Smoking is not contra-indicated in maggot debridement therapy in the chronic wound

Based on a study of 125 wounds in 109 patients

Abstract
Smoking has demonstrated negative effects on acute wound healing. However, the effect on healing of chronic sloughy or necrotic wounds is less clear. Patients that were treated with Maggot Debridement Therapy (MDT) from 1 August 2002, and who were finished with MDT on the first of March 2006 were included in the present study. The patient group consisted of a total of 109 patients, who were treated with MDT for 125 infected chronic wounds. In the current study there were 37 smokers and 72 non-smokers. The overall results of MDT were comparable in both groups (success rate of MDT is 67.7% in smokers versus 70.8% in non-smokers; a statistically non-significant difference). In our opinion, although smoking has been proven to have negative effects on acute wound healing, it does not seem to influence healing in the chronic sloughy or necrotic wound. Smoking should therefore not be regarded as a (relative) contra-indication for MDT.
Keywords: Maggot debridement – smoking – outcome

INTRODUCTION

The negative effects of smoking on acute wound healing were first reported in 1977, in a smoker with impaired healing of a hand-wound.[1] Cigarette smoke contains over 4000 different components with different effects on a variety of tissues in the body.[2;3] There is a vast amount of literature describing the negative effects of smoking on acute wound healing.[4] There is also evidence that[5 6-9] smoking cessation programs improve healing rates, compared to patients that continue to smoke.[10] These effects are, however, less clear in the chronic wound.[3] Maggot debridement therapy (MDT) is effective in the debridement of chronic sloughy or necrotic wounds, with success percentages of around 80%.[11] Patients with cutaneous ulcers should be instructed to refrain from smoking[12], but this is not always feasible in a chronic wound population. Also, there are many other factors besides smoking that influence the healing of chronic wounds.[13] We questioned ourselves whether MDT-healing rates were influenced by smoking, because smoking is considered as a (relative) contra-indication for MDT in another hospital in the Netherlands. We believe this could be important in traumatic acute wounds, but believe this should be reconsidered in the chronic wound care group in whom amputation sometimes seems to be the only alternative. We believed MDT in smokers would be a better alternative to the standard surgical debridement that was performed in our clinic before the introduction of MDT. Here we report MDT-results on 125 wounds in 109 patients, with special emphasis on the possible detrimental effects of smoking.

METHODS

In the period August 2002 to March 2006, patients who presented with chronic wounds with signs of gangrenous or necrotic tissue at our surgical department and seemed suited to MDT were treated with MDT. This is a descriptive consecutive case-series. Chronic wounds were arbitrarily defined as wounds existing for more than four weeks. The accepted definition of a chronic wound relates to any wound that fails to heal within a reasonable period. There is no clear-cut definition that points to how chronic a wound is.[12] Three physicians, three nurses and one nurse practitioner were involved in the actual maggot therapy. Patients were not eligible for the study if the treating surgeon believed an urgent amputation could not be postponed (for example in case of severe sepsis) or if life expectancy was shorter than a few weeks. All patients gave informed consent for MDT. Patient characteristics like age and sex were also reported. The patient was recorded as a non-smoker if they had never smoked or had been non-smoking for more than three months. ▶

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Maggot debridement therapy

At the start of this study, maggots were not commercially available. We were able, however, to get them at the nearest university medical center. Currently, maggots can be ordered up to 24 hours before start of the clinic (BiologiQ^{TM}, Apeldoorn, The Netherlands). The maggot applications are performed in our outpatient department twice a week. MDT was performed until thorough debridement was achieved. Each maggot application remained on the wound for three to four days. The free-range technique is more effective[14] and is our preferred technique. However, with reference to patient preference[15], painful wounds[16], coagulation problems in the patient[17] and problems with ensuring an adequate barrier for preventing maggot escape the contained technique was chosen. In total 65/125 (52%) wounds were treated with the contained technique.

Outcome

Maggots are debriding agents; if the wound is clean from bacteria, necrosis and slough maggots are no longer useful in the wound, and other wound-treatments must be followed in order to close the wound. In this study we defined eight different outcomes of MDT, based on outcome definition in the literature.[11;18-21] and our own experience[14;16;22;23]

Effect of MDT observed (beneficial outcome)

1) Wound fully closed by second intervention (for example split skin graft);
2) Wound spontaneously fully closed;
3) Wound free from infection and <1/3 of original wound size;
4) Clean wound (free from infection/necrosis/slough), but same as initial size or up to 1/3 smaller.

No effect of MDT observed (unsuccessful outcome)

5) No difference observed between the pre- and post-MDT-treated wound;
6) The wound is worse;
7) Minor amputation (for example partial toe amputation);
8) Major amputation (for example below knee amputation).
9) Unknown outcome.

In this study outcomes 1-4 are arbitrarily determined beneficial outcomes and outcomes 5-9 are determined unsuccessful outcomes. They are arbitrary because in some patients a fully debrided wound does not offer any advantages for the patient (for example he/she still needs wound care) and for another patient only a partial toe amputation (which is defined as non-successful) could mean the difference between being in a wheelchair and being fully ambulatory.

Statistical analyses

To study the impact of smoking on the outcome of MDT, a univariate analysis using Chi-square statistics was performed.

RESULTS

From August 2002 until March 2006, 109 patients with 125 wounds were treated with MDT in our hospital. In total 110 patients were offered MDT, one alcoholic patient, with a psychiatric history refused. For one patient the outcome was not known, due to the patient's death during maggot treatment. The patient died in another hospital, due to a myocardial infarction, which was unrelated to the MDT. There were 59 male (54.1%) and 50 female patients treated. The average age was 71 years (range: 25-93 years). The wounds existed on average seven months before starting with MDT (range 1 week-11 years).

Of the 125 wounds treated with MDT, 76 (69.7%) had beneficial outcomes (Table 1). MDT resulted in complete debridement and epithelialization, leading to a stable and pain-free scar with no subsequent breakdown in 64 of the 125 wounds (51.2%), while 14 wounds (11.3%) were free from necrosis, slough and infection and the wound dimensions were less than one third of original wound size. A major amputation was needed in 28 patients (22.4%). In the current study there were 37 smokers and 72 non-

The woundteam,
from left to right:
Louk van doorn, nurse practioner
Geertje Abrahamse, woundcare nurse
Pascal Steenvoorde, resident surgery
Nicolette hof, nurse practioner
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Jacques Oskam, vascular surgeon

Table 1. Results of MDT in 109 patients with 125 wounds, divided by smokers and non-smokers

	All wounds*			All patients**		
		Smokers	Non-smokers		Smokers	Non-smokers
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Total	125 (100)	41 (32.8)	84 (67.2)	109 (100)	37 (33.9)	72 (66.1)
Beneficial outcome	85 (68.0)	29 (70.7)	56 (66.7)	76 (69.7)	25 (32.9)	51 (67.1)
1. Wound fully closed by second intervention (for example split skin graft)	23 (18.4)	9 (22.0)	14 (16.7)	23 (21.1)	9 (24.3)	14 (19.4)
2. Wound spontaneously fully closed	41 (32.8)	16 (39.0)	25 (29.8)	34 (31.2)	13 (35.1)	21 (29.2)
3. Wound free from infection and <1/3 of original wound size	14 (11.2)	2 (4.9)	12 (14.3)	13 (11.9)	2 (5.4)	11 (15.3)
4. Clean wound (free from infection/necrosis/slough), but same as initial size or up to 1/3 smaller	7 (5.6)	2 (4.9)	5 (6.0)	6 (5.5)	1 (2.7)	5 (6.9)
Unsuccessful outcome	40 (32.0)	12 (29.3)	28 (33.3)	33 ((30.3)	12 (36.4)	21 (63.6)
5. There is no difference between before and after MDT	5 (4.0)	2 (4.9)	3 (3.6)	3 (2.8)	2 (5.4)	1 (1.4)
6. The wound is worse	1 (0.8)	0 (0.0)	1 (1.2)	1 (0.9)	0 (0.0)	1 (1.4)
7. Minor amputation (for example toe)	5 (4.0)	2 (4.9)	3 (3.6)	5 (4.6)	2 (5.4)	3 (4.2)
8. Major amputation (below knee amputation or above knee amputation)	28 (22.4)	8 (19.5)	20 (23.8)	23 (21.1)	8 (21.6)	15 (20.8)
9. Unknown result	1 (0.8)	0 (0.0)	1 (1.2)	1 (0.9)	0 (0.0)	1 (1.4)

** Chi-square: smoker's/non-smoker's wounds vs. 2-group outcome: $X^2=0.209$ (df=1), P-value=0.647 (via Fishers Exact correction: P-value=0.688)*
*** Chi-square: smoking/non-smoking patients vs. 2-group outcome: $X^2=0.123$ (df=1), P-value=0.725 (via Fishers Exact correction: P-value=0.826)*

smokers. Of the smokers 25 (67.7%) had a good result, compared to 51 (70.8%) in the non-smokers group. This difference was non-significant (Table 1). The same result was true if success was defined only as a closed wound (outcome 1 or 2). Nor did smokers have a higher chance of amputation (outcome 7 and 8).

DISCUSSION

Smoking is a risk factor for complicated wound healing; it is a systemic risk factor in line with diabetes and malnutrition. It seems to be one of the most important (preventable) risk factors for impaired healing, considering more than 25% of the adult population smokes.[3] Smoking causes damage to blood vessels, there is decreased collagen production[24], increased aging of collagen[25] and keratinocytes show impaired migration.[26] Nicotine has been shown to impair wound contraction from the sixth to the tenth day in a rabbit-ear model.[27] Tobacco smoke contains over 4000 different compounds of particles or gases. There are many toxic components like nicotine, carbon monoxide, cyanide, heavy metals, additives and numerous different chemical compounds known as condenate.[3] The effect of the cigarette smoke is a thrombogenic state through an effect on the blood constituents, vasoconstricting prostaglandins and an effect on the dermal microvasculature.[28] Eventually all these factors lead to tissue hypoxia.

There is a vast amount of literature describing the negative effects of smoking on acute wound healing. Sternal wound-healing[4], hip and knee arthroplasty[5], ankle arthrodesis[29], spinal fusion[6], intra-oral implant placement[7], skin flaps[8], incisional hernia[30], leg amputation[31] and breast reduction[9] are all examples of acute wounds that have delayed healing in smokers. For example, delayed healing after breast reduction was significantly associated with smoking. In a study on 179 patients undergoing breast reduction surgery; 22% had delayed healing in the smoking group versus 7.7% in the non-smoking group (p=0.03)[9]; thus demonstrating a relatively strong effect. Evidence of the negative effect of smoking is not only seen in (skin-)wound healing, there is also evidence, in the fields of (for example) fracture healing[32] and bowel anastomosis[33] where it has been shown that smoking negatively affects healing. There is a dose-response association in heavy smokers with all cause higher morbidity, however it is not clear if this is also the case for wound healing.[34] One study found that high-level smokers (> 1 pack per day) had developed tissue necrosis three times more frequently compared to low-level smokers (<1 pack per day).[35] In literature we could find no reports describing the differences between cigarette and cigar smokers, nor on passive smoke. Almost all smokers in the current study were cigarette smokers, there was one cigar smoker.

In patients undergoing elective hip or knee replacement, a smoking intervention study (with smoking cessation or at least a 50% reduction in smoking) led, in a randomised controlled trial (n=120), to a reduction in the wound-related complications from 31% to 5% (p=0.001).[10] This effect was found if the patients had been subject to a six-eight week program. In experimental rat studies, Kaufman and others found that exposure to tobacco smoke seven days prior to the flap procedure affected flap survival more ▶

adversely than did smoking postoperatively. They, however, did not find cessation of smoking to greatly improve flap survival.[36] Others found a critical time period of seven to 14 days of preoperative cessation of smoking before this increase in flap survival occurred.[37] It seems therefore that pre-operative smoking is more important than post-operative smoking. However, all these reports relate to acute wound healing, and we are dealing with patients with chronic wounds. In our study many patients claimed they would stop smoking during the MDT, but we classified them as smokers, because the duration of MDT is shorter than the time needed before healing rates would be comparable to non-smokers.

In this type of study, with relatively small sample sizes, one should always be careful interpreting the results. In this study we found no indications that smoking should be considered a contra-indication in MDT of chronic wounds. It is always possible that there is an effect, but one not shown by the statistics. Regarding our study, however, it is not very likely a negative effect of smoking in chronic wound therapy was missed as even a somewhat larger percentage of smokers had beneficial outcomes as compared to non-smokers.

In this study on maggot debridement therapy on chronic wounds, we could not observe any statistically significant difference between smokers and non-smokers in outcome. Tissue hypoxia is the end-result of the detrimental effects of smoking, which occurs through different pathways.[28] It has been shown in the acute wound that smoking has negative effects, and we hypothesize that this is due to tissue hypoxia in the smokers group. The patients in our study were a selection of many worst-case scenarios. We could postulate that all these wounds had tissue hypoxia at presentation, caused by different mechanisms, such as arterial insufficiency, diabetes mellitus or smoking. It could be that, because all wounds were in some sort of tissue hypoxia at the start of MDT, that is the reason why we didn't observe any difference between the smokers and the non-smokers in outcome.

CONCLUSION

Smoking has an adverse effect on acute wound healing, but in chronic wound care this effect has been less proven. In this study, smoking was not found to affect the results of maggot debridement therapy in chronic wounds, and smoking should, therefore, not be a contra-indication for maggot debridement therapy in these wounds.

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