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The use of medicinal leeches in microsurgery

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Medicinal leeches have been used to treat a variety of ailments for thousands of years. During the past decade the leech has become valuable for salvaging surgically uncorrectable venous insufficiency which is occasionally encountered after microsurgical free flap and replantation procedures.

Leech anatomy and physiology are reviewed. Indications and the technique for application of medicinal leeches is discussed, as well as potential complications of leeching.

Key words: Leech, microsurgery, replantation, venous insufficiency, salvage, infection, *Aeromonas hydrophila*.

Introduction

The medicinal leech (*Hirudo medicinalis*) is indigenous to Europe.[1] This bloodsucking animal feeds on mammals, amphibians and fish.[2]

The leech has three sharp jaws that create a Y-shaped wound into which it injects hirudin, a polypeptide elaborated by perioral glands. The constant flow of blood is assured by the anticoagulant factor(s) that prevents clotting during, and for several hours after, the bloodsucking activity.

These remarkable characteristics have been recognized since ancient times, and although there was no scientific justification, the leech was widely used as a medical treatment for a variety of ailments.

The earliest documented use of leeches is found on an Egyptian tomb wall painting from the 18th Dynasty (1567 - 1308 BC). Leeching is described in detail in the early Sanskrit system of medicine of ancient India. The Greeks and Romans also used leech therapy several centuries BC.[2]

John Hunter, in his book *A Treatise of Blood, Inflammation and Gunshot Wounds*,[3] discusses the use of leeches and cautions against their use in patients with gunshot wounds, particularly in the area of devitalized tissue.

Widespread use of leeches in Europe began during the 17th century and peaked during the first part of the 19th century, largely due to the influence of Broussais, Napoleon's military surgeon. During that time, French hospitals were using enormous numbers of leeches. According to French import records, over a billion leeches were imported into France during the 19th century. Their use became so extensive that in 1910 the medicinal leech was thought to have become extinct in Britain.

In 1884, Haycraft of Wales isolated hirudin, the anticoagulant elaborated by the leeches. However, it was not until 1955 that hirudin was chemically analysed and found to be a small peptide consisting of 65 amino acids with specific antithrombin activity.

Renewed interest in leeches has developed over the past several years, particularly in microsurgery as a result of reported favourable European experiences. Foucher *et al.*,[4,5] have reported the use of leeches to successfully treat digit replants, where no venous outflow vessels were available. They applied a leech twice a day for 5 days and salvaged six out of ten such cases.

Other reports[6,7] of the successful use of leeches in the treatment of venous congestion in skin flaps have also increased the investigation and use of the leech. These animals have provided the only solution to such a vexing problem as venous congestion in an ear replant, where there was no suitable axial venous outflow.[8]

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Leech anatomy and physiology

The medicinal leech has been described in great detail by Mann and others.[9-11] The leech is ~ 12 cm long, but is usually contracted to about one-third of this size at rest. It is a dark brownish-green colour with black or dark brown stripes running longitudinally. The body consists of 102 annuli with five annuli constituting a segment, except at each end, where the number of annuli per segment is decreased progressively. The body is tapered at each end, the narrower being the anterior sucker, or mouth, and the larger, disk-like end, being the posterior, or attachment sucker.

The anterior sucker is equipped with a retractable system of three sharp jaws comprised of semicircular muscular ridges with numerous minute teeth along their edges. The jaws are brought forward, and with a sawing action, create a Y-shaped incision through which a local anaesthetic, hirudin, a vasodilator, and other physiologically active substances are instilled. These substances are elaborated by perioral unicellular salivary glands.

Leeches are hermaphrodites, having both male and female pores. They feed infrequently and according to some authors may live for as long as 200 days without food.[11-13] Upon feeding they can intake from two to five times their body weight in blood at one meal. The blood is then digested in the gut over a 100-day period, during which water is extracted and excreted through 17 pairs of ventrally located nephridia.

The digestion process appears to be carried out by symbiotic bacteria as no proteolytic gut enzymes have been identified.[14-17] Original studies of leech digestion identified the predominant leech enteric organism as *Pseudomonas hirudinis* or *Aeromonas liquefacients*.[18,19] Current studies[19] identify *Aeromonas hydrophila* as the predominant organism, and some researchers caution against the use of leeches because they pose a danger of serious infection. Whitlock *et al.*[20] suggested the use of 'Hirudoid' cream with antispasmodic, as well as its standardized anticoagulant activity.

Despite these concerns, leeches have been increasingly used without widely reported infection problems. Perhaps the reason for this low infection rate is the continued bleeding following leech therapy which serves to rinse out the wound and thus clear bacteria from the wound. Sawyer[21] suggested that this bleeding has adaptive significance in the wild, as infection of the host might lead to the leech's demise and thus deplete the available food source, thus jeopardizing the leech's own survival.

This theory appears to be reinforced by the observation that use of leeches on or near open wounds, macerated tissue, or eschar can result in superficial or invasive *Aeromonas hydrophila* infection.[22-24] Therefore, antibiotics should be considered when leeches are used, especially when they are placed adjacent to compromised tissue. The leeches ingest circulating medication contained in their host's blood,[24] and thus, antibiotics effective against *Aeromonas hydrophila* may therefore sterilize the leech gut as well as protect host tissue against infection.[16] Parenteral antibiotics that are effective against *Aeromonas hydrophilia* include cefoxition, third-generation cephalosporins (e.g. cefotaxime), and trimethoprim-sulphamethoxasole.[24-27]

Because of concerns about potential infection, leeches are used only for a single application. Once applied, the leech is left undisturbed until it detaches voluntarily to minimize the possibility of infection from the regurgitation of gut contents.

Indications for use of the leech

The principal indication for use of leeching is venous insufficiency. This is usually the result of an inadequate number or size of veins available for repair to accommodate the arterial inflow to a flap, or replanted digit. The leech relieves this problem by enhancing the circulation through the vasodilation and vascular decompression resulting from its feeding activity. Some authorities have advocated the use of leeches for arterial insufficiency although this indication is less widely accepted. The theory is that the vasodilatory and decompressing activity of a feeding leech will enhance inflow into the suffering tissue.

Technique of leech application

It is important to use a leech that is exhibiting feeding behaviour in order to assure that leeching will be successful. Thin, active leeches are more likely to attach to a 'host'. If the leech does not readily attach, and adequate arterial circulation is present, a different leech should be sought. If a leech is used immediately after surgery, it may stop feeding because of absorption of anaesthetic agents from both general or local anaesthesia.

Initially, before recognizing this phenomenon related to the anaesthetic agents, we had called this problem the 'lazy leech syndrome' wrongly blaming the leech. The solution to this problem is to allow sufficient time for the anaesthetic agent to clear prior to applying the leech.

Ointment, skin antiseptics, or old blood should be removed from the congested flap or digit. The desired area of attachment is then surrounded with gauze to inhibit the leech from moving to another area. Alternatively, a plastic sheet, (Op Site, Acme United Corporation, Bridgeport, CT, USA) can be applied and a hole made where the leech is to be attached. A pinprick is

made in the skin and some blood expressed. Alternatively, in order to limit trauma to the tip of a replanted digit, a portion of the nail plate may be removed and the exposed nail bed used as the attachment site.

To induce attachment, a drop of 5% glucose (D5W) is then placed on the wound, and the mouth sucker, narrow end, of the leech is applied to the blood and glucose droplet. The use of disposable gloves and gentle handling with forceps reduces the possibility of the leech being injured or attaching itself to the applier's hand. Once the leech has begun feeding as evidenced by peristaltic motion it should be left undisturbed until it becomes engorged, at which time it will either fall off or may be removed by stroking it with an alcohol or saline swab.

The leeches are applied to the congested flap or digit three or four times a day for 2 or 3 days, then two or three times a day for 2 or 3 days and gradually tapered as the clinical findings of venous insufficiency resolves.

The leeches may be kept in a Bell jar filled with spring water (or distilled water treated with Hirudosalt™, Biopharm (UK) Ltd, UK) and capped with a nylon stocking cover, held with a sturdy elastic band and placed in a refrigerator, where the cold temperature decreases their activity and the need for feeding for several weeks. The water is changed weekly or sooner if it becomes cloudy, but this requirement will vary with the density of leech population the jar supports.[20] Commercial suppliers of leeches generally provide detailed instructions for leech care and maintenance and should be consulted as needed.

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