Assessment of the antimicrobial properties of maggots

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ABSTRACT

Chronic bacterial colonisation or infection of wound is one of the major factors interfering proper wound healing, especially in diabetic foot ulcers. This study assesses the potential antimicrobial properties of maggots in vitro. This is a prospective randomised experimental study. Complete lysis of methicillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa*, vancomycin-resistant *Enterococcus* and *Candida albicans* cultures in the area of maggot application was observed 24 hours after application of live maggots in all culture plates and was confirmed by Gram staining. This lysis persisted for more than 5 days after the maggot application. Complete lysis of the bacterial or fungal cultures in the area of maggot application provides convincing evidence for the antimicrobial property of maggots. This effect has a significant implication in management of diabetic foot ulcers and vascular ulcers.

Key Points

- Chronic bacterial colonization or infection of wound is one of the major factors interfering proper wound healing, especially in diabetic foot ulcers.
- The maggot therapy has been used for debridement of necrotic tissues; however, no formal experimental studies were conducted for potential antimicrobial properties.
- This is a prospective randomized experimental study that assesses the potential antimicrobial properties of maggots in vitro.
- Live maggots were applied to a total of 48 culture plates.
- The maggots were covered by a small plate inside the big plate with the pathogen.
- The plates were incubated in the standard incubator and examined every 24 hours for 5 days after application of maggots.

INTRODUCTION

Chronic bacterial colonisation or infection of wound is one of the major factors interfering proper wound healing, especially in diabetic foot ulcers. Certain fly larvae can infest corpses or the wounds of live hosts. Those which are least invasive on live hosts have been used therapeutically to remove dead tissue from wounds and to promote healing. With the introduction of other debridement agents and antibiotics, maggot therapy fell out of favour; however, medicinal use of the maggots is recently increasing around the world due to its efficacy, safety and simplicity. The maggot therapy has been used for debridement of necrotic tissues; however, no formal experimental studies were conducted for potential antimicrobial properties (1). This a prospective randomised experimental study that assesses the potential antimicrobial properties of maggots in vitro.

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METHODS

Live maggots, larvae of *Lucilia (Phaenicia) sericata*, were applied to a total of 48 culture plates of methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, vancomycin-resistant *Enterococcus* (VRE) and *Candida albicans* (12 plates in each group). The maggots were covered by a small plate inside the big plate with the pathogen. All the plates were incubated in the standard incubator and examined every 24 hours for 5 days after application of maggots.

Degree of lysis of the bacterial or fungal cultures in the area of maggot application was determined.

Gram staining of maggot-applied area was performed.

RESULTS

Complete lysis of the bacterial or fungal cultures in the area of maggot application was observed 24 hours after application of live maggots in all culture plates and confirmed by Gram staining. This complete lysis was persistent for more than 5 days after the maggot application.

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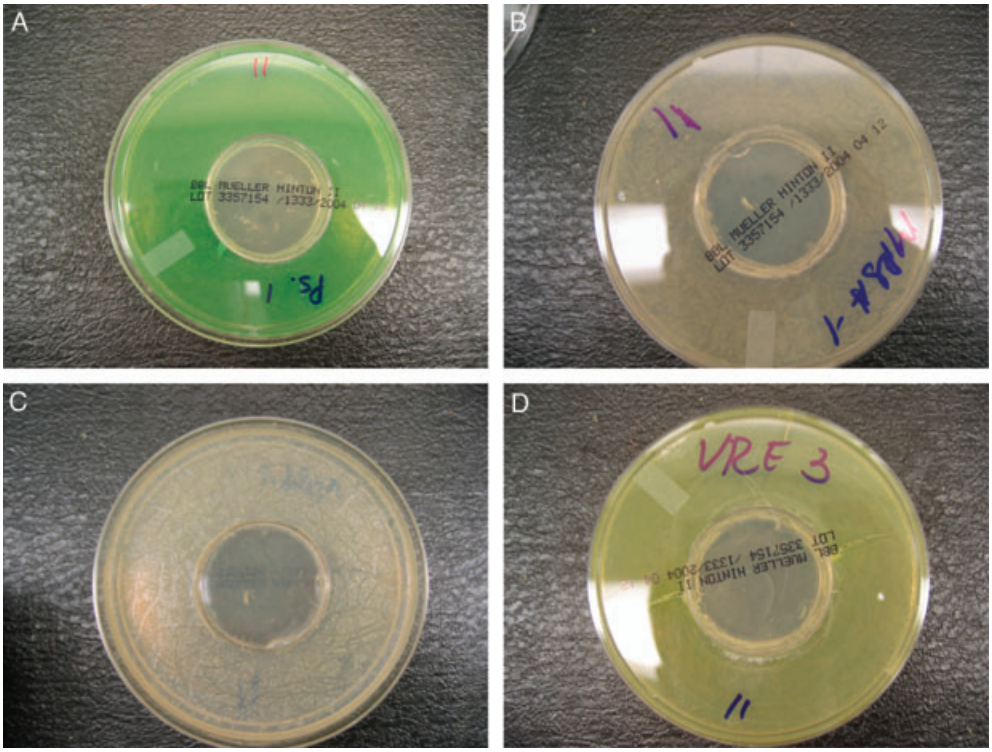

Figure 1. Complete lysis of the cultures 24 hours after maggot application. (A) *Pseudomonas aeruginosa*, (B) methicillin-resistant *Staphylococcus aureus*, (C) *Candida albicans*, (D) vancomycin-resistant *Enterococcus*.

DISCUSSION

Maggots debride the wound and promote healing –a fact known for centuries, especially to military surgeons who found that battle wounds accidentally infested with maggots healed quickly without becoming infected. The use of larvae (maggots) in wound management was popular in the 1930s. Now the advent of multiresistant strains of bacteria has led to its reintroduction in some hospitals, when other avenues have exhausted (2).

A clinical study in a cohort of 103 inpatients with 145 pressure ulcers showed that within 3 weeks, wounds treated with maggot contained one-third of the necrotic tissue ($P = 0.05$) and twice the granulation tissue ($P < 0.001$) compared with wounds not treated with maggot. Eighty percent of maggot-treated wounds were completely debrided, while only 48% of wounds were completely debrided with conventional therapy alone ($P = 0.021$) (3).

Another clinical study suggested that outpatient maggot debridement is safe, effective and acceptable to various patient populations, even when administered by non physicians (4). In this study, maggot debridement is a valuable and rational treatment option for many ambulatory, home-bound and extended-care patients who have non healing wounds (4). A prospective controlled study that evaluated the utility of maggot therapy for treating pressure ulcers in patients with spinal cord injury showed that wound healing was more rapid during maggot therapy than during antecedent conventional therapy ($P = 0.01$) (5). No complications were seen during the maggot treatment.

There are clinical observations suggesting that live maggots combat infections in variety of wound types, including those with antibiotic-resistant strains (6–10). Maggots were suggested to kill or inhibit the growth of a range of pathogenic bacteria such as MRSA, group A and B *Streptococci* and *Pseudomonas* to some extent (8). No formal prospective experimental study, however, was conducted in the past to investigate the potential antimicrobial property of the maggots. Our study showed complete lysis of MRSA, VRE, *Pseudomonas aeruginosa* and *Candida albicans*, confirmed by Gram staining in the area of maggot application.

Key Points

- Maggots debride the wound and promote healing–a fact known for centuries especially to military surgeons who found that battle wounds accidentally infested with maggots healed quickly without becoming infected.
- A clinical study in a cohort of 103 inpatients with 145 pressure ulcers showed that within 3 weeks, wounds treated with maggot contained one third of the necrotic tissue and twice the granulation tissue compared with wounds not treated with maggots.
- Eighty percent of maggot treated wounds were completely debrided, while only 48
- In this study, maggot debridement is a valuable and rational treatment option for many ambulatory, home bound and extended-care patients who have non healing wounds.
- No complications were seen during the maggot treatment.

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Key Points

- No formal prospective experimental study was conducted in the past to investigate the antimicrobial property of the maggots.
- This study showed complete lysis of MRSA, VRE, Pseudomonas aeruginosa and candida albicans, confirmed Gram staining in the area of maggot application.
- The mechanism of antimicrobial action of maggots requires further investigation.

The mechanism of antimicrobial action of maggots requires further investigation. It may be related to ammonia that raises wound pH (8) or to antibiotic agents secreted by maggots. Complete lysis of the bacterial or fungal cultures in the area of maggot application provides convincing evidence for the antimicrobial property of maggots. This effect has a significant implication in management of diabetic foot ulcers and vascular ulcers.

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