Efficacy of Superficial Versus Deep Nano Silver Gel Phonophoresis on Burn Wound

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ABSTRACT

Background: Management of burn injury has always been the domain of burn specialists. Management of burn wound inflected by the different physical and chemical agents requires different regimes which are poles apart from the regimes used for any of the other traumatic wounds. Purpose: The purpose was to evaluate the efficacy of superficial versus deep nano silver gel phonophoresis on burn wound. Material & methods: Thirty patients with deep partial thickness burn wound from Kasr Aini Hospital, Burn Unit, were randomly assigned into three groups (Group (A), Group (B) and Group(C)) of equal number. Patients were (12 males and 18 females), their ages ranged from 20-40 years, they were free from any other diseases that might affect or influence the results. Patients in group (A) (Deep phonophoresis group) received deep phonphoresis of Nano silver gel three times per week for 3 weeks while patients in group (B) (Superficial phonophoresis group) received superficial phonophoresis of Nano silver gel three times per week for 3 weeks while in group (C) (Nano silver gel group) received Nano silver gel three times per week for 3 weeks. Assessment: The method of assessment was tracing method then calculates the area by AutoCAD program. The results: Results showed a significant improvement in the three groups in favor of group (A). Conclusions From the findings of the current study it is concluded that deep phonophoresis of Nano silver gel is more effective than superficial phonophoresis in improving burn wound healing. ***Key Words****: Nano silver, Phonophoresis, Burn wound.*

INTRODUCTION

A burn is a type of injury to flesh caused by heat, electricity, chemicals, light, radiation or friction. Most burns only affect the skin (epidermal tissue and dermis) .Rarely, deeper tissues, such as muscle, bone and blood vessels can also be injured **(12).**

Phonophoresis is the process of increasing skin absorption and penetration of the topical medications to the deep tissues using ultrasound. Phonophoresis is a non-invasive, painless method that has fewer side effects and well tolerated and has been used in musculoskeletal and dermatologic disorders in several years **(8).**

Nano scale science is the discipline that examines the unique behaviors and properties of materials that emerge at the size range of 1 to 100 nanometers (a billionth of a meter). Nano biotechnology is a sub-discipline of Nano-science that has arisen more recently. It manipulates unique behaviors and properties at the Nano scale to manipulate materials for various applications in biology. Nano biotechnology already impact in medicine as therapeutic agent **(11)**.

Nano silver (NS), comprising silver nanoparticles, is attracting interest for a range of biomedical applications owing to its potent antibacterial activity. It has recently been demonstrated that NS has useful anti-inflammatory effects and improves wound healing **(4).**

PATIENTS AND METHODS

Thirty patients who had deep partial thickness burn wound were participated in this study. Patients were randomly divided into three groups equal in number: one treated with deep phonophoresis of Nano silver gel (Group A) while patients in group (B) treated with superficial phonophoresis of Nano silver gel and group (C) treated with Nano silver gel.

The inclusive criteria

Patients were of both sexes. Their ages ranged from 20-45 years suffering from deep partial thickness burn wound. Patients total body surface area was 15-35%.

The exclusive criteria

Patients with any of the following: Patients were under age of 20 years or above the age of 40 years. Patients had life threatening disorders as renal failure, myocardial infarction or others. Patients had skin diseases, diabetes, varicose veins, trauma and peripheral vascular diseases. All patients those presented with active malignancy. Patients had suffering from myasthenia gravis, hyperthyroidism, and hemorrhage. Patients had acute viral diseases, acute tuberculosis, mental disorders or those with pace makers

Ethics

The protocol of this study was approved by the ethical committees of the Faculty of Physical Therapy, Cairo University, Egypt. Every patient applied informed consent before starting the study. All participants were informed about the nature and the effect of the treatment device and measurement tools. The patients were also instructed to report any side effects during the treatment sessions.

Measurements

Wound surface area by Tracing method:

Manual tracing method by tracing wound edges before the beginning of the treatment and after the end of the treatment on a transparent sheet **(10).** AutoCAD program was used to calculate the surface area of the wound.

Treatment Procedures

(GroupA)Deep phonophoresis (1MHz) group:

The patient was placed in suitable position. The wound was cleaned and Nano silver gel applied to the skin (covering treated area by about 1mm thickness). Sterilized glove filled with ultrasound gel put above wound. Above the glove an ultrasound gel then the ultrasound head applied. The ultrasound device turned on and the parameters were set Frequency: 1 MHz, Duty cycle: 1-4, Intensity: 0.5 according to patient tolerability, Treatment time: 5 minutes.

The ultrasound head turned in circular manner with minimal pressure.

When the treatment ended the head removed, the device switched off, the glove removed, the wound cleaned. Sterile dressing applied to wound. The sessions were three times per week for three weeks.

(GroupB)(Superficial phonophoresis(3MHz)group:

The patient was placed in suitable position. The wound was cleaned and Nano silver gel applied to the skin (covering treated area by about 1mm thickness). Sterilized glove filled with ultrasound gel put above wound. Above the glove an ultrasound gel then the ultrasound head applied. The ultrasound device turned on and the parameters was set Frequency: 3 MHz, Duty cycle: 1-4, Intensity: 0,5 according to patient tolerability, Treatment time: 5 minutes.

The ultrasound head turned in circular manner with minimal pressure. When the treatment ended the head removed, the device switched off, the glove removed, the wound cleaned. Sterile dressing applied to wound.

(GroupC)(Nano silver gel group):

The patient was placed in suitable position. The wound was cleaned and Nano silver gel applied to the skin (covering treated area by about 1mm thickness). Sterile dressing applied to wound.

Statistical procedures

Data of the study recorded as the means ±SD. The data analyzed by using SPSS 18 (SPSS inc. USA). Compare between three groups of the study performed by (ANOVA).

RESULTS

Comparison between mean values of the age:

There was no significance difference between groups (A,B,C) in the age mean values as showed in table (1) and figure (1).

Table (1): ***Comparative between mean values of age (years) of the groups A, B, and C:***

	Age (years)		
	Group A	**Group B**	**Group C**
$\overline{X}$ **± SD**	35.2 ± 6.16	33.9 ± 5.38	34.6 ± 4.67
Maximum	43	41	38
Minimum	22	21	23
F-value	0.14		
p-value	0.86		
Significance	**NS**		

$\overline{X}$ **: Mean** **p value : Probability value**
SD : Standard deviation **NS : Non significant**

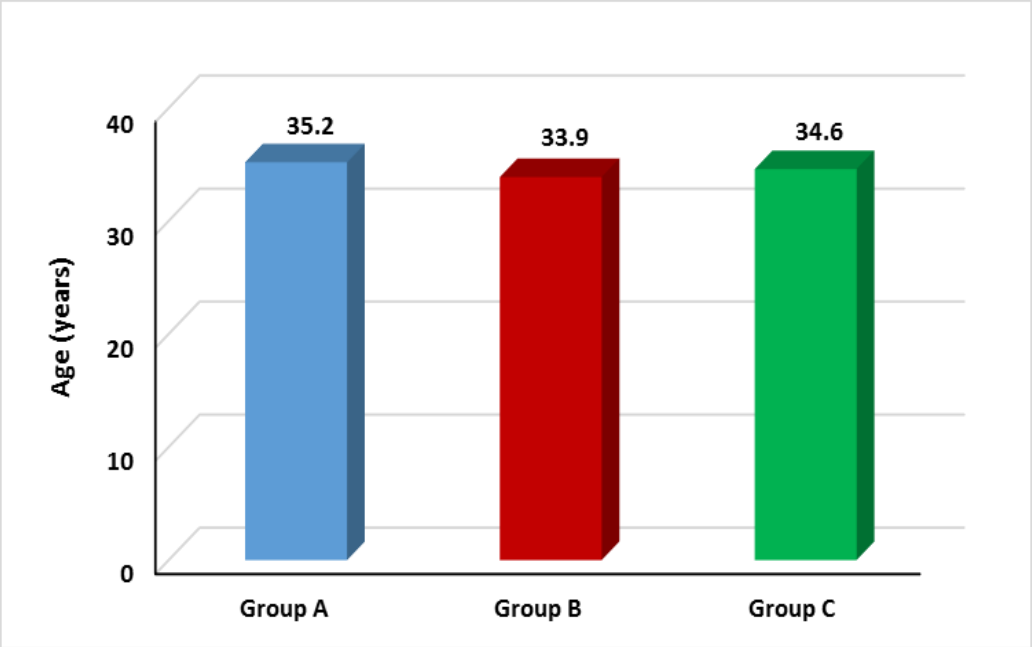

Fig. (1): Mean age (years) of group A, B, and C.

Comparison between sex distributions:

There was no significance difference between groups (A,B,C) in sex distribution as showed in table (2) and figure (2).

Table (2): Sex distribution in group A, B, and C:

	Group A		Group B		Group C	
	Female	**Male**	**Female**	**Male**	**Female**	**Male**
No.	6 (60%)	4 (40%)	5 (50%)	5 (50%)	7 (70%)	3 (30%)
Total	10 (100%)		10 (100%)		10 (100%)	

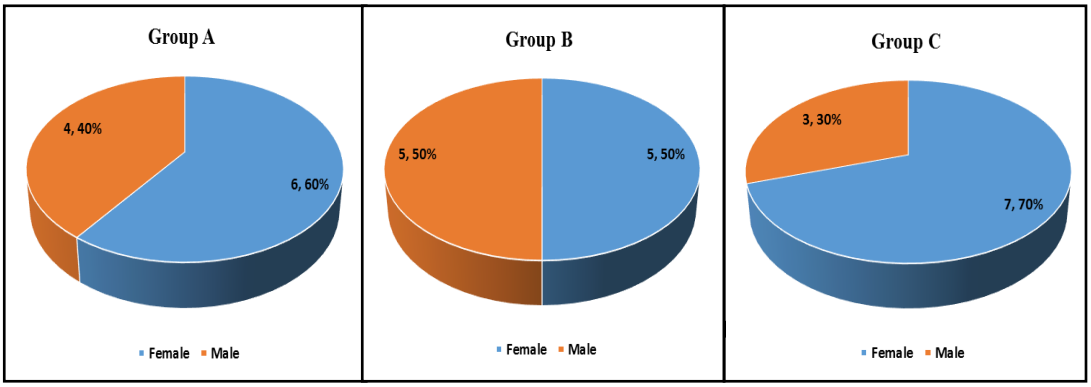

Fig. (2): Sex distribution of group A, B and C.

Comparisons of the wound surface area mean values pre and post treatment:

There was a significant difference (improvement) in wound surface area in 3 groups of treatment as showed in table(3,4,5) and figure(3,4,5) in favor of group (A).

Table (3) ***Pre and post treatment mean values of wound surface area in group A:***

	Wound surface area (cm^2) $\overline{X}$ **±SD**	**MD**	**% of improvement**	**t- value**	**p-value**	**Sig**
Pre	35.8 ± 6.37	26.6	74.3	15.51	0.0001	**S**
Post	9.2 ± 1.54					

$\overline{X}$ **: Mean** **MD : Mean difference** **Pvalue : Probability value**
SD : Standard deviation **t value : Paired t value** **S : Significant**

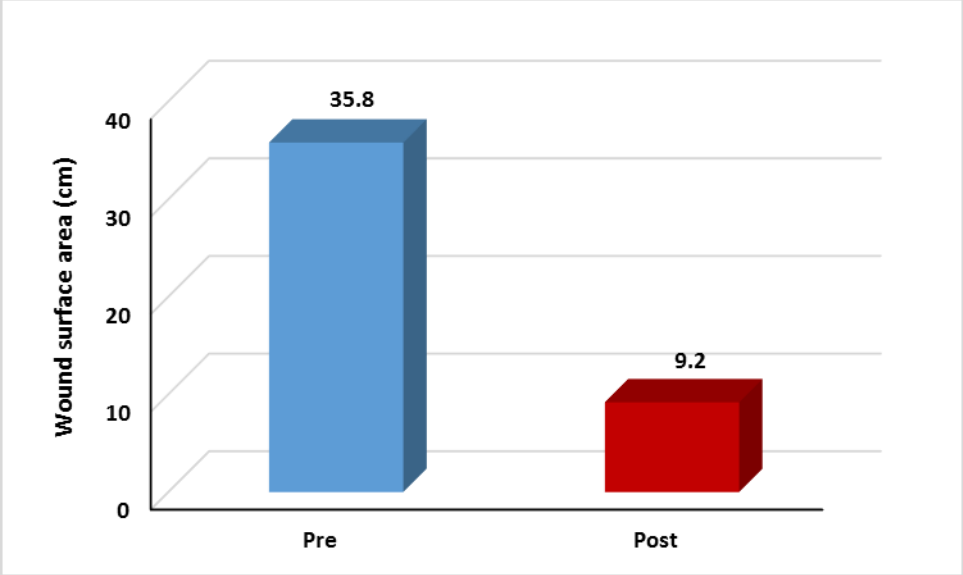

Fig. (3): Pre and post treatment mean values of wound surface area (Cm^2) of group A.

Table (4): ***Pre and post treatment mean values of wound surface area in group B:***

	wound surface area (Cm^2)	MD	% of improvement	t-value	p-value	Sig
	$\overline{X}$ ±SD					
Pre	34.3 ± 5.41	20.3	59.18	13.82	0.0001	**S**
Post	14 ± 4.24					

$\overline{X}$: Mean MD : Mean difference p value :Probability value
SD :Standard deviation t value : Paired t value S : Significant

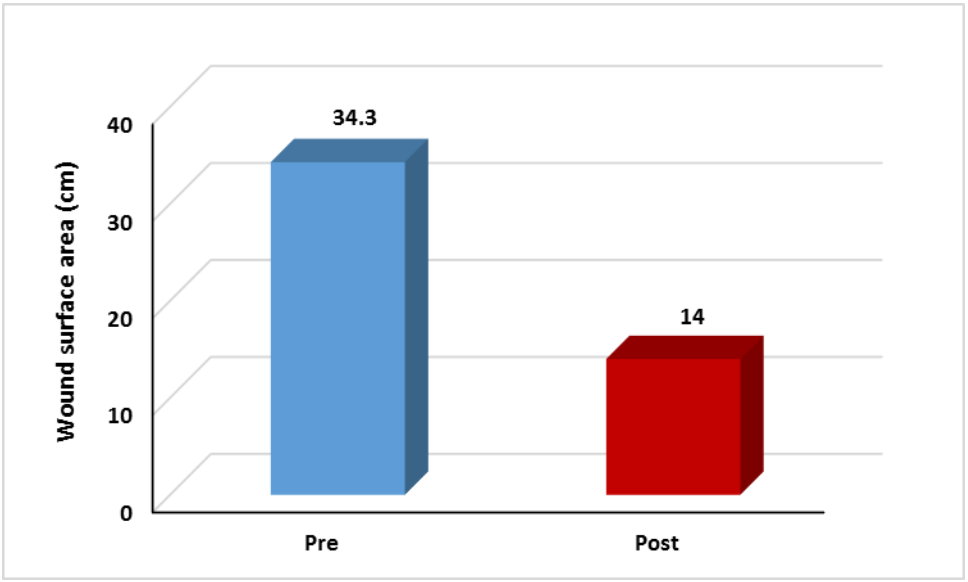

Fig. (4): Pre and post treatment mean values of wound surface area (Cm^2) of group B.

Table (5): ***Pre and post treatment mean values of wound surface area of group C:***

	wound surface area (Cm^2)	MD	% of improvement	t-value	p-value	Sig
	$\overline{X}$ ±SD					
Pre	33.2 ± 5.78	14.5	43.67	9.81	0.0001	**S**
Post	18.7 ± 4.64					

$\overline{X}$ **: Mean** **MD : Mean difference** **p value : Probability value**
SD :Standard deviation **t value : Paired t value** **S : Significant**

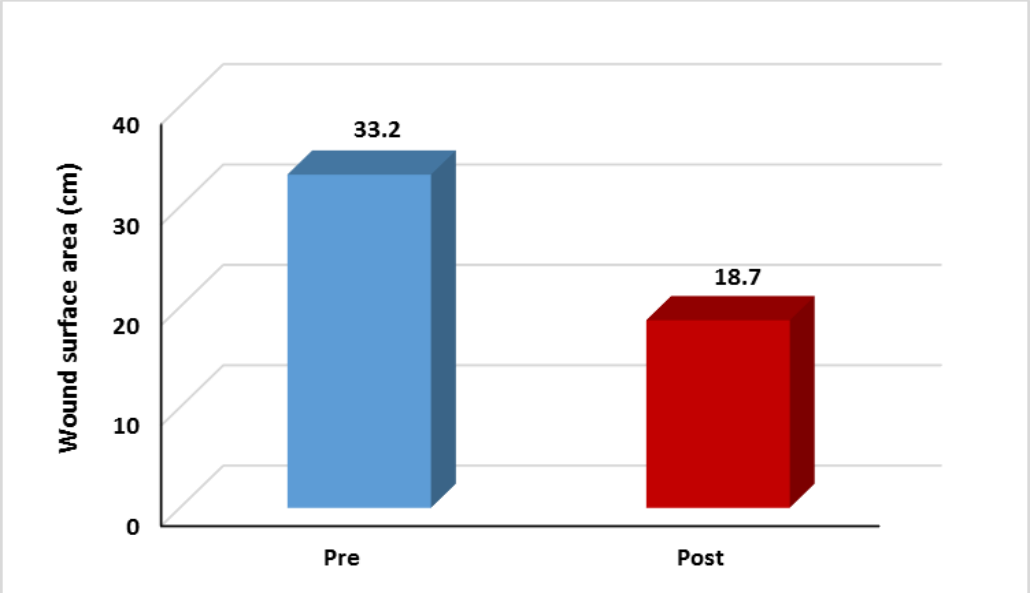

Fig. (5): Pre and post treatment mean values of wound surface area (Cm^2) of group C.

Comparison between post treatment mean values of wound surface area (cm^2) in all groups:

There was a significant difference (improvement) in post treatment mean value of wound surface area in 3 groups of the treatment as showed in table(6) and figure(6).

Table (6): ***Comparison between post treatment mean values of wound surface area (cm^2) of group A, B, and C:***

Wound surface area (Cm^2)			**F- value**	**p-value**	**Sig**
$\bar{X}$ ± SD					
Group A	**Group B**	**Group C**			
9.2 ± 1.54	14 ± 4.24	18.7 ± 4.64	16.12	0.0001	**S**
Multiple comparison (Bonferroni test)					
	MD	**p- value**		**Sig**	
Group A - Group B	-4.8	0.02		**S**	
Group A - Group C	-9.5	0.0001		**S**	
Group B - Group C	-4.7	0.02		**S**	

$\bar{X}$: Mean **MD : Mean difference** **S : Significant**
SD :Standard deviation **p value :Probability value**

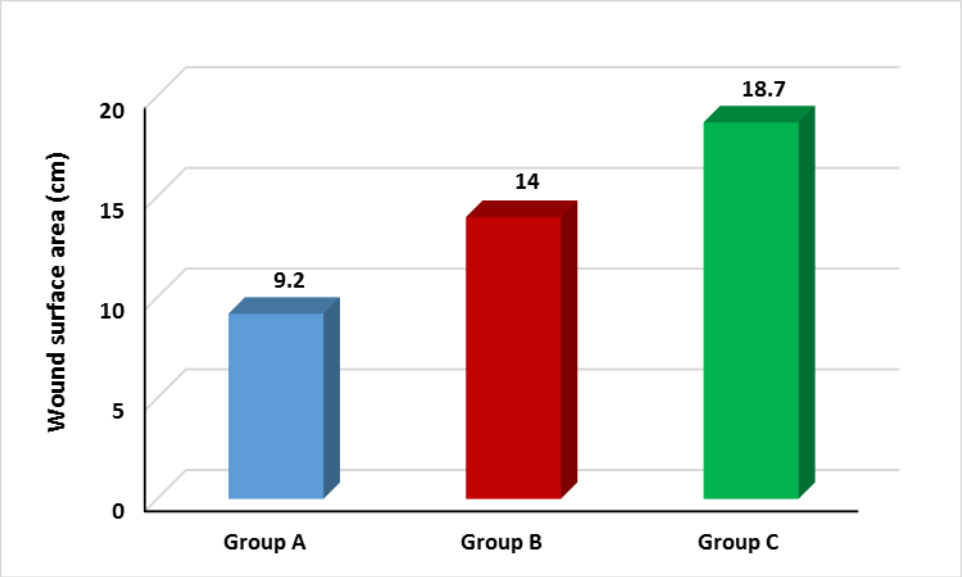

Fig. (6): Post treatment mean values of wound surface area (Cm^2) of group A, B, and C.

DISCUSSION

The transdermal route of drug delivery has attracted medical and pharmacological researchers due to its advantages over other methods of drug delivery. However, the stratum corneum acts as a barrier that limits the penetration of substances through the skin. Application of ultrasound to the skin believed to increase its permeability and enables the delivery of various substances into and through the skin **(9).**

Phonophoresis is well defined as the process of increasing skin absorption

and penetration of the topical medications to the deep tissues using ultrasound **(8).**

Phonophoresis, also known as sonophoresis, has been claimed to enhance the percutaneous absorption of certain pharmacological agents such as anti-inflammatory steroids from intact skin into the underlying subcutaneous structures by ultrasound, therefore improving their effectiveness **(14).**

Silver has been used for centuries to prevent and treat a variety of diseases including pleurodesis, cauterization, and healing of skin wounds **(5).** Its antibacterial effect may be due to blockage of respiratory enzyme pathways and alteration of microbial DNA and the cell wall. In addition to its recognized antibacterial properties, some authors have reported on the possible pro-healing properties of silver **(13).**

The results of this study revealed that there was a significant difference in burn wound surface area between the Deep phonophoresis group (group A) compared to the Superficial phonophoresis group (group B) and Nano silver gel group (group C). Post-treatment results of the present study showed reduction in the wound surface area after the treatment of the three groups (A),(B) and (C) with a percentage of improvement 74.3%, 59.18%, 43.76% respectively.

Researchesconfirmed that direct application of ultrasound resulted in enhanced angiogenesis **(7).**

Despite a wide usage of phonophoresis in physical therapy, doubts persist as to the relevance, efficacy and conditions underlying the efficacy of phonophoresis treatment. Although phonophoresis utilize ultrasound to increase the skin penetration of permeates, the mechanisms associated with this physical enhancer are not well understood in physiotherapeutic point of view. Specifically, mechanisms responsible for skin permeability enhancement and the location of these effects **(9).**

In studyinvestigated the wound-healing properties of silver nanoparticles in an animal model and found that rapid healing and improved cosmetic appearance occur in a dose dependent manner **(3)**. Silver is capable of aiding the wound healing process, mainly through its antibacterial activity. The broad spectrum of the silver ion's antibacterial activity -a result of the multiplicity of the bactericidal mechanism- has proven itself to be effective on a variety of bacteria species in multitudinous studies. Although silver has already been incorporated into commercially available products, the advancement of such wound care would have positive implications for the health and economy of humanity, especially if the less developed countries were granted an increased access to such medical necessities. Through the development of nanoparticles, and their modification at the molecular and Nano level, the application efficiency of wound treatments containing silver has been improving noticeably. These developments may be able to significantly reduce the time required for the wound area to reach its normal homeostatic equilibrium, while reducing the risk of unwanted

complications and improving the physical appearance of the scar by reducing hypertrophic scarring **(2).**

Silver nanoparticles and SSD cream produced a similar reduction in bacterial colonization of the wounds; in the Vaseline gauze group colonization increased Healing time for superficial second degree wounds was significantly shorter for the silver nanoparticle group than for the SSD or Vaseline gauze groups ($p<0.01$)**(1).**

Silver dressing chosen by clinician versus non-silver low adherence dressing for 12 weeks (n=213). There was no difference between the dressings in the proportion of ulcers healed at 12 weeks (59.6% in silver group; 56.7% in control group). There was no difference between groups in median time to healing or in health-related quality of life scores. The significantly higher cost for patients treated with antimicrobial dressings was partly due to increased frequency of dressing change and partly due to cost of the dressings**(6)**.

CONCLUSION

From the findings of the current study it is concluded that deep phonophoresis of Nano silver gel is more effective than superficial phonophoresis in improving wound healing.

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