

Treatment of non-healing foot ulcer by conventional therapeutic ultrasound – Report of 2 cases

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Abstract

Non healing foot ulcer due to diabetes mellitus is one of the commonly seen reasons for the hospitalization and associated morbidity, with a prevalence of about 14.3% in India. Two patients with chronic non-healing foot ulcers were treated in a self-own physiotherapy clinic on Out Patient (OPD) basis. Non-contact low frequency Ultrasound (NCLU) is commonly used as an adjunct to the standard wound care. However, non-availability and costly NCLU US machine precludes the physiotherapist from using this useful therapy as an adjunct to standard care in managing non-healing ulcer. We report use of non-NCLU therapeutic ultrasound in 2 cases to effectively manage the chronic non-healing ulcer.

Key Word: Foot ulcer, pulsed ultrasound

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INTRODUCTION

Wound is a discontinuity or break in the surface epithelium¹ caused by various forms of physiological and pathological changes occurring as a result of underlying systemic disease. Most common causes which can hamper process of wound healing include circulation or clotting disorders often caused by arteriosclerosis, diabetes, venous insufficiency, hypertension, kidney failure, lymphedema, malnourishment etc^{1,2}. Various trophic changes are seen in and around non healing wound such as cold skin on palpation, pain around wound area, necrotic and pale wound base lacking granulation tissue and dry skin etc.² Wound heals by two processes namely tissue regeneration and repair. Phases of wound healing

involve inflammation, proliferation and maturation of the tissues. Reasons for non-healing of ulcers can be wound infection, inadequate scar or contracture scar formation leading to wound dehiscence, poor blood supply or peripheral neuropathy resulting in repeated injury. Skin graft failure due to inadequate blood supply may be seen following surgical procedure, Chronic systemic diseases like diabetes mellitus (Vasculopathy, neuropathy and hyperglycemia) and nutritional deficiencies are other common causes. India rapidly becoming the world capital of diabetes mellitus, there is a high prevalence of non-healing wounds (14.3%). Added to this, are the high costs of traditional surgical methods, elimination of financial reimbursement for the wound treatment following burns, venous leg ulcers or trophic ulcers created the need for alternate wound healing methods^{1,3}. During the recent years several methods have been developed for chronic and acute wound treatment including LASER, direct current, electric and magnetic fields, light and electromagnetic fields. Recent physio-therapeutic methods used for chronic wound healing include Pulsed electromagnetic field therapy, LASER therapy, therapeutic ultrasound (US) etc. Ultrasound is being looked as the promising, easy to use and affordable modality^{4,5,6}. Ultrasound waves can be highly oriented and focused therapy that penetrates the wound bed and deep-seated tissues with

lesser side effects when compared with other methods^{3,4,5} Antimicrobial effects and triggering wound-healing are proposed physiological mechanisms for the efficacy of ultrasound in wound healing^{3,5}. Very few patients are referred to the physiotherapy clinic for the management of chronic non-healing wounds. We are presenting case reports of 2 such cases of diabetic chronic non-healing wound managed successfully using ultrasound as the main modality.

CASE REPORTS

CASE 1: 65 year old male with diabetes and Parkinson’s disease had an ulcer located below great toe. It was a chronic non-healing foot ulcer with an area of 1.67 cm².

CASE 2: 50 year old female diabetic had pressure ulcer with an area of 3 cm² located near 5th metatarsal on plantar surface. The patient’s wound did not heal properly after surgical intervention including debridement and dressings

METHOD AND MATERIALS

Therapeutic Ultrasound machine used for the treatment was of BMS DIGI SOUND-Dual having two probes of 1MHz and 3MHz frequency. Treatment parameters-Frequency: 3MHz Mode: Pulse, 1:1 Intensity: 0.1 -0.5 W/cm^{2,7} Time duration:7 minutes Number of sittings: Total 14 which included consecutive daily 7 sittings followed by alternate sittings over next 2 weeks Ultrasound therapy was given using water bag method in the present case study. Water bag method is preferred choice of application of US over irregular bony areas

and pressure ulcers. With water bag method, it’s also easy to maintain the aseptic conditions and treat the wound efficiently^{3,4,5} Standard sterile and commercially affordable latex rubber surgical gloves were used as a water bag for Ultrasound application in the present study. Sterile Latex rubber surgical gloves were filled with degassed water i.e. water was boiled to remove all the dissolved gas bubbles, to avoid reflection of ultrasound energy during treatment. Ends of latex gloves were sealed properly to avoid leakage of water. A thin layer of coupling gel was applied over the surface of the palm portion of the glove filled with degassed water. The coupling gel media eliminated the air space between the transducer head and the surface through which the ultrasound has to pass to reach the body tissue. The bag was placed over the area to be treated and fixed on to the place with help of tape applied at its edges. Ultrasound was applied directly on the outer surface of the water bag. The ultrasonic waves pass through the two layers of latex and degassed water to reach the target tissue¹² PUSH wound healing scale was used as an outcome measure for wound healing⁸. Wound evaluation was done on day 1, day 7 and day 21 before US therapy and dressing. Scoring of wound was done using following PUSH scoring chart. Wound area scores -0 = 0cm², 1= wound area < 0.3cm², 2= 0.3 cm² - 0.6 cm², 3= 0.7-1.0 cm². 4=1.1cm² -2 cm²,5=2.1cm²-3cm², 6=3.1cm² -4.0cm²,7=4.1cm²-8.0cm²,8=8.1cm²-12cm²,9=12.1cm²-24cm²,10=>24cm².Exudatescores- 0= None,1=light,2=Moderate,3= Heavy Tissue type scores-0 = Closed/Resurfaced,1=Epithelial tissue,2= Granulation tissue, 3 = slough, 4 = Necrotic tissue.

OBSERVATIONS AND RESULTS

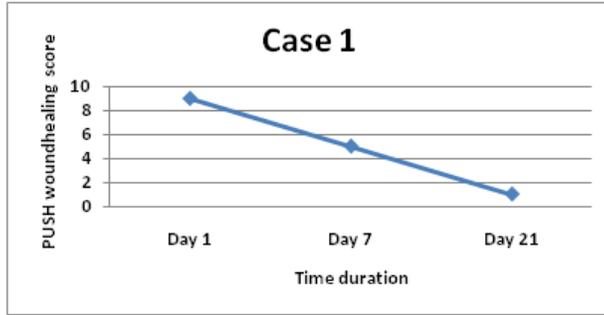
CASE 1: Ulcer below great toe on plantar surface



After the US intervention the wound area decreased from 1.67 cm² to 0.3 cm²

Table 1: Pressure ulcer healing record

PUSH	Day 1 score	Day 7 score	Day 21 score
Length X Width (Cm ²)	4	2	1
Exudate amount	2	1	0
Tissue type	3	2	0
Total score	9	5	1



Graph 1: Pressure ulcer healing graph showing PUSH Wound Healing Score



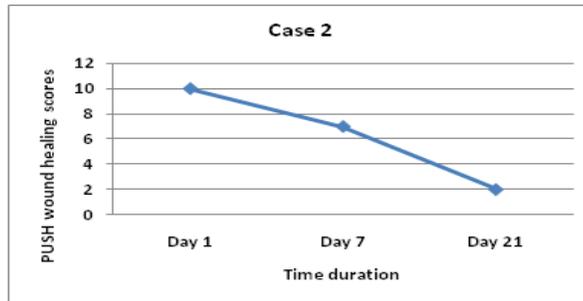
CASE 2: Ulcer near 5th metatarsal on plantar surface

After US intervention, the wound area decreased from 3 cm² to 0.5 cm²

Table 2: Pressure ulcer healing record

PUSH	Day 1 score	Day 7 score	Day 21 score
Length X Width (Cm ²)	5	4	2
Exudate amount	2	1	0
Tissue type	3	2	0
Total score	10	7	2

Graph 2: Pressure ulcer healing graph showing PUSH wound healing score



DISCUSSION

There was significant decrease in the size of pressure ulcer in both cases, from 1.67 cm² to 0.3cm² in case 1 and from 3cm² to 0.5 cm² in case 2. Ennis WJ *et al*¹¹ in their meta-analysis stated that the physiological effects of ultrasound, such as cavitation, micro-streaming, thermal and non-thermal effects facilitate wound healing. Cavitation involves the production and vibration of micron-sized bubbles within the coupling

medium and fluids within the tissues. The movement and compression of the bubbles can cause changes in the cellular activities of the tissues subjected to ultrasound waves¹¹. Micro streaming is defined as the movement of fluids along the acoustical boundaries as a result of the mechanical pressure wave associated with the ultrasound beam. The combination of cavitation and micro streaming, provide a mechanical energy capable of altering cell membrane activity^{9,11}. In-vitro studies

have demonstrated that leukocyte adhesion, growth factor production, collagen production, increased angiogenesis, increased macrophage responsiveness, increased fibrinolysis are some of ultrasound induced cellular effects^{9,10,11} A prospective RCT by using low frequency ultrasound demonstrated statistically significant reduction in ulcer size after 4 weeks, in patients with venous leg ulcers⁶ Chronic non-healing ulcer management is a challenging task. In present case study, both the patients who had ulcer located at plantar surface of foot were referred to us (Physiotherapist) as a last resort. We did not have expensive non-contact low frequency US (NCLU) machine. Reports about sole use of conventional ultrasound with water bag method in the treatment of Chronic non-healing ulcers are not widely published. Ganvir *et al*¹³ have used water bag method in combination with LASER therapy in treatment of pressure ulcer. MojtabaOlyaie *et al*¹⁴ compared the effects of high frequency US versus NCLU for venous leg ulcers and got encouraging results in both groups however differences between the two ultrasound therapy groups were not statistically significant. We have used water bag method with non-NCLU conventional US as an effective, available, applicable OPD modality which is affordable to all our patient population. The present study of 2 cases shows effective wound healing, confirmed by the PUSH wound healing scale.

CONCLUSION

In conclusion, in this study of 2 cases a novel, easily applicable, affordable (non-NCLU) conventional Ultrasound was effectively used on an OPD basis by us (Physiotherapist) to manage challenging non-healing chronic ulcers which was confirmed by the PUSH wound healing scaleshowing good results.

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