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MAGGOT DEBRIDEMENT THERAPY: CONCEPTS, METHODS, ISSUES AND FUTURE

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ABSTRACT

In the several recent centuries, maggots have been used to treating infected and necrotic wounds. After using frequently of maggot debridement therapy especially in the half first of 20th century, the attention to this method of debridement has dramatically declined. The reason of this disinclination was introducing antibiotics. However, due to several reports of antibiotic resistance emergence maggot debridement therapy has gained popularity again. Since antibiotic resistance maggots are under the auspices of physicians used in humans treat chronic ulcers which is not responding to common treatments. Studies shows that maggots not also are practically debriding ulcers but also disinfect wounds and effectively helping granulation tissue formation. Especially maggots have greater disinfection effect on wounds colonized by gram positive bacteria than gram negative bacteria. In comparison with helpful effects, their adverse effects are negligible. Yuck factor which is meaning difficulties in obtaining patient permission for maggot debridement therapy is one of the problems in maggot therapy debridement. In some cases, just a slight pain and bleeding in treating area with maggots is reported. Nowadays, for eliminating side effects of maggot debridement therapy biobags which maggot secretions can go cross through it and absorbing exudation while allowing oxygen to reach the maggots.

Key words: *Luciliasericata*, Chronic Wounds, Diabetes, Treatment.

INTRODUCTION

Nowadays, the weight of population is dramatically increased which resulting increase in some diseases such as diabetes. Increasing the number of people which suffer diabetic problem, caused increasing in the number of patients suffering from chronic wounds [1]. Chronic wounds are wounds that do not heal within about three months [2].

Treating chronic wounds, especially in presence of co-existing factors viz. infection and simply diabetes which they are the most important inhibition factors in healing is very difficult. Chronic wounds reported as an important risk factor for hospitalization, amputation and even death. In addition to being painful and uncomfortable, chronic wounds therapy represents a significant financial burden both to the individual and the society.

Since above mentioned difficulties, uclers may never heal or taking time and create a financial burden [3]. Remarkable progressive in wound treating caused healing a lot kind of wounds. However, in some cases common methods of wound healing could not work well. The increasing problems of antibiotic resistance in human being have caused more adsorption interest in any alternative treatment which may lead to less use of antibiotics. In view of this study, different aspects of maggot debridement therapy as an alternative for conventional methods were reviewed.

Larval Therapy – a Historical Perspective

Effects of maggots in wounds healing have been recognized since the 16th century. The idea of purposefully maggots rearing for using in wound care was

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born in early 20th century [4]. During World War I, several military surgeons showed the beneficial effect of these on wounds [4,5]. Treating two injured soldiers with wounds filled with maggots caused believe that maggots can prevent and cure the infections. While these soldiers had been lying on the battlefield for a week with no access to food or water, they hadn't shown any symptoms of fever septicemia. After these observations, some experiments were performed on voluntaries. In these experiments, maggots successfully were used in wound care and carried on to treat several cases of osteomyelitis [5].

Maggot debridement therapy had been popular in human medicine for healing human wounds and was frequently used in hospitals in the first half of the 20th century before falling out of favor due to antibiotics introduction and improvement of surgery methods [6-7]. But, after occurrence of antibiotic resistance attentions adsorbed again to maggot debridement therapy as alternative [6,8].

Antibiotic Resistance

Due to some reasons viz. use and misuse of antibiotics resistance has developed [9]. Emergence of resistance to broad range of antibiotics viz. cephalosporins, penicillins and carbapenems in *Staphylococcus aureus* and *Staphylococcus pseudintermedius* which are the most commonly occurring bacteria in human wounds is reported. Emergence of these resistances was the most important motivator to tendency toward maggot debridement therapy in wounds which is not responded to conventional ways.

Debridement Definition

Debridement which is removing necrotic tissue seems to be one of the most important steps in wound management especially in treatment of chronic wounds [10-11]. Debridement is dividing into four methods viz. surgical, chemical, autolysis and biosurgery (including maggots) [12]. The most important and common step in treating of ulcers is debriding necrotic tissues which research is showed that they make a barrier to migration of epithelial cells and result in healing the wound be slowed down. These statements clarify usefulness of good debriding in treating a chronic wound. In this study, some aspects of biosurgery method in healing chronic wounds are studied. Biosurgery is using of live organisms like maggots.

Biology of Flies Use in Debridement

Those flies whose larvae use in debridement belong in family Calliphoridae of dipteral. These flies which feed on dead animals especially their dead parts lay their eggs on necrotic and gangrenous tissues of living animals; this phenomenon in animal is called myiasis. Maggots which cause myiasis divided into three types, the first type will feed just on dead tissue, the second one feeds on live tissue, and the last one feeds some on both live and dead tissue. The second type is usually used in the maggot debridement therapy [13].

The species which playing most important role in debridement commonly is *Lucilia sericata*. Female adults of this species lay their eggs in clusters in a large number (about 2000–3000) directly on the source in the few weeks of life. Eggs hatch within about 18 to 24 h into first larvae. These small larvae (1–2 mm in length) immediately begin to feed actively and vigorously on food. Larvae after two molting and increasing in size to about 8-10 mm leave the wound to find a suitable place to pupate. Adult emerges from the pupa after metamorphosis. In clinical use obtaining sterilized larvae is very important; to approaching this goal sterilized eggs by chemical substances is used. Then emerged larvae are maintained under the aseptic conditions before using [14-15].

Advantages, Disadvantages and Warnings of Maggot Debridement Therapy

Comparison between maggot debridement therapy and other ways of debridement showed more rapid debridement than wounds treated by common debriding methods. Granulation tissue formation by using maggot debridement therapy is reported more than common treatment. Also, treatment wounds by maggots results in reduced odor and reduced exudates [16].

However, some possible disadvantages viz. bleeding and pain can happen. The possibility of bleeding in patients who take antiplatelet medication is more probable than other patients. Also, pain is varied with individuals and can be overcome by using drugs. In maggot debridement therapy is very important to avoiding in use of the maggots near major vessels. In these cases, maggots can be use in biobag [17-18]. Yuck factor which is meaning difficulties in obtaining patient permission for maggot debridement therapy. It might be due to common misunderstanding about the cleanliness of maggots by the general public [19].

Biosurgery is defined as a procedure which maggots are using to perform debridement on necrotic wounds [15-20]. The most common maggots which are using in biosurgery are maggots of *Lucilia sericata.* These maggots are effective necrophagus and the most preferable for maggot therapy [10, 13]. The most important advantage of *L. sericata* is feeding relatively superficially of wounds without feeding of flesh [21]. Maggots cause wound healing in three ways; i) debriding necrotic tissues, ii) promoting granulation tissue formation and iii) helping to disinfect the wound [20,22].

Debriding Necrotic Tissues

Larvae of *L. sericata* have a pair of mouth-hooks which they use them to break down and chew their food [8,21]. Also, these maggots have proteolytic enzymes

secretions that dissolve necrotic tissue from the wound surface and make it into a fluid form and fit for ingestion [15,23]. These proteolytic enzymes mainly include serine proteinases of subclasses chymotrypsin-like and trypsin-like proteinases [22-23]. These proteinases cause break down and partial digestion of necrotic tissue into microscopic scale form, and then liquefied food sucks into their alimentary tract via their pharynx [8,21].

Disinfection

Disinfection of wounds achieves by destruction of bacteria through ingestion and secretion of antibacterial compounds [8,15]. Consistent production of antibacterial substances in the maggots saliva following ingestion causes killing bacteria while they pass through the digestion tract. The effectiveness of antibacterial secretions was determined by feeding green fluorescent protein-producing *Escherichia coli* to sterile maggots. The investigation showed that the most of these bacteria were destroyed in the anterior part of the hindgut and before the anus there were not left viable bacteria [21-24].

Excretions of maggots in a mechanism which called lucifensin demonstrate antibacterial activity against a range of bacteria especially growth of Gram-positive bacteria would be inhibited, however, growth of Gram-negative bacteria is only effected and would be just slowed down. Observations in wounds treated by maggots approve this claim in vivo [25-26].

In addition to antibacterial secretions, alkylation through ammonia, urea and allantoin excretion make the wound environment unsuitable for broad range of bacterial species. Also present of these substances in secretion cause high PH which provide optimum condition for proteolytic enzyme activities [21,23, 27-28].

Promotion of Granulation Tissue Formation

Maggot secretions by changing fibroblasts behavior, reduction of fibroblast adhesion and promotion of fibroblasts in spreading across protein surfaces cause increase in granulation tissue formation [20]. Also secretion of substances like allantoin results in optimum environment for healing [8]. Also must not be neglected that secretion of Chymotrypsin-like serine proteinases in maggot secretions not only can improve of removing necrotic tissue but also promote wound healing by increasing the remodeling of provisional extra cellular matrix [29,23].

Number of Maggots Required

Exact prediction of needed maggots depends on several factors viz. amount of necrotic tissue, width of wound area, depth of wound and bacteria species. One factor that must be considered for treatment is the amount of necrotic tissue. With increasing amount of necrotic tissue increasing of maggots is unavoidable [21]. Blake *et al*., (2007) pointed out 100 maggots for 50 grams of necrotic tissue during one treatment period. Another important factor is wound area width which increases this area result in more maggots needed [30]. Recommendation of maggots number is differ from 5 to 10 base on wound in different studies [10,21, 31]. Wound depth is too important and may also need to be considered especially in wound by the depth more than 2 cm. In this situation, depth must be multiplied by the surface area [32]. As above-mentioned, maggot secretions are more effective on Gram-positive bacteria and less on Gram-negative species. Less effectiveness on Gram-negative infections required more maggots in these wounds than wounds infected by Gram-positive bacteria [33].

Application Methods: Biobag or Free Range

Two method of maggots therapy is recommended, direct and using biobag. In the first technique, maggots put freely on the wound. However, maggots can be placed in a sealed biobag, made by porous bag made of nylon mesh or polyvinyl alcohol [21-33]. The porous enables the proteolytic secretions to reach the necrotic tissue without direct contact of maggots and wounds [21, 34-35].

Two main advantages have mentioned for biobag method, requiring less experience and less painful for patient. Simplicity of using biobag resulted possibility of doing maggot debridement therapy even by inexperienced persons [30]. Also, due to indirect contact patients don't feel any pain and even anxiety which is very important in sensitive patients [33]. On the other hand, disadvantages of each method must be mentioned. The most important disadvantages of direct method are being almost painful in some cases. However, the most considerable disadvantage of the biobag is that maggot debridement is just effective in its direct vicinity, causing biobag less effective in irregularly shaped wounds [30]. Another disadvantage of using biobag has considered as likely that debridement is less efficient as the maggots cannot use their mouth hooks through the biobag [21].

Length of Treatment

Length of treatment is completely depending on width and depth of wound and also amount of necrotic tissue. In the maggot debridement therapy, maggots depend on above factors needs to be used in several cycles until complete debridement, complete granulation tissue and no signs of infection is achieved [22, 36-37].

The Future for Maggot Debridement Therapy

Several years of applying maggots in healing chronic wounds has been shown this species as an effective and safe way of treatment chronic wounds. However, several limitations are existing when considering its local applicability. Overcoming these limitations and improving accessibility can be approachable by using new, faster and safer delivery system. Another aspect which nowadays is more considered than before is identification of molecules from

L. sericata mediating promotion of wound healing. Identification of these molecules is just the first step which can be followed by production and application of corresponding synthetic or recombinant analogues result in expand the use of insect-derived molecules beyond maggot debridement therapy of wounds.

RESULTS AND DISCUSSION

This article showed how maggot debridement therapy can help human beings in treatment of chronic wounds. A large amount of studies have been carried out around antibiotic resistance. These studies demonstrate needs to find an alternative way for treating antibiotic resistant wounds. These articles introduce the maggot debridement therapy as a potential treatment for this kind of wounds. But, more studies are needed to recognize of molecule which effects healing and possibility of their synthetic production.

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