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HONEY THERAPY VERSUS ULTRAVIOLET RADIATION IN THE TREATMENT OF PELVIC PRESSURE ULCERS IN PATIENTS WITH SPINAL CORD INJURY.

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ABSTRACT
Pressure ulcers represent an immense problem among elder and disabled population. This study was conducted to compare the therapeutic efficacy of both honey and ultraviolet radiation in healing of pressure ulcers in patients with complete or incomplete spinal cord injury. Forty five male patients participated in this study; having pelvic pressure ulcers ranging between grades III and IV. Fifteen patients received honey therapy and regular wound care (Group I), 15 received ultraviolet -C radiation and regular wound care(Group II) and 15 received traditional physical therapy and regular wound care (Control Group III).Evaluation of pressure ulcers was performed through measuring the wound surface area and volume of pressure ulcer ; pre-, 7 days post –initiation of therapy (Post I), 14 days (Post II)and 21 days (Post III) by tracing method and a syringe respectively. There was a significant difference between ultraviolet –C and honey therapy groups before treatment regarding wound surface area, while there was no significant difference regarding the volume. There was non significant difference between both groups for the mean values of wound surface area and its` volume after 7, 14 and 21 days from the initiation of treatment. But, there was a percentage of improvement in favor of honey therapy. It has been concluded that the application of honey therapy was better than ultraviolet –C radiation for treating and improving the rate of healing process of patients with complete or incomplete spinal cord injury and having pelvic pressure ulcers.

KEYWORDS: Honey therapy–Ultraviolet radiation–treatment–pressure ulcer.

INTRODUCTION
Skin ulceration due to pressure and shear are frequently referred to as decubitus ulcers, bedsores, ischemic ulcers and pressure sores. Pressure sores are common in elderly or immobile people; both in hospital and in community. This occurs in some 8% of bed ridden or chair bound patients. As well as the discomfort and risk of local or systemic infection, pressure sores delay rehabilitation and are costly in terms of bed space, nursing care and materials (Berg et al.,1990).

Pressure ulcer is defined as a localized area of tissue necrosis that tends to develop when soft tissue is compressed between a bony prominence and an external surface for a prolonged period of time (Delisia, 1985).Classification systems comprised 4-6 grades of pressure damage. All classifications rely on visual appearance; although some are more descriptive than others does. Any devitalized tissue will mask the true extent of tissue damage until debridement has been achieved (Macklebust and Sieggreen, 1996). Pressure ulcer grade III is a shallow, irregular defect extending through the dermis to the subcutaneous fat junction; being healed in months. Pressure ulcers grade IV extends through the full thickness of the skin into the subcutaneous tissue fascia or muscle; with healing requiring months or surgery(Delisia classification, 1985). Wound healing represents a high dynamic, integrated series of cellular, physiological and biochemical events that occur exclusively in whole organisms. Tissue injury is healed more frequently through reconstruction of connective tissue vasculature and covering epithelium than through regeneration (Madden and Arem, 1991).

Various physiotherapeutic modalities have been employed to enhance wound healing; including honey therapy (Vijaya and Nishteswar, 2012). The use of the latter as wound dressing material; was associated with rapid clearance of infection, decreased inflammation and pain, hastening of granulation and epithelialization, with

minimal scarring (Barui et al., 2013). The antimicrobial properties of honey prevent microbial growth in the moist healing environment created (Mandal and Mandal, 2011 as well as Jull et al., 2013). Unlike other topical antiseptics, honey cause no tissue damage (Zumla and Lulat, 1989).

Existing literature concentrates on broad spectrum ultraviolet light sources to clear wound from bacteria, to remove slough, to stimulate granulation tissue, epidermal growth, activation of steroids, vasomotor stimulation, metabolic stimulant, analgesic to nerve endings and finally psychological benefits (Shriber, 1981).Ultraviolet rays increases pro-vitamin D production with low dosage and has germicidal effects with increased doses(Khan, 1994).

Because of honey properties and wide spread applications of ultraviolet separately by physiotherapists, this study was carried out to determine whether honey dressing is more effective than application of ultraviolet ; to accelerate the healing process of bed sores, prevent infection and disabilities as well as decrease hospitalization period for patients with pressure sores and having either complete or incomplete spinal cord injury.

Subjects and Methods

Forty five male patients; having spinal cord injuries and who had developed pressure ulcers, were included in this study. They were 20-40 years old, with pelvic pressure ulcers classified III and IV grades according to Delisia classification (1985), with no malignancy or deep vein thrombosis in the area to be treated, no radiotherapy during last 6 months, non smokers and with no cardiac, diabetic or mental disorders. All patients were selected from El-Kasr El-Ani hospital and they were randomly divided to 3 equal groups:

Group I: Honey Therapy Group. They received honey therapy and regular wound care.

Group II: Ultraviolet–C Group. They received Ultraviolet-C and regular wound care.

Group III: Control Group. They received regular wound care and traditional physical therapy.

Lime honey was used; being obtained from the National Research Center and having the following physical properties: Moisture: 17.5, specific gravity: 1.4211, Viscosity: 69.0, Colour: o.15, Liability to fermentation: safe regardless to yeast count, Ph3.8, fructose: 37.2, Glucose: 29.2, sucrose: 6.5 and maltose:7.5.

Evaluation of pressure ulcers was performed through measuring the wound surface area(WSA) pre-, post-7, post-14and post-21 days by tracing method (Bohannon and Pfaller,1983) and by measuring the volume of pressure ulcers, by isotonic solution using a syringe (Berg et al., 1990). Measurement of wound volume were conducted pre-treatment, after 7 days (post I), 14 days (post II) and after 21 days (post III).

All the 3 groups received first wound care; including positioning and exercise therapy. Prone lying position of patients was appropriate for pelvic floor ulcers .Wounds were cleaned first , abscess were opened , pockets of pus were drained and necrotic tissue was removed. Moreover, scrubbing of wounds with a soft tooth brush, followed by hydrogen peroxide, saline and betadine. Honey was poured into the wound to three quarters volume of pressure ulcer. Wound was covered with addressing in the form of clean sterilized gauze and well fitted to the skin through silk adhesive plaster. Honey was applied every other day for 3 weeks. For ultaviolet group; vigorous rubbing of skin was done with alcohol; for removing any oils or impurities. Ultaviolet –C was applied every other day for 3 weeks (Nussbaum et al., 1994).

RESULTS

In the present investigation,45 patients completed the study; their ages ranged between 20 and 40 years. Their spinal cord injury duration ranged from 1 to 7 years and their ulcer duration ranged from2 to 33months.

The mean value of wound surface area for pre- treatment application (pre) was 18.91 ±8.77 cm^2 .After 7 days of initiation of treatment with honey (post I) was 15.07±8.3, after 14 days (post II) 12.87 ±7.52cm^2 and after 21 days (post III) 9.73 ±6.23cm^2(Table:1). This revealed highly statistical significant reduction of wound surface area; when comparing the mean values post with pre-treatment. The surface area was significantly reduced on comparing Post II and Post III with post I. Moreover, Post III was significantly reduced when compared with II(Table :1). As revealed from table: 2; the percentage of reduction in wound surface area was 20.2, 31.9 and 43.22 cm^2in post I, Post II and Post III respectively.

The mean value of wound volume for pre- treatment application (pre) was 13.95 ±7.69 cc. After 7 days of initiation of treatment with honey (post I) was 11.49 ±7.19, after 14 days (post II) 8.31 ±6.29 cc and after 21 days (post III) 6.3±1.38 cc(Table:3). This revealed highly statistical significant reduction of wound volume; when comparing the mean values post with pre-treatment. The volume was significantly reduced on comparing Post II and Post III with post I. Moreover, Post III was significantly reduced when compared with II (Table: 3). As revealed from table: 4; the percentage of reduction in wound volume was 17.63, 40.4 and 54.83 in post I, Post II and Post III respectively.

The mean value of wound surface area for pre- treatment application (pre) was 10.91 ±9.45 cm^2 .After 7 days of initiation of treatment with ultraviolet therapy (post I) was 9.94±8.65, after 14 days (post II) 8.84 ±7.86cm^2 and after 21 days (post III) 7.22 ±7.17cm^2(Table:5). This revealed statistical significant reduction of wound surface area ; when comparing the mean values post with pre-treatment. The surface area was highly significantly reduced on comparing Post II and Post III with post I.

Moreover, Post III was significantly reduced when compared with II(Table: 5). As revealed from table: 6; the percentage of reduction in wound surface area was 8.89, 18.97 and 33.82 cm^2 in post I , Post II and Post III respectively.

The mean value of wound volume for pre- treatment application (pre) was 9.39 ±9.17cc. After 7 days of initiation of treatment with ultraviolet therapy (post I) was 8.39 ±8.24, after 14 days (post II) 9.62±7.49 cc and after 21 days (post III) 5.75 ±6.85 cc(Table:7). This revealed highly statistical significant reduction of wound volume; when comparing the mean values post with pre-treatment. The volume was highly significantly reduced on comparing Post II and Post III with post I. Moreover, Post III was significantly reduced when compared with II (Table:7). As revealed from table: 8; the percentage of reduction in wound volume was 10.64, 28.3 and38.76 in post I, Post II and Post III respectively. The mean value of wound surface area for pre- treatment (pre) for the control group was 18.10 ±8.94 cm^2 .After 7 days (post I) was 15.94±6.35, after 14 days (post II) 15.94 ±6.5cm^2 and after 21 days (post III) 15.69 ±6.54cm^2(Table:9). This revealed statistical significant reduction of wound surface area; when comparing the mean values post with pre-treatment. The surface area was significantly reduced on comparing Post III with post I. On the other hand, on comparing Post I with Post II; no significant reduction was noticed. Moreover, Post III was significantly reduced when compared with II (Table: 9). As revealed from table: 10; the percentage of reduction in wound surface area was 11.93, 11.93 and 13.3 cm^2 in post I , Post II and Post III respectively.

The mean value of wound volume for pre- treatment (pre) for the control group was 12.13 ±4.21cc .After 7 days (post I) was 12.58±4.37, after 14 days (post II) 12.69±4.32cc and after 21 days (post III) 12.56±4.26 cc(Table:11). This revealed no significant reduction of wound volume; when comparing the mean values post with pre-treatment. The volume showed no significant reduction on comparing Post II and Post III with post I. Moreover, Post III showed no significant reduction when compared with II (Table :11). As revealed from table: 12; the percentage of reduction in wound volume was 3.5, 4.6 and 3.5 in post I, Post II and Post III respectively.

As shown in table: 13; there were significant differences in mean values of wound surface area between control and honey therapy group. The same for ultraviolet group and also on comparison of between honey and ultraviolet groups. As regards mean values of wound volume (table: 14), the same results were obtained.

Table 1: Statistical analysis of mean differences of wound surface area of pre-,post I,II & III for honey therapy group

Statistics	Time of wound surface area measurements (in cm) for honey group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	18.9	15.07	18.9	12.87	18.9	9.73	15.07	12.87	15.07	9.73	12.87	9.73
SD	8.77	8.32	8.77	7.52	8.77	6.23	8.32	7.52	8.32	6.23	7.52	6.23
MD	3.83		6.03		9.17		2.2		5.34		3.14	
t-value	7.38		9.89		10.38		7.63		8.35		7.25	
P-value	0		0		0		0		0		0	
Level of significance	S		S		S		S		S		S	

Table 2: Percentage of wound surface area reduction for honey group

Statistics	Wound surface area					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	18.9	15.07	18.9	12.87	18.9	9.73
MD	3.38	6.03	9.17			
%of improvement	20.26		31.9		43.22	

Table 3: Statistical analysis of mean differences of wound volume of pre-, post I, II & III for honey therapy group

Statistics	Wound volume					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	13.95	11.49	13.95	8.31	13.95	6.3
MD	2.46		5.64		7.65	
% of improvement	17.63		40.43		54.83	

SD: Standard Deviation, MD: Mean Difference, S: Significance

Table 4: Percentage of wound volume reduction for honey therapy group

Statistics	Time of wound volume measurements (in cc) for honey group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	13.95	11.49	13.95	8.31	13.95	6.30	11.49	8.31	11.49	6.30	8.31	6.30
SD	7.69	7.19	7.69	6.29	7.69	5.38	7.19	6.29	7.19	5.38	6.29	5.38
MD	2.46		5.64		7.65		3.18		5.19		2.01	
t-value	8.48		8.24		9.76		6.55		8.01		7.61	
P-value	0	0	0	0	0	0						
Level of significance	S	S	S	S	S	S						

MD:Mean Difference

Table 5: Statistical analysis of mean differences of wound surface area of pre-,post I,II & III for ultraviolet-C group

Statistics	Time of wound surface area measurements (in cm) for ultraviolet-C group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	10.91	9.94	10.91	8.84	10.91	7.22	9.94	8.84	9.94	7.22	8.84	7.22
SD	9.45	8.65	9.45	7.86	9.45	7.17	8.65	7.86	8.65	7.17	7.86	7.17
MD	0.79		2.07		3,69		1.10		2.72		1.62	
t-value	4.45		4.81		5.71		4.73		5.99		6.28	
P-value	0.001		0		0		0		0		0	
Level of significance	S		S		S		S		S		S	

SD: Standard Deviation, MD: Mean Difference, S: Significance

Table 6: Percentage of wound surface area reduction for ultraviolet-C group

Statistics	Time of wound volume measurements (in cc) for ultraviolet-C group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	9.39	8.39	9.39	6.92	9.39	5.75	8.39	6.92	8.39	5.75	6.92	5.75
SD	9.17	8.24	9.17	7.94	9.17	6.85	8.24	7.94	8.24	6.85	7.94	6.85
MD	1.0		2.47		3.64		1.47		2.64		1.17	
t-value	4.12		5.28		5.58		6.28		6.21		5.70	
P-value	0.001		0		0		0		0		0	
Level of significance	S		S		S		S		S		S	

MD: Mean Difference.

Table 7: Statistical analysis of mean differences of wound volume of pre-, post I,II & III for ultraviolet-C group.

Statistics	Wound volume (in cm)					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	9.39	8.39	9.39	6.92	9.39	5.75
MD	1		2.47		3.64	
%of improvement	10.64		26.30		38.76	

SD: Standard Deviation, MD: Mean Difference, S: Significance

Table 8: Percentage of wound volume reduction for ultraviolet-C group

Statistics	Wound surface area					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	10.91	9.94	10.91	8.84	10.91	7.22
MD	0.97		2.07		3.69	
%of improvement	8.89		18.97		33.82	

SD: Standard Deviation, MD: Mean Difference, S: Significance, NS: Non Significant.

Table 9: Statistical analysis of mean differences of wound surface area of pre-, post I,II & III for the control group

Statistics	Time of wound surface area measurements (in cm) for the control group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	18.10	15.94	18.10	15.94	18.10	15.69	15.94	15.94	15.94	15.89	15.94	15.69
SD	8.94	6.35	8.94	6.5	8.94	6.54	6.35	6.5	6.35	6.54	6.5	6.54
MD	2.16		2.16		2.41		0.00		0.35		0.35	
t-value	2.17		2.16		2.45		0.10		3		3.29	
P-value	0.04		0.04		0.03		0.9		0.01		0.005	
Level of significance	S		S		S		NS		S		S	

MD: Mean Difference.

Table 10: Percentage of wound surface area reduction for the control group

Statistics	Time of wound volume measurements (in cc) for the control group											
	Pre-	Post I	Pre-	Post II	Pre-	Post III	Post I	Post II	Post I	Post III	Post II	Post III
Number	15	15	15	15	15	15	15	15	15	15	15	15
Mean	12.13	12.56	12.13	12.69	12.13	12.65	12.65	12.69	12.56	12.56	12.69	12.56
SD	4.21	4.37	4.21	4.32	4.21	4.26	4.37	4.32	4.73	4.26	4.32	4.26
MD	-0.43		-0.56		-0.43		-0.13		0		-0.13	
t-value	-1.10		-1.54		-1.13		-1.39		0.09		1.15	
P-value	0.29		0.15		0.28		0.18		0.93		0.27	
Level of significance	NS		NS		NS		NS		NS		NS	

MD: Mean Difference

Table 11: Statistical analysis of mean differences of wound volume of pre-,post I,II & III for the control group.

Statistics	Wound surface area (in cm)					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	18.1	15.94	18.1	15.94	18.1	15.69
MD	2.16		2.16		2.41	
%of improvement	11.93		11.93		13.31	

SD: Standard Deviation, MD: Mean Difference, NS: Non Significant.

Table 12: Percentage of wound volume reduction for the control group

Statistics	Wound volume (in cm)					
	Pre	Post I	Pre	Post II	Pre	Post III
Number	15	15	15	15	15	15
Mean	12.13	12.56	12.13	12.69	12.13	12.56
MD	-0.43		-0.56		-0.43	
%of improvement	3.5		4.6		3.5	

MD: Mean Difference.

Table 13: Comparison between the mean values of wound surface area after 21 days

Statistics	wound volume measurements after 21 days					
	Control Group	Honey Group	Control Group	Ultraviolet Group	Honey Group	Ultraviolet Group
number	15	15	15	15	15	15
Mean	12.56	6.3	12.56	5.75	6.3	5.75
SD	4.26	5.38	4.26	6.85	5.38	6.85
MD	6.26		6.81		0.45	
t-value	3.53		3.26		0.24	
P-value	0.001		0.003		1.80	

Level of significance	S	S	NS

SD: Standard Deviation, MD: Mean Difference, S: Significant, NS: Non Significant.

Table 14: Comparison between the mean values of wound volume after 21 days

Statistics	wound surface area measurements after 21 days					
	Control Group	Honey Group	Control Group	Ultraviolet Group	Honey Group	Ultraviolet Group
number	15	15	15	15	15	15
Mean	15.69	9.73	15.69	7.22	9.73	7.22
SD	6.54	6.23	6.54	7.17	6.23	7.17
MD	5.96		8.47		2.51	
t-value	2.55		3.37		1.02	
P-value	0.02		0.002		0.32	
Level of significance	S		S		NS	

Standard Deviation, MD: Mean Difference, S : Significant , NS : Non Significanta.

DISCUSSION

This study was designed to evaluate the therapeutic efficacy of honey therapy versus ultraviolet radiation on healing of pressure ulcers in patients with spinal cord injury.

Most of the factors that might influence the healing were controlled; as all patients were non smokers, used same quality of bed mattresses and wheelchair, cushions, received an equivalent qualitative and quantitative diet, there was no malignancy or deep vein thrombosis in the area to be treated, patients didn`t receive any radiotherapy in the area to be treated in the last 6 months and all patients were free from any cardiac diseases or diabetes.

After 21 days of application of treatment, the results indicated a decrease in mean values of wound surface area and wound volume in the 2 groups of study. Patients receiving topical honey therapy showed considerable differences in wound surface area and volume .i.e. honey is an effective method to enhance healing process of pressure ulcers in the form of reduction of the mean values of wound surface area and volume. This might be due to production of h_2O_2 in honey through the enzymatic activity of glucose oxidase enzyme, the effect of high osmotic pressure of honey on microorganisms and the effect of acidic pH on bacteria, all of these factors are to sterilize wound, while the presence of carbohydrates, acids, minerals, amino acids, enzymes, vitamins, lipids, acetyl choline and choline are major components to give nutrition to the wound. This is consistent with Condon (1991), Arieh et al., (1996) and Vijaya and Nishteswar, 2012. Zumla and Lulat (1989) showed remarkable improvement following topical application of honey for 59 skin ulcer patients. Slough and necrotic tissue were rapidly replaced with granulation tissue and advancing epithelialization (Barui et al., 2013). Burn wounds treated early, healed quickly and were not colonized by bacteria(Mandal and Mandal, 2011 as well as .Jull et al., 2013). Moreover, ultraviolet therapy is considered as one line of treatment to accelerate wound healing as well as reduce wound surface area. Our ultraviolet results went hand in hand with some current researches observed by Crous and Malberbe (1988), Nussbaum et al., (1994) and Mac Kinnon and Cleek (1984). The latter authors showed that erythema is caused by vasodilatation and the subsequent increase in blood within the dermis. The increased capillary permeability causes protein to move from capillaries into the dermis. This results in change in osmotic pressure; consequently water is drawn into the area and edema occurs. Leucocytes and monocytes pass into the dermis and to a small degree into epidermis. These cells phagocytose dead cells and other debries. At 24 hours, the inflammatory process is completed and at 30 hours, the rebuilding begins. The reparative process is characterized by increased activity of keratocytes and result in a thickening of epidermis (MacKinnon and Kleek, 1984). One of the previous explanations may be the reason for the results of initiation of Ultraviolet C treatment.

On comparing the mean values of wound surface area and volume for honey therapy and ultraviolet C after 7, 14 and 21 days from initiation of treatment, it was found that there was no significant difference; but there was a percentage of improvement in favor of honey therapy. Regarding the mean value of wound surface area for honey group before treatment; it was 18.91, while for ultraviolet group was 10.91. So, the percentage of reduction of wound surface area for honey therapy group was 43.22%, while for ultraviolet group was 33.82. On the other hand, the percentage of reduction of wound volume for honey therapy group was 54.83 % , while for ultraviolet –C group was 38.76%. Also, significant difference for the mean values of wound surface area and volume was found between honey therapy as well as ultraviolet–C groups and the control group after 21 days of initiation of treatment.

So, application of topical honey treatment may represent a valuable and beneficial method for treating and improving rate of healing process of patients; with pelvic ulcer in cases with complete or incomplete spinal cord injury. Moreover, we can consider honey therapy as a

better comprehensive wound management than ultraviolet –C after 21 days from the initiation of treatment in patients with pressure ulcers in spinal cord injuries.

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