Maggot therapy

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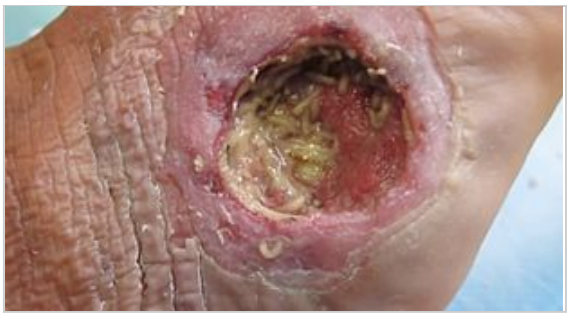
Maggot therapy (also known as **maggot debridement therapy** (**MDT**), **larval therapy**, **larva therapy**, **larvae therapy**, **biodebridement** or **biosurgery**) is a type of biotherapy involving the introduction of live, disinfected maggots (fly larvae) into the non-healing skin and soft tissue wound(s) of a human or animal for the purpose of cleaning out the necrotic (dead) tissue within a wound (debridement) and disinfection.

There is evidence that maggot therapy may help with wound healing.[1]



Maggot debridement therapy on a wound on a diabetic foot

Contents

Medical uses

Maggot therapy improves healing in chronic ulcers.[1]

In diabetic foot ulcers there is tentative evidence of benefit.[2]

In 2004, the FDA cleared maggots for use as a medical device in the United States for the purpose of treatment of:[3]

- Non-healing necrotic skin and soft tissue wounds
- Pressure ulcers
- Venous stasis ulcers
- Neuropathic foot ulcers
- Non-healing traumatic or post-surgical wounds

Limitations

The wound must be of a type which can benefit from the application of maggot therapy. A moist, exudating wound with sufficient oxygen supply is a prerequisite. Not all wound-types are suitable: wounds which are dry, or open wounds of body cavities do not provide a good environment for maggots to feed. In some cases it may be possible to make a dry wound suitable for larval therapy by moistening it with saline soaks, applied for 48 hours.

Patients and doctors may find maggots distasteful, although studies have shown that this does not cause patients to refuse the offer of maggot therapy.[4] Maggots can be enclosed in opaque polymer bags to hide them from sight. Dressings must be designed to prevent any maggots from escaping, while allowing air to get to the maggots.[5] Dressings are also designed to minimize the uncomfortable tickling sensation that the maggots often cause.[6]

Mechanisms of action

The maggots have 4 principal actions:

- Debridement[7]
- Disinfection of the wound[8]
- Stimulation of healing[8]
- Biofilm inhibition and eradication[9]

Debridement

In maggot therapy, large numbers of small maggots consume necrotic tissue far more precisely than is possible in a normal surgical operation, and can debride a wound in a day or two. The appearance of a wound's surface is typically increased with the use of maggots due to the undebrided surface not revealing the actual underlying size of the wound. They derive nutrients through a process known as "extracorporeal digestion" by secreting a broad spectrum of proteolytic enzymes[10] that liquefy necrotic tissue, and absorb the semi-liquid result within a few days. In an optimum wound environment maggots molt twice, increasing in length from 1–2 mm to 8–10 mm, and in girth, within a period of 48-72 hours by ingesting necrotic tissue, leaving a clean wound free of necrotic tissue when they are removed.

Disinfection

Any wound infection is always a serious medical complication. Infected living tissue cannot heal. If the wound is infected with an antibiotic-resistant bacterial strain, it becomes difficult or impossible to treat the underlying infection and for any healing to occur. Wound infection could further be limb- and life-threatening. Maggot secretions are also effective against some antibiotic-resistant bacteria and have been shown to possess potent antimicrobial activity in early experimental studies from the 1930s. As early as 1957, a specific antibiotic factor was found in maggot secretions and published in the journal Nature.[11] Secretions believed to have broad-spectrum antimicrobial activity include allantoin, urea, phenylacetic acid, phenylacetaldehyde, calcium carbonate, proteolytic enzymes, and many others.[12] Bacteria not killed by these secretions are subsequently ingested and lysed within the maggots.

In vitro studies have shown that maggots inhibit and destroy a wide range of pathogenic bacteria including methicillin-resistant *Staphylococcus aureus* (MRSA), group A and B streptococci, and Gram-positive aerobic and anaerobic strains. Therefore, maggot therapy might represent a cost-effective method for managing MRSA infection. Other bacteria like *Pseudomonas aeruginosa*, *E.coli* or *Proteus* spec are not attacked by maggots and in case of *Pseudomonas* even the maggots are in danger.[13] Consequently, using maggots alone might lead to a change of bacteria cultures on the wound.

Biology of maggots

Those flies whose larvae feed on dead animals will sometimes lay their eggs on the dead parts (necrotic or gangrenous tissue) of living animals. The infestation by maggots of live animals is called "myiasis." Some maggots will feed only on dead tissue, some only on live tissue, and some on live or dead tissue. The flies used most often for the purpose of maggot therapy are "blow flies" (Calliphoridae); and the species used most commonly is *Lucilia sericata*, the common green bottle fly. Another important species, *Protophormia terraenovae*, is also notable for its feeding secretions, which combat infection by *Streptococcus pyogenes* and *Streptococcus pneumoniae*.[14]

Lucilia sericata, Green Bottle Fly

History

Protophormia terraenovae, Northern blowfly

Written records have documented that maggots have been used since antiquity as a wound treatment.[15] There are reports of the use of maggots for wound healing by Maya Native Americans and Aboriginal tribes in Australia. There also have been reports of the use of maggot treatment in Renaissance times. Military physicians have observed that soldiers whose wounds had become colonized with maggots experienced significantly less morbidity and mortality than soldiers whose wounds had not become colonized. These physicians included Napoleon's general surgeon, Baron Dominique Larrey. Larrey reported during France's Egyptian campaign in Syria, 1798–1801, that certain species of fly consumed only dead tissue and helped wounds to heal.[16]

Dr. Joseph Jones, a ranking Confederate medical officer during the American Civil War, is quoted as follows, "I have frequently seen neglected wounds ... filled with maggots ... as far as my experience extends, these worms eat only dead tissues, and do not injure specifically the well parts." The first therapeutic use of maggots is credited to a second Confederate medical officer Dr. J.F. Zacharias, who reported during the American Civil War that, "Maggots ... in a single day would clean a wound much better than any agents we had at our command ... I am sure I saved many lives by their use." He recorded a high survival rate in patients he treated with maggots.[17]

During World War I, Dr. William S. Baer, an orthopedic surgeon, recognized on the battlefield the efficacy of maggot colonization for healing wounds. He observed one soldier left for several days on the battlefield who had sustained compound fractures of the femur and large flesh wounds of the abdomen and scrotum. When the soldier arrived at the hospital, he had no signs of fever despite the serious nature of his injuries and his prolonged exposure to the elements without food or water. When his clothes were removed, it was seen that "thousands and thousands of maggots filled the entire wounded area." To Dr. Baer's surprise, when these maggots were removed "there was practically no bare bone to be seen and the internal structure of the wounded bone as well as the surrounding parts was entirely covered with most beautiful pink tissue that one could imagine." This case took place at a time when the death rate for compound fractures of the femur was about 75–80%.[18]

Regulation

In January 2004, the U.S. Food and Drug Administration (FDA) granted permission to produce and market maggots for use in humans or animals as a prescription-only medical device for the following indications: "For debriding non-healing necrotic skin and soft tissue wounds, including pressure ulcers, venous stasis ulcers, neuropathic foot ulcers, and non-healing traumatic or post-surgical wounds."[19][20]

Veterinary use

The use of maggots to clean dead tissue from animal wounds is part of folk medicine in many parts of the world.[21] It is particularly helpful with chronic osteomyelitis, chronic ulcers, and other pus-producing infections that are frequently caused by chafing due to work equipment. Maggot therapy for horses in the United States was re-introduced after a study published in 2003 by veterinarian Dr. Scott Morrison. This therapy is used in horses for conditions such as osteomyelitis secondary to laminitis, sub-solar abscesses leading to osteomyelitis, post-surgical treatment of street-nail procedure for puncture wounds infecting the navicular bursa, canker, non-healing ulcers on the frog, and post-surgical site cleaning for keratoma removal.[22]

However, there have not been many case studies done with maggot debridement therapy on animals, therefore, it can be difficult to assess how successful it is.[23]

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External links

- Maggot Medicine film (https://www.youtube.com/watch?v=KrmA85IuoFU) produced by Robert Cibis
- National Geographic video segment on Maggot Medicine on youtube.com (http://youtube.com/watch?v=6Xt6NWkgydM)
- The NIH Record; Medieval Miracle Workers — Are Maggots Making a Medical Comeback? The National Institutes of Health experience with maggot therapy (http://nihrecord.od.nih.gov/newsletters/2004/07_20_2004/story01.htm)

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