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Therapeutic applications of blowfly maggots: A review

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Abstract

Blowfly maggots (Diptera: Calliphoridae): greenbottle blowflies (*Lucilia illustris*; Meigen, *L. sericata*; Meigen) and blackbottle blowfly (*Phormia regina*; Meigen) used in maggot therapy. Necrotic wounds that are complicated and resistant to conventional treatment are treated with maggot therapy due to its effectiveness and environmental friendly nature. It is used for the treatment of traumatic wounds such as pressure ulcers, diabetic ulcers, neurovascular and vascular ulcers, osteomyelitis, postsurgical wound infections, and burns. Recently, maggots are produced and distributed especially and supplied to hospitals as a medical device using in medicine. There is still little research on the effectiveness of maggot therapy in comparison to other conventional treatments. We should recommend maggots therapy in hospitals due to cost effective and rapid debridement of dead tissue.

Keywords: Blowfly-Maggots, maggot-therapy, osteomyelitis, ulcers, traumatic-wounds

Introduction

For centuries, non-healing soft tissue wounds are treated with maggots' therapy^[1], secondarily it is known as maggot debridement therapy (MDT), larval therapy, larva therapy, larvae therapy, bio-debridement or biosurgery that is used for the treatment of chronic wounds^[2, 3, 8]. For a while, due to improved surgical techniques and antibiotics, it is disappeared. Recently, it has made resurgence and inspected medicinal maggots^[1]. Maggots are preferred to kill and obstruct the growth of many pathogenic bacteria^[4, 8] by producing antimicrobial peptides^[5]. In this therapy live sterile maggots are kept into soft wounds of animals and humans for removal of the dead tissue and disinfection^[3]. Maggot's therapy has 3 benefits: Debridement of necrotic tissue, development of tissue granulation, and wound antiseptic due to antimicrobial activity of maggots^[4, 6, 28]. The three species of blowflies (Diptera: Calliphoridae) used in maggot therapy. These are greenbottle blowflies (*Lucilia illustris*; Meigen, *L. sericata*; Meigen) and blackbottle blowfly (*Phormia regina*; Meigen)^[6, 8, 11-14, 19, 21]. Adult flies of all three species are kept in incubators at temperature of 26.7 °C and 40-60% relative humidity. There is no need of sterilization of fly cages, but they should keep clean. Diluted honey and yeast mixture, or sugar or sliced bananas are fed to the flies. A piece of beef make available for flies to lay eggs, about 100 fly colony lays 1000 eggs per day. 10% formalin, or mercuric chloride, alcohol and hydrochloric acid solution is used for the sterilization of eggs. Than larvae are kept at sterilized food source, hatched within 24 days and grow into 7 days. For maggot therapy we used larvae after 2 days of hatching. At wound site 200-400 larvae are deposited^[6, 11, 12, 14, 33]. In human medicine, a dose of 5-10 maggots/cm² of wound surface area is applied. In veterinary medicine, a dose of 5-10 maggots/cm² and 8-12 maggots/cm² of wound surface area is applied^[8]. Average larva eats 10-15g dead tissue per day. After 4-5 days, when larvae full grown, stop feeding. They are removed from wound and new cluster of larvae introduced. This process is repeated for 3-4 weeks^[6]. Maggots secrete mixture of proteolytic enzymes (carboxypeptidases A and B, leucine aminopeptidase, collagenase, and serine proteases) at wound site, where these enzymes remove dead tissue, microbes and foreign matter. Growth of bacteria is blocked due to the secretion of sodium bicarbonate by maggots^[8, 12, 27]. They also remove calcium carbonate that increases phagocytosis^[11]. There are two ways to apply maggots on wound: one is direct application of maggots on wound while secondly we apply maggots contacting bag along with foam to provide ideal environment to maggots^[35, 36, 39].

Therapeutic Applications of Blowfly Larvae for Treatment of Osteomyelitis and Venous Ulcers

Few decades ago maggot therapy was used in the United States. Osteomyelitis (bone infection) were treated by the application of blowfly larvae (Diptera: Calliphoridae) [6, 9, 10]. Inflammation of bone and bone marrow is known as osteomyelitis. It is the indication of infection and mainly caused by bacteria, also caused by fungi, parasites, and other microorganisms [6, 7]. Maggots excretion include urea and allantoin that is important for the treatment of osteomyelitis because its decreases secondarily infections [11, 18]. An 88-year-old woman was referred from a local convalescent hospital to the Emergency Room of San Francisco General Hospital Medical Center facial tumor. Blowfly larvae were used to treat this facial tumor. In 1930, 89 patients of osteomyelitis were treated by using maggots of blowfly larvae [23]. A 74 year old man with venous ulcers treated by using blowfly maggots [25].

Therapeutic Applications of Blowfly Larvae for Treatment of Chronic Wounds

The larvae of the green-bottle fly *Lucilia (Phaenicia) sericata* used to treat chronic wounds [26]. Initially, maggot therapy is used for the treatment of chronic wounds in humans, but later it is used for animals due to its safe and effective method to cure untreated wounds. Deep penetrating wounds such as palmer regions of the foot, navicular apparatus, digital cushion, and coffin joint infections of animals are treated with maggot therapy. Maggot therapy has been used successfully in a wounded bull, two donkeys, two ponies, mule and horses [8]. Growth factors, cytokines and chemokines are bioactive molecules and regulators of wound healing. Platelet-derived growth factor (PDGF), epidermal growth factor (EGF), fibroblast growth factor (FGF) and transforming growth factor (TGF), are growth factors that released from wound site to assemble inflammatory cells to the wound site. Differentiation of leucocytes and chemokine occur by cytokines, involved in chemotaxis and activation of leukocytes. Vasodilation and increased capillary permeability to the wound site occur by growth factors, cytokines and chemokine, causing entry of polymorphonuclear leucocytes (PMNs) and macrophages play important role in clearing of wound [13, 14, 17, 34, 37, 52]. Maggots of the blowfly *Lucilia sericata* affect the wound healing by effecting the differentiation of monocytes into pro-inflammatory and anti-inflammatory macrophages, because these cells are important in wound healing [42].

Therapeutic Applications of Blowfly Larvae for Treatment of Chronic Leg Ulcers

Maggot therapy is used for the treatment of diabetic foot ulcers [20]. Twenty five patients suffering chronic leg ulcers and pressure sores were treated through maggot therapy. Maggots of the green bottle fly, *Phaenicia sericata* were used for his treatment. Wounds were chronic; thirty five wounds were present on foot, one on thumb, whereas pressure sores were present on lower back. Maggots were applied at wound sites 2-3 times weekly. Hospitalized patients were treated in different departments of the Israel Hadassah Hospital. Complete debridement was attained in 38 wounds (88.4%); in three wounds (7%), the debridement was significant, in one (2.3%) partial, and one wound (2.3%) remained unchanged [15]. A 43 year old man foot wound was treated through maggot therapy. His foot had degloving

injury foot and lost most of his soft skin. After 4 weeks minimal skin were recovered than maggots were implanted on wound for 48 hours, than second implementation occurred after 72 hours. There was daily dressing change for next 6 weeks. Patients got recovery without any intervention [16]. Maggots of *Phaenicia (Lucilia) sericata* were used to treat diabetic foot ulcers; there were 18 patients with 20 non-healing wounds. Conventional therapy was used to treat 6 wounds, maggots' therapy was also used to treat 6 wounds, and remaining 8 wounds were treated firstly conventional therapy than maggot therapy. During 14 days of conventional therapy, there was no significant change in wound. While maggots removed most of the dead tissue from the wound in first 14 days of treatment. So maggot therapy was the most effective than conventional therapy to treat diabetic foot ulcers [21]. In May 1999, A 53 year old man left leg ulcers was treated by the application of common greenbottle fly (*Lucilia sericata*) maggots on wound site at satisfactory level [31]. A 51 year old white female had multiple necrotic ulcers on hips and lower extremities. Those ulcers were treated by the application of sterile surgical maggots, *Phaenicia sericata* [32]. Maggot therapy used to treat diabetic foot ulcer of 74 year old lady by using larvae of *Chrysomya megacephala*. There was reduction in wound size of 0.7 cm² in area by applying the therapy for 43 days [47].

Advantages and Disadvantages of Maggot Therapy

Blowfly maggots feed only on dead tissue, so they don't give harm to normal tissue. These maggots are easily available and this therapy is cost-effective [24, 29, 30, 41, 45, 46, 48]. Necrotic wounds that are complicated and resistant to conventional treatment are treated with maggot therapy due to its effectiveness and environmental friendly nature [3, 43]. It reduces the healing time [6], and relatively rapid treatment for chronic wounds that require surgery and resistant to conventional therapy [15]. Initially, when larvae are introduced at wound site, they cause itching sensation over normal skin around the wound by crawling. This is inhibited by covering the wound containing larvae with gauze [6, 8].

Current Status of Maggot Therapy

Necrotic tissue and wounds treated with maggot therapy are decreased an average of 4.1cm and 33% in 4 weeks. Wound sores significantly reduced by maggot therapy as compared to conventional therapy. Maggots therapy used for the treatment of traumatic wounds such as pressure ulcers, diabetic ulcers, postsurgical wound infections, and burns [34, 38, 49-51]. It is more effective than conventional therapy [40] because of inducing chronic wound healing and initiating tissue granulation [44]. Recently, maggots are produced, distributed especially and supplied to hospitals as a medical device using in medicine. In 20 countries, there are 12 laboratories that supply maggots to wound care center at low price [45].

Maggot Therapy Future Prospects

In case of diseases, osteomyelitis and deep wound infections, when conventional antibiotic and surgical therapy remain unresponsive than maggot therapy become available for treatment [6, 13]. In future, it may be used for superficial infection. It should use for medical and veterinary aspects [34].

Conclusion

Recently, chronic ulcers were treated by using antibiotics and surgery while maggot therapy used for wound healing. When we focus on debridement than maggot therapy is best option and gives good results. Surgery is harmful and sometimes causes damage to healthy tissues while maggot therapy only debride dead tissues and don't cause damage to healthy one but harmful only for bacteria. This review shows the effectiveness of blowfly larvae for the treatment of non-healing wounds, pressure ulcers, diabetic ulcers, chronic wounds, osteomyelitis and venous ulcers. There is still little research on the effectiveness of maggot therapy in comparison to other conventional treatments.

Recommendations

Maggot therapy is effective than conventional therapy and surgery method. It should be used for the treatment of many diseases that are incurable to antibiotic and surgery. It should be used for the treatment of many above mentioned diseases instead of using conventional therapy. But care always should be in mind while using maggot therapy. Maggots should be sterilized when used for treatment. Dressing must be done on wound to prevent maggots from escaping. Tickling and itching sensation by maggots crawling should be minimized by doing dressing on wounds. We should recommend maggots therapy in hospitals due to cost effective and rapid debridement of dead tissue.

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