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Ulcer Surface Area and Colony Count Response to Ultraviolet Radiation (Type B) Followed by Honey Topical Application in The Treatment of Pressure Ulcers

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ABSTRACT

Background: Pressure ulcers are a common complication in patients with spinal cord injuries, often requiring innovative therapeutic strategies. This study evaluated the efficacy of ultraviolet radiation type B (UVB) combined with topical honey application in promoting pressure ulcer healing.

Methods: Sixty patients with sacral pressure ulcers were randomly assigned to three groups. Group A received UVB followed by topical honey, Group B received UVB alone, and Group C received honey alone. All groups also received standard medical, nursing, and physical therapy care. Treatment was applied every other day for six weeks or until healing. **Results:** Both UVB and honey independently reduced bacterial colony counts and ulcer surface area. However, the combined intervention (UVB plus honey) demonstrated superior efficacy in accelerating ulcer healing compared with either treatment alone.

Conclusion: The combination of UVB and topical honey represents a more effective approach to enhancing pressure ulcer healing in patients with spinal cord injuries.

Keywords: Honey therapy, Ultraviolet (Type B), Pressure ulcers, ulcer surface area and Colony count.

INTRODUCTION

Pressure ulcers can form on areas of skin and tissue injury. They are typically brought on by prolonged sitting or laying in one posture. Some parts of the body are compressed as a result. The blood flow to the skin and subcutaneous tissues may be diminished by the pressure. A sore may develop if there is insufficient frequency of positional changes and the blood supply becomes insufficient. Decubitus ulcers, pressure ulcers, and bed sores are other names for pressure sores [1, 2].

Pressure ulcers may arise from inadequate blood flow and subsequent reperfusion injury when blood re-enters tissue. Healthy people may experience a minor pressure sore when they sit in the same position for long periods of time. This dull pain indicates that there is a blockage in the blood supply to the afflicted areas. This lack of blood flow, known as ischemia, can cause tissue damage and cell death in a matter of hours. The sore will begin as a painful, red spot and progressively develop purple. The skin could rupture and get infected if treatment is not received. Wet skin is more prone to infection and is more vulnerable to tissue ischemia and necrosis [3, 4].

In addition to interfering with rehabilitation and medical care, pressure ulcers increase patient morbidity. Additionally, it is often cited as a primary contributing factor to the patient's death. Since the outset, the disabled and debilitated patient has surely suffered from skin ulceration, particularly over bony prominences. Prior to the development of antibiotic therapy, subsequent infections of ulcerations caused premature mortality; however, patients nowadays typically live for extended periods of time. increased life expectancy, which has led to a greater number of people than ever before reaching a comparatively advanced age. As a result, more patients are receiving care in nursing homes and hospitals. The salvage rate of the growing number of persons experiencing catastrophic trauma has been significantly increased by greatly enhanced comprehensive team-concept trauma care, improved patient transport techniques, more efficient receiving facilities, and emergency medical care with highly skilled paramedics. Professional medical care is becoming more and more necessary to maintain and rehabilitate the elderly and severely crippled [5, 6]. Longer than X-rays but shorter than visible light, ultraviolet (UV) radiation is a kind of electromagnetic radiation with wavelengths ranging from 10 nm (equivalent to a frequency of roughly 30 PHz) to 400 nm (750 THz). UV radiation, which accounts for around 10% of the Sun's total electromagnetic radiation output, is found in sunlight. It can also be produced by electric arcs and specialty lights such as mercury-vapor lamps, tanning lamps, and black lights. Since its photons lack the energy to ionize atoms, long-wavelength ultraviolet light is not considered an ionizing radiation, even though it can drive chemical reactions and make a variety of objects shine or fluoresce [7].

rays that are invisible but contribute to solar energy. Melanoma and other forms of skin cancer, sunburn, and thickening and darkening of the epidermis are all brought on by ultraviolet B radiation. Additionally, it may result in immune system and ocular issues. Use of sunscreens that shield the skin from UV rays is advised by skin specialists. UVB radiation, which is also produced by special lamps or lasers, is used in medicine to treat skin conditions such psoriasis, vitiligo, and skin tumors caused by cutaneous T-cell lymphoma. Another name for UVB radiation [8, 9].

A natural commodity, Honey's therapeutic qualities have led to its widespread use. It is said to contain more than 200 compounds. Honey is mostly composed of fructose and glucose, but it also contains

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fructo-oligosaccharides, a number of amino acids, vitamins, minerals, and enzymes. The plants that bees feed on determine the content of honey. However, nearly all-natural honey contains phenolic acids Ascorbic acid, tocopherols, catalase (CAT), superoxide dismutase (SOD), reduced glutathione (GSH), peptides, Millard reaction products, ellagic, caffeic, p-coumaric, and ferulic acids, and flavonoids (apigenin, pinocembrin, kaempferol, quercetin, galangin, chrysin, and hesperidin). Most of those substances work together to create a synergistic antioxidant effect [10, 11].

For generations, honey has been revered in traditional medicine. However, because it lacks scientific backing, its application in contemporary medicine is restricted. There has long been evidence that honey can help with gastrointestinal, cardiovascular, and liver issues. Honey was used to treat intestinal wounds and illnesses by the ancient Egyptians, Assyrians, Chinese, Greeks, and Romans. Numerous research groups have been doing laboratory and clinical studies on honey since a few decades ago. The most noteworthy finding was honey's antimicrobial properties, which have been noted in a number of research [12, 13]. Natural honey has bactericidal properties against Helicobacter pylori, Shigella, Escherichia coli, Salmonella, and other bacteria. In an inflammatory model of colitis, honey performed equally well as prednisolone. Furthermore, research has indicated that honey might have anti-inflammatory qualities and strengthen the body's resistance to wounds [14].

PATIENTS AND METHODS

60 patients, ages 30 to 50, who were identified by neurologists at Cairo University Hospitals' El-Kasr El-Aini as having either a total or partial spinal cord injury, participated in this study. They were free of conditions that could interfere with the healing process and affect the outcome, such as diabetes mellitus, heart disease, cancer, deep vein thrombosis, or anemia. but suffered from sacral pressure ulcers that were categorized as grades 2–3 by the **National Pressure Ulcer Advisory Panel and the European Pressure Ulcer Advisory Panel (NPUAP/EPUAP).**

Every patient received the same standard nursing and medical attention. Measurements were taken as a first record prior to the start of the treatment and as a second (final) record after the conclusion of the treatment.

Instrumentation:

The ultraviolet (Type B Device) and honey topical administration were the treatment tools used in this investigation, whereas the measuring instruments were the colony count and the wound surface area (WSA) measurement in cm2 [15].

Procedures:

Evaluation:

Measurement procedures:

A- Wound surface area (WSA) measurement in cm^2:

By covering the wound with a piece of sterile transparency film and using a fine-tipped transparency marker to trace the perimeter of the wound on the film, the planimeter approach was used to determine the wound surface (WAS). A distinct transparency was applied to each incision. The number of 1 mm squares inside the perimeter is then counted when the tracing is spread out on metric graph paper. After that, the area is converted to square centimeters. The wound area was measured both before the experiment began and after the treatment was finished [2, 3].

B. Colony count: Swapping tools: gloves, sterile swab, and culture sample media. Before therapy (First record), and after a month of treatment or till healing (Second record), these tools were used to measure the burn wound's healing and colony count [16].

B- Colony count: Semi quantitative culture of the wound surface area: Using a sterile cotton swab, the entire wound area was coated. A 5 ml sterile solution containing 0.9% NaCl was used to thoroughly emulsify the swab material. Using 0.5 ml aliquots and 4.5 ml of sterile saline per aliquot, three successive 1:10 dilutions of the suspension were prepared. The blood gar plate's surface was covered with a 0.1 ml sample of each dilution and the original suspension. Every plate was incubated for 24 hours at 37C0. The number of colonies on the plate that grew between 30 and 300 colonies was used to calculate the number of organisms per milliliter of the swab suspension. The count in step 6 was multiplied by the dilution factor to determine the number of colonies on the plate. Each colony count was completed independently. To determine each colony, count in advance, Gram staining, important tests such as oxidase and catalase tests, and colony morphology were conducted [17].

1- Treatment procedures:

Every patient in the three groups (A), (B), and (C) got the same nursing care, prescribed drugs, traditional physical therapy regimen, conservative pressure ulcer treatment, and food. Every patient in the three groups received the same dressing, which was sterile Vaseline gauze (Sofra-tulle dressing), which was changed once a day. UV (Type B) procedures with topical application of honey **for the first study group (1):** were applied for ten minutes, followed by topical honey administration on the sacral pressure ulcers, daily wound care from the doctor and nurse, and typical physical therapy (exercises and posture) for six weeks or until the ulcers healed. Group 2 (the second study group) was exposed to type B UV radiation for ten minutes, along with standard medical and nursing care for wounds and typical physical therapy (exercises and positions) for six weeks or until the wound healed. During the course of treatment, which lasted six weeks or until the wounds healed, Group 3 got topical honey application for the sacral pressure ulcers, frequent medical and nursing wound care, and traditional physical therapy (positioning and exercises) [13].

Ethical approval:

Approval was obtained from Faculty of Physical Therapy, Cairo University Institutional Review Board (IRB). Informed written consent was obtained from all patients. . This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Data analysis

Prior to therapy, as a first record, and six weeks into the intervention, as a second final record, the ulcer surface area and colony count of the three groups were measured. The collected data have been processed, encoded, and analyzed using the SPSS version 21.0 for Windows, such as mean, standard deviation, minimum, and maximum, were calculated for each group. The t-test was used to compare the mean difference between the two groups before and after application, as well as within each group. An alpha point of 0.05 was chosen as the significance criterion [18].

RESULTS

The ulcer surface area in cm^2 was 15.08 ± 5.15 in the first group (UV and Honey group) prior to therapy, and 4.270 ± 3.322 cm2 following treatment, as indicated in table (1) and figure (1). The ulcer surface area in cm2 decreased significantly, according to these results ($P < 0.0001$). Prior to therapy, the ulcer surface area in the UV group was 15.05 ± 5.11 cm^2, and following treatment, it was 8.130 ± 2.833 cm2. According to these findings, the ulcer surface area in cm2 decreased significantly, but in the third group (topical honey application), the mean ulcer surface area in cm2 was 15.06 ± 5.12 cm^2 prior to treatment and 8.133 ± 2.811 cm^2 following treatment. These findings showed that the ulcer surface area in cm2 had significantly decreased. ($P < 0.0001$).

Table (1): Comparison of the mean values of the ulcer surface area in cm^2 before and after treatment in the three groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Ultraviolet followed by topical honey application Group	**15.08**	**5.15**	**4.270**	**3.322**	**10.8100**	**7.89**	**<0.0001**	**Highly significant decrease**
Ultraviolet application Group	**15.05**	**5.11**	**8.130**	**2.833**	**6.92000**	**5.30**	**<0.0001**	**Highly significant decrease**
Topical honey application group	**15.06**	**5.12**	**8.133**	**2.811**	**6.92700**	**5.30**	**<0.0001**	**Highly significant decrease**

The colony count in C before treatment was 25110 ± 4198 in the first group (UV and honey application), and after treatment it was 278.0 ± 131.5, as seen in figure (2) and table (2). Prior to treatment, the UV group's mean colony count in C was 25111 ± 4622 C; following treatment, it was 442.0 ± 200.8) C. According to these findings, the colony count in C decreased in a **statistically significant** way ($P < 0.0001$). Prior to treatment, the mean colony count in the honey application group was 25111 ± 4622 C; following treatment, it was 442.0 ± 200.8) C.

Table (2): Comparison of the mean values of the colony count in C before and after treatment in the three groups

	Before treatment		After treatment		Mean difference	T-value	P.value	Level of significance
	Mean	SD	Mean	SD				
Ultraviolet followed by topical honey application Group	**25110**	**4198**	**278.0**	**131.5**	**24832.0**	**26.44**	**<0.0001**	**Highly significant decrease**
Ultraviolet application Group	**25112**	**4106**	**443.0**	**203.0**	**24669.0**	**26.84**	**<0.0001**	**Highly significant decrease**
Topical honey application group	**25111**	**4622**	**442.0**	**200.8**	**24669.0**	**23.85**	**<0.0001**	**Highly significant decrease**

DISCUSSION

One of the main issues facing medical personnel who are tasked with overseeing the treatment of patients who are severely incapacitated or debilitated is pressure ulcers. Every caregiver is fully aware of the challenges that arise when a patient becomes bedridden or has an ulcer in their chair. In addition to interfering with rehabilitation and medical care, pressure ulcers increase patient morbidity. Additionally, it is often cited as a primary contributing factor to the patient's death. Since the outset, the disabled and debilitated patient has surely suffered from skin ulceration, particularly over bony prominences. Prior to the development of antibiotic therapy, subsequent infections of ulcerations caused premature mortality; however, patients nowadays typically live for extended periods of time [1, 2].

increased life expectancy, which has led to a greater number of people than ever before reaching a comparatively advanced age. As a result, more patients are receiving care in nursing homes and hospitals. The salvage rate of the growing number of persons experiencing catastrophic trauma has been significantly increased by greatly enhanced comprehensive team-concept trauma care, improved patient transport techniques, more efficient receiving facilities, and emergency medical care with highly skilled paramedics. The need for professional health care to sustain and rehabilitate the elderly and seriously disabled is growing [17, 19].

Lesions called bedsores, also referred to called decubitus or pressure ulcers, are caused by applying pressure on any area of the body for an extended period of time, especially over cartilaginous or bony regions. Bedsores are totally curable if discovered early, but they can become fatal if left untreated. Localized regions of cellular necrosis known as pressure ulcers typically develop around bony prominences that are exposed to pressure above capillary pressure for extended periods of time. Any disease that disrupts this exchange will have an impact on the cell's ability to operate because regular cellular metabolism depends on the uptake of nutrients and the removal of metabolites. The peripheral blood in circulation satisfies the cells' metabolic requirements, causing alterations in cellular circulation. Long-term circulation disruption eventually results in cell death [3, 5].

Pressure ulcers may arise from inadequate blood flow and subsequent reperfusion injury when blood re-enters tissue. Sitting in the same position for extended periods of time might cause a mild pressure sore in healthy people. This dull pain indicates that there is a blockage in the blood supply to the afflicted areas. This ischemia, or loss of blood flow, can cause tissue damage and cell death in a matter of hours. The sore will begin as a painful, red spot and progressively develop purple. The skin could rupture and get infected if treatment is not received. Wet skin is more prone to infection and is more vulnerable to tissue ischemia and necrosis [1, 6].

Electromagnetic radiation with wavelengths between 10 and 400 nm, or photon energies between 3 and 124 eV, is known as ultraviolet (UV) light. This wavelength is longer than X-rays but shorter than visible light. The wavelength of UV light determines its capacity to enter human tissue. Among the UV groups, UV-A is the most invasive and can lead to cataract development and skin damage. The most harmful type of UV is UV-B, which can result in corneal burn and erythema, or sunburn. The erythema threshold of UV-B is 1,000 times lower than that of UV-A, and it is far more efficient than UV-A at damaging living tissue. UV-C can cause ocular burns but cannot penetrate the dead layer of human skin. UV-C is utilized in germicidal lamps because it kills microorganisms [20].

Long-term exposure to UV radiation from the sun results in photoaging, or early skin aging, which is typified by wrinkles, a loss of skin tone, and pigmentation changes. In photoaged skin, there are discernible alterations in the collagenous extracellular matrix of connective tissue. Over the past 20 years, a great deal of research has been done on the molecular mechanism behind the UV-induced aging process of human skin. We now know that UV radiation triggers a complicated series of chemical reactions that ultimately change the structure of the dermal extracellular matrix, leading to wrinkles, decreased skin elasticity, heightened skin fragility, and compromised skin barrier function. UV radiation-induced collagen degradation is typically partial, resulting in the buildup of partially broken collagen fragments that weaken the skin's structural integrity and adversely affect the production of new collagen. As a result, wrinkles and sagging skin develop. In addition to degrading the suppleness of the skin, UV also reduces the quantity of Langerhans cells in the dermis [8, 9].

Honey's antibacterial properties revealed that diluted honey exhibited effectiveness against 17 microorganisms. Bacterial filters were able to retain the light-sensitive activity. They called it "inhibines" and linked it to comparable antibacterial properties they had observed in other naturally occurring compounds. Glucose oxidase, found in honey, breaks down glucose into gluconic acid and hydrogen peroxide (H2O2). It was demonstrated that the existence of such enzymes in honey supported the identification of inhibine as hydrogen peroxide generated by the honey's glucose oxidase, as well as the fact that the inhibine number of the honey sampled is directly correlated with the hydrogen peroxide concentration, demonstrating the impact of H2O2 on Staphylococcus aureus. When honey is exposed to Cobalt 60 gamma radiation up to 25 KGy, its antibacterial properties caused by glucose oxidase are not readily compromised. However, a sterilizing dose of 18 KGy is sufficient to eradicate the higher natural contamination with Clostridium botulinum spores [10, 11].

The study's findings showed that the means of the first record USA (1) (before to application) and the second record USA (2) (after six weeks of the ultraviolet + honey+ routine medical and nursing regular ulcer care

as well as the traditional physical therapy application) ($P < 0.0001$).

Additionally, results indicated that the second group (Ultraviolet+ routine medical and nursing regular ulcer treatment as well as the typical physical therapy) had a highly significant drop in the means of the second and first records ($P < 0.0001$).

Additionally, the third group's means of the second and first records (Honey+ routine medical and nursing regular ulcer treatment as well as the typical physical therapy application) demonstrated a highly significant decrease ($P < 0.0001$).

Additionally, the results showed that the means of the first record, CC (1), which was taken before treatment, and the second record, CC (2), which was taken after six weeks of UV radiation (type B), had decreased significantly. followed by the topical application of honey on the sacral pressure ulcers, routine medical and nursing regular wound care, and the traditional physical therapy application) ($P<0.0001$).

According to the current study's findings, the means of CC (2) and CC (1) decreased significantly ($P < 0.0001$).

The current study's results also revealed a significant drop in the means of CC (2) and CC (1) ($P < 0.0001$).

These significant differences, between the three groups; the first group (ultraviolet radiation (type B) followed by the honey topical application on the sacral pressure ulcers, routine medical and nursing regular wound care as well as the traditional physical therapy (positioning and exercises) through the treatment period of 6 weeks or till healing) and the second group (ultraviolet radiation (type B) and the same routine medical and nursing regular wound care as well as the traditional physical therapy (positioning and exercises) through the treatment period of 6 weeks or till healing) groups, the third group (honey topical application on the sacral pressure ulcers, routine medical and nursing regular wound care as well as the traditional physical therapy (positioning and exercises) through the treatment period of 6 weeks or till healing, They were in line with those noted and documented by the USA and CC and showed an extremely significant decline[1,2,3,6,10,11,15,21,22,23] .

The application of both UV (type B) and honey therapy had beneficial healing effects on pressure ulcers, as evidenced by patients with total or partial spinal cord damage showing extremely large reductions in USA and CC, according to the results of the study and the reports of earlier researchers in related fields. However, the first group's application of both was more successful than the second or third groups' application of only one.

CONCLUSION

As demonstrated by the highly substantial reductions in USA and CC in patients with total or partial spinal cord damage, the application of both ultraviolet (type B) and honey therapy had beneficial healing effects on pressure ulcers. However, the first group's application of both was more successful than the second or third groups' application of only one.

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