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Use of non-contact low frequency ultrasonic debridement on adult burn wounds: A case report

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Abstract

Low Frequency Ultrasound Debridement (LFUD) is a less painful, less traumatic method of wound debridement by imploding pulsatile ultrasound shockwaves to a selected wound bed along with a wound irrigation solution. Apart from wound debridement, LFUD is capable of biofilm disruption and wound contraction. We report a patient with a deep dermal burn treated with non-contact LFUD and its outcome. A 57 year old male patient who presented late to the outpatient department with a 3% deep dermal burn over right lower thigh and leg was subjected to a single attempt of non-contact LFUD. Different stages of wound healing were observed during subsequent visits. Complete DE sloughing of the wound with minute bleeding was achieved immediately after the LFUD. The patient was mobilized immediately with minimal pain. Peripheral epithelialization with central healthy granulation were noted on day 3. There was no evidence of microbial colonization after LFUD.

Near complete healing was achieved within 28 days. LFUD may be effectively used on burn wounds which are at risk of developing chronicity. However high quality comparative studies are needed for confirmation. LFUD may be used as an alternative or adjunct to sharp debridement in adult burn wound management.

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Keywords: Low frequency ultrasonic debridement; Burns; Plastic surgery; Deep dermal wounds.

Background

Low Frequency Ultrasound Debridement (LFUD) is a less invasive, less painful technique of wound debridement as compared to conventional surgical wound debridement. This process is carried out using an ultrasound wave generator which creates intermittent pulses of an irrigation solution on to a wound bed. Sonoca 185 was used as the ultrasound debridement device in this study. The apparatus comprises of a low frequency ultrasound wave generator and a hand piece which delivers ultrasound pulses to wound bed along with an irrigation solution. It acts by two different mechanisms namely, acoustic streaming and cavitation where the motion of the fluid and intermittent implosion of fluid on wound bed account for wound debridement. Acoustic streaming is described as the steady mechanical force that goes directly to the tissues from the fluid medium emitted from the probe. Cavitation is defined as the formation of micro-bubbles in a liquid medium induced by ultrasound-induced compression or traction forces. These mechanisms not only cause debridement but also shows bactericidal and wound healing stimulatory effects [1]. It is known to disrupt the bacterial biofilm as well [2].

LFUD is available in two forms namely, contact LFUD and non-contact LFUD. The effect of LFUD has been widely studied on chronic ulcers [3-5]. However the literature on use of LFUD on burn wounds is sparse, preliminary or limited to animal models. Still the evidence shows positive outcome of LFUD on burn

wounds such as accelerated wound closure [6-8]. We report a patient with a poor glycaemic control having a 3% deep dermal burn wound involving right lower thigh and leg being treated with non-contact LFUD with a polyhexanide and betaine combined preparation used as the irrigation fluid and its outcome. The case was reported due rarity of such techniques being used on adult burn wounds. Informed written consent was obtained from the patient for anonymized reporting of data.

Case presentation

A 57 year old patient sustained a burn injury to right lower thigh and leg following an accidental hot water spill in March 2024. The patient has been diagnosed to have type 2 diabetes mellitus and dyslipidaemia with a poor glycaemic control. The patient presented to burns unit of national hospital of Sri Lanka in April 2024 which was more than 2 weeks after the injury. The late presentation has made his wound at risk, which had a risk of getting converted to a chronic wound. After the initial assessment it was revealed that the patient had a deep dermal burn with a burn surface area of 3% (Figure 1). The initial management plan was to proceed with a burn wound excision with split thickness skin grafting. However it was found that the wound was colonized with Methicillin Sensitive Staphylococcus Aureus (MSSA) and the patient's glycaemic control was poor. Hence it was decided to postpone the surgical intervention as the wound bed was not suitable for a skin graft and had a higher chance of graft failure due to presence of MSSA. It was finally decided to proceed with non-contact LFUD. The non-contact LFUD was carried out under aseptic conditions 2 days after the admission. Sonoca 185 (Figure 2) was used as the ultrasound wave generator and polyhexanide and betaine combined preparation as the irrigation solution. No form of anaesthesia was needed for the procedure. Debridement was continued for 15-20 minutes in a circular motion keeping the tip of the hand piece few millimetres above the surface of the wound as tolerated by the patient (Figure 3). After the debridement, the wound was dressed with polyhexanide and betaine combined preparation containing gel. The patient was discharged on the same day and reviewed at the outpatient clinic once in every 3 days and the wound healing process was observed. Near total desloughing of the wound was achieved with minute bleeding immediately after LFUD. Peripheral epithelialization started appearing since day 3 after the intervention. Subsequent swab cultures from wound bed showed no colonization. Near complete healing of the wound was achieved within 28 days (Figure 4).

Figure 1: Initial appearance of the wound.

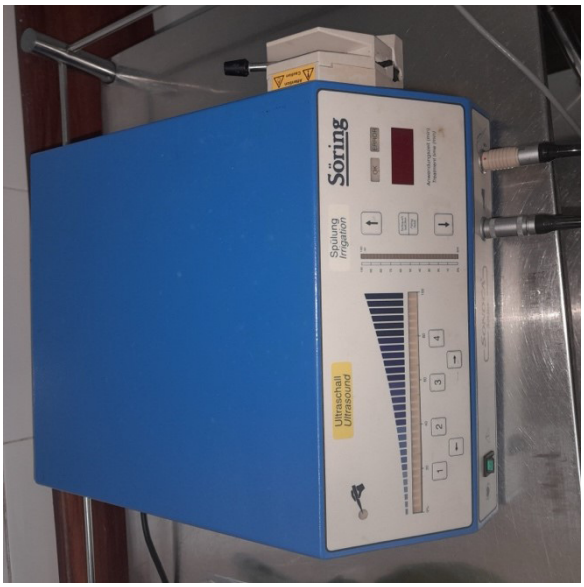

Figure 2: Sonoca 185 ultrasound wave generator.

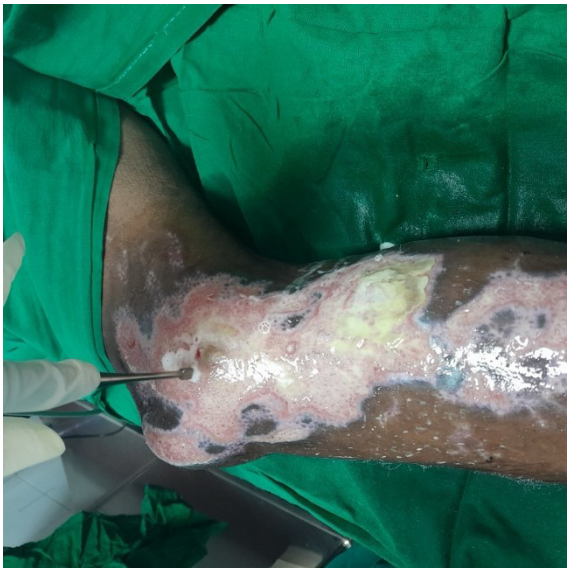

Figure 3: Ultrasound debridement process.

Figure 4: After 28 days.

Discussion

Availability of less traumatic, less painful, effective wound debridement techniques are vital in wound management. LFUD is an emerging technique which needs minimal infrastructure and expertise for wound debridement compared to conventional surgical wound debridement. It's a procedure which can be performed in out patient department without anaesthesia or with minimal anaesthesia by any trained health care worker. Its effect on chronic ulcers has been significantly studied. It has been found out that LFUD significantly reduces the number of non healed chronic diabetic ulcers and reduces the area of the ulcers. Depending on the frequency used and the distance from the wound bed, the technique can be classified as high or low frequency and contact or non contact debridement. The low frequency high intensity contact ultrasonic debridement can even be superior to the sharp debridement [3]. Some studies show that it's the sharp debridement that is superior [5].

However high quality comparative studies done on the use and outcome of LFUD on deep dermal or full thickness burns which will otherwise need split skin grafts in conventional management, are almost difficult to find. However animal models have suggested that LFUD limits the necrosis and improves wound contraction in third degree burns while inducing angiogenesis and persistent inflammation during proliferative phase of wound healing which will lead to chronicity of burn wounds [7]. A small case series has revealed that LFUD can be safely and effectively used on partial to full thickness burn wounds [9]. However most of the available studies suggest multiple attempts of LFUD compared to a single attempt which is the major drawback of our study and likely cause for taking 28 days to achieve wound healing. Polyhexanide and betaine combined irrigation solution was used due to its effects on bacterial biofilm disruption [10]. Deep dermal and full thickness burns are unlikely to heal spontaneously. Even if they do so it will cause significant scarring with poor cosmetic outcome. In Sri Lankan setting most of the patients with deep dermal burns are subjected to burn wound excision and split thickness skin grafting for the same reason. In this patient a single attempt of LFUD has led to spontaneous healing of a deep dermal wound within 28 days. Multiple attempts of LFUD would have further increased the wound healing rates.

However high quality large sample size studies will be needed for further decision making on selecting LFUD on burn patients. And LFUD will be a good alternative for patients who are not fit for surgery under major anaesthesia. With the ability to provide LFUD in an outpatient wound care facility, the cost of wound care and the need of hospitalization will be further less.

Conclusion

LFUD may be used as an adjunct or a alternative to sharp surgical debridement in burn wound which are less likely to heal spontaneously without a burn wound excision. If successfully established it might reduce the cost of burn care by reducing the hospital stay of the patients and by necessitating fewer theatre facilities. However high quality comparative studies are needed for further implementation of LFUD facilities. No form of generative artificial intelligence was used in planning, executing and reporting of the study.

Declarations

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Conflict of interest: The authors declare no conflicts of interest.

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Research ethics and consent: The institution where the study was carried out, does not mandate ethics approval for case reporting. Informed written consent was obtained from the patient for case and image reporting.

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