leeches should be left on until they detach themselves, and the wounds should be wiped with a moist or heparin-soaked gauze every 15 to 30 minutes to encourage continued passive bleeding. New leeches should be applied once passive bleeding has stopped. This cycle should continue until the flap has revascularized. Antibiotic prophylaxis should be given. Oral ciprofloxacin, 250 to 500 mg, can be used empirically in twice-daily dosage.

The following points bear repeat mention: (1) feeding can be stimulated by topical application of a glucose/saline solution or blood, and tissue must be warm to have the leech latch on to the tissue. (2) Hirudin, a polypeptide isolated from leech salivary glands, is a potent natural anticoagulant that acts as a direct inhibitor of thrombin. It does not require antithrombin III, and blocks the final step of both intrinsic and extrinsic clotting cascades. (3) Hirudin is a highly useful anticoagulant that can be used in patients with antithrombin III deficiency as well as in patients who are at risk for heparin-induced thrombocytopenia. (4) The most common complication of leech use is infection with *A. hydrophilia*, which lives symbiotically in the leech digestive tract and aids in the digestion of ingested blood. *Aeromonas* has a high affinity for muscle tissue, and deep infection may resemble clostridial infection.

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JOURNAL CME QUESTIONS

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What is the biomechanical compound in leech saliva responsible for anticoagulation?

a. Heparin
b. Hirudin
c. Hyaluronidase
d. Coumadin
e. Antithrombin III

What factors directly affect the amount of active and passive blood loss during leech therapy?

a. Leech starvation
b. Leech size
c. Concentration of secretions
d. All of the above

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