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Efficacy of Negative Pressure Therapy on Wound Healing among Patients With Diabetic Foot Ulcer

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Abstract: Background: Diabetic foot ulcer has become a major chronic health problem worldwide, described as an infection, ulceration, lead to tissue breakdown, resulting in morbidity and possible amputation. Negative pressure wound therapy represents a significant technological advancement in wound healing . Purpose was to determine efficacy of negative pressure wound therapy versus conventional moist wound dressings on wound healing among diabetic foot ulcers patients. Design: A quasi-experimental research design was utilized. **Setting**: Study was carried out at general surgical department of El-Menshawy Hospital which affiliated to Ministry of Health –Tanta - Gharbia Governorate. **Sample**: A convenience sample of 60 adult patients with diabetic foot wound were selected and divided alternatively and randomly into two equal groups (30 study -30 control) .**Instruments of the study**: Two instruments were used for data collection:Structured interview questionnaire, Bates-Jensen wound assessment Tool (BWAT) .**Results**: There was highly statistically significant difference in wound healing among study group than control group regarding total mean scores of BWAT assessment .The mean total BWATscores of the study group assessed at first week, second week and third week were (50.50± 8.67, 37.03± 11.09 &19.96 ± 9.04 respectively) while the total mean score of the control group were (50.73 ± 8.63, 48.96 ± 9.83&47.43 ± 11.18 respectively). **Conclusions**: Negative pressure wound therapy was safe and effective on wound healing and didn't cause any side effects, accelerate wound healing. **Recommendations**: Negative pressure wound therapy should be used as an alternative therapy for wound healing as it safe, cost effective, accelerate wound healing and decrease length of hospital stay for patients with diabetic foot ulcer.

Key words: *Diabetic foot ulcer, Negative pressure wound therapy, Wound healing.*

Introduction

Diabetic foot ulceration (DFU) represents a significant global health concern. There is compelling epidemiological evidence indicating an increased mortality rate in individuals with diabetic foot syndrome. It can be defined as a group of syndromes in which neuropathy, ischemia, and infection lead to tissue breakdown, resulting in morbidity and possible amputation (Chowdhury, et al ;(2024). In a meta-analysis study reported that 6.3% of the total diabetes mellitus (DM) patients worldwide had DFUs. North America has the highest prevalence (13.0%), followed by Africa (7.2%) and Asia (5.5%). In Egypt, 6.1% to 29.3% of diabetes patients have diabetic foot ulcers (Chen, et al; 2021). Wound healing is a highly orchestrated process, which commences with getting rid of debris and combating infection .Nevertheless , inflammation clears the wound area for angiogenesis to increase wound site blood flow. Subsequently, the wound heals through deposition of granulation tissue, contraction and maturation. As one of these steps fails; the wound becomes unable to heal efficiently (Branch, ; 2023).

Wound dressings represent the most fundamental and prevalent form of treatment. Despite their indispensable role in the management of DFU, other modalities have demonstrated superior efficacy when used in conjunction with or as an alternative to wound dressings (Mohd, et al., 2020). Negative pressure wound therapy (NPWT) represents a significant technological advancement in the field of wound healing. It is one of the most effective and widely utilized interventions for problematic wounds, particularly in acute and chronic wound care settings (Leek, et al., 2024). The NPWT system was developed in the 1990s in Germany and the United States, has been widely adopted for the treatment of DFUs (Maranna, et al., 2021). It has been demonstrated to cause mechanical stress in the wound bed, removing healing inhibitors and excess tissue fluid from the extravascular space (Rayman, et al., 2020).

Moreover, NPWT reduce tissue edema and promote cell and granulation tissue growth by increasing the peripheral microcirculation blood flow during the early stages of wound inflammation; eliciting local oxygenation to the wound edges, which accelerate granulation tissue formation and the healing process is provoked by creating negative pressure around the wound, lowering the pressure over the wound than in the atmosphere, which pulls the wound edges together (Qiu, et al ; 2024) & (Seth,et al ; (2024). NPWT delivers subatmospheric pressure between –50 and –175 mmHg through a non-disposable pump with an attached disposable canister, which is used to collect and manage high volumes of exudates (Topuz, et al., 2023).

The application of lower negative pressure is more beneficial when treating diabetic wounds due to NPWT induces hypoperfusion to the tissue vicinity to the wound, especially prominent the subcutaneous tissue,

resulting in minimal ischemic tissue damage. The process mapping highlights how NPWT allows a reduction of hospitalization days compared with standard dressing. NPWT protects the incision from external contamination, helps to hold incision edges together, removes fluid and infection materials (Wu, et al., 2023) & (Tang, et al ;(2024).

The nurse has an important role, she is considered the corner stone for promotion of wound healing through assessing the patient conditions, planning patients care, and providing efficient care for respiratory and circulatory systems maintaining mobility, restoring the patients emotional and physical capacity, nutritional balance status, wound care and prevention of infection. To promote healing of wound, the nurse has two main responsibilities toward the patients to enhance wound healing primarily through the assessment of wound site, size, depth, edge surrounding area necrotic tissue and exudates (Kinoro, ;2023).

Secondary responsibility is through caring for the wound. The dressing of wound has many techniques this puts a burden on the nurse to decide which technique is best to use for the patients. Nurses play a critical role in the management of wounds during Negative Pressure Wound Therapy (NPWT). Their responsibilities encompass several key areas to ensure effective treatment and promote optimal healing outcomes. (Kinoro2023) & (Olutoye, et al ;2024).

Significance of the study

Negative pressure wound therapy (NPWT) is a relatively new technology to manage acute and chronic wounds. NPWT is a non-invasive technique by which negative pressure is delivered uniformly to a wound. Growing research suggests that negative pressure wound therapy help to promote wound healing. In addition, it's hoped that current study will open the door for evidence-based practice to evaluate efficacy of negative pressure wound therapy versus conventional moist wound dressings on wound healing

Purpose of the study.

To determine efficacy of negative pressure wound therapy versus conventional moist wound dressings on wound healing among diabetic foot ulcers patients.

Research hypothesis

Patients who received negative pressure dressing as wound therapy have rapid wound healing than patients who received conventional moist wound dressings.

Methods

Design:

A quasi-experimental research design (study and control group) was utilized to achieve the purpose of this study.

Setting:

The study was conducted at inpatient surgical department of El-Menshawy Hospital which affiliated to Ministry of Health –Tanta - Gharbia Governorate.

Sampling:

A convenience sample of sixty adult patients with open wound were selected and divided alternatively and randomly into two equal groups, 30 patients for each group (study – control).

- **Study group (1):** Diabetic foot patients received negative pressure dressing as wound therapy.
- **Control group (II)**: Diabetic foot patients received traditional dressing according to hospital policy.

Inclusion criteria:

- Adult Patients (20 - 55 years).
- Diabetes mellitus type Π.
- Random blood sugar level should range from 80- 200.
- Patients should be fully conscious.
- Patients who had diabetic foot wounds.
- Grade III and IV of diabetic foot ulcer according to Wagner classification.

Exclusion criteria:

- Patients who had untreated underlying osteomyelitis because those patients had wounds infection and bone erosion.
- Patients who had dry gangrene due to ischemia as those patients have a lack of blood circulation and this hinders the work of VAC.
- Patients who had wounds resulting from electrical, chemical, or radiation burns and those with collagen vascular disease, as the study only on diabetic foot ulcer patients
- Patients who had any life threatening diseases such as cancer or have exposed arteries or veins malignancy within wounds because it risks tumor spread, bleeding and delays appropriate oncological treatment.
- Grade I, II, V of diabetic foot ulcer according to Wagner classification, as those grades I, II not need negative pressure wound therapy and grade V need amputation.

Sample size

Based on the previous studies that examined the effect of NPWT on wound healing which found significant differences. The average sample size was 60 to achieve 80% power to detect this difference with confidence level 95% based on this formula

- $N = Z^2 p q / e^2$
- z^2 = is the desired confidence level is 95%.
- e = is the desired level of precision 0.05.
- p = is the estimated proportion of an attribute that is present in the population.
- q = is 1-p.

Instruments:

For collecting the necessary data and achieving the aim of the study two instruments were utilized by the researcher. These Instruments were:

Instrument one: Structure interview questionnaire:

It was developed by the researcher to assess biosocial-demographic data which includes four parts:

- **Part 1: Socio-demographic data:** It contained questions related to patient's age, gender, occupation, education, income, residence and marital status etc….

- **Part 2: Medical data**: It contained questions about past and present medical history, diagnosis, previous duration of hospitalization, family history and allergy to medication. Laboratories investigations as random blood sugar (RBS) and post prandial glucose.
- **Part 3: Clinical status of the patients**: It contained questions related to patient's weight, height, body mass index (BMI),vital signs, and clinical data included date of admission, onset of ulcer, ulcer site, prescribed treatment, Smoking history.
- **Part 4: Photographic pictures**: It contained pictures that were taken to assess diabetic foot ulcer healing.

Instrument two: Bates-Jensen Wound Assessment Tool (BWAT):

It was developed by Bates-Jensen in 1990 and revised in 2001. It was a valid and reliable tool that was used to assess and monitor healing of all types of wounds. Bates-Jensen consists of thirteen assessment parameters which include size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudates type, exudates amount, skin color, edema, induration, granulation and epithelialization
(Bates-Jensen et al ;2019).

Scoring system

Each item was scored 1 to 5, with 1 being the best for that attribute. After each item was assessed and scored, the 13 sub scores were summed to get a total score. An additional asset of BWAT was using the score to measure wound severity. This was important, since the goal of wound care was to reduce wound severity. The total BWAT scores were divided into four severity categories:

- A score from 13- 20 indicated minimal severity.
- A score from 21– 30 indicated mild severity.
- A score from 31– 40 indicated moderate severity.
- A score from 41– 65 indicated extreme severity.

Validity of instruments

All the instruments of the study were tested for face and content validity by a jury panel of 5 experts in the field of medical-surgical nursing and necessary modifications were done accordingly to ascertain relevance and completeness. Content validity index = 98.8%

Pilot study:

A pilot study was carried prior to data collection on 10% of the study sample (6) patients to evaluate the tentative tools for clarity, applicability, relevance and feasibility of the tools as well as to estimate the time needed for data collection then necessary modifications was carried out. Data obtained were excluded from the current study.

Ethical Consideration.

- A written approval was obtained from ethical and research committee of the Faculty of Nursing, Menoufia University.
- All participants were informed about purpose, procedure, and benefits of the study, and then a written consent was obtained from each participant.

- All participants were informed that participation in the study was entirely voluntary, and they can withdraw from the study at any time without penalty.
- Confidentiality and anonymity were assured through coding all data and put all papers in a closed cabinet.
- The nature of study didn't cause any physical or emotional harm.

Data collection process:

- Data collection was extended over a period of 11 months from October 2023 to August 2024.
- Patients who agreed to participate in the study and fulfilled the inclusion criteria were included in the study.
- Each subject of both groups was interviewed individually by the researcher.
- The included subjects were selected and randomly divided alternatively into two equal group (30 patients for each group):
  - **Study group**: Those patients who received negative pressure wound therapy twice a week and the wound was assessed at 7 th, 14 th, 21st day to monitor wound healing.
  - **Control group**: Those patients who treated by traditional dressing according to hospital policy and the wound was assessed at 7th, 14th, 21st day to monitor wound healing.
- The researcher deal with the control group (Π) firstly then the study group (I) to avoid the contamination of data collection. Purpose of the study was explained to each subject in both groups.
- The data collection was carried out in four consecutive phases assessment phase, planning phase, implementing phase and evaluation phase.

Assessment& Planning phase

- The purpose of this phase was to assess patient's base line data to be a guide for comparison.
- Both groups were interviewed to assess their bio socio demographic, medical data, clinical status and Photographic pictures using first instrument.
- Every patient in each group who agree to participate in the study and fulfil the inclusion criteria was interviewed individually by the researcher to collect Bio socio demographic data using part one and two of instrument one at surgical department between 8 am and 12 pm for 10 minutes, the time will be away from medical round or investigation time.
- The researcher assessed the wound for each patient of both groups by utilizing instrument II (Bates-Jensen Wound Assessment Tool).
- This phase was completed in about 15- 20 minutes then the researcher proposed a plan based on assessment of collected data.

Implementing phase (for the study group)

In this phase each patient of study group was interviewed individually or with his or her family.

- The researcher conducted at least three teaching sessions or more for each patient according to patient's need and level of understanding.

The session of Implementation phase were described as follow:

- The first session: The researcher provided patients with knowledge about diabetic foot ulcers (definition, causes, clinical manifestation, risk factors, and complications)
- The duration of this session was carried out within 20 – 30 minutes according to patient's level of education and understanding.
- The second session: The researcher refreshed the previous knowledge and then provided education about diet for diabetic foot patients; they should consume a healthy diet that contains nutrient-dense foods. A diet that provides adequate protein, calories, vitamins, and minerals can help maximize immune function. This session took 10- 15 minutes.
- The third session: The researcher refreshed the previous knowledge and then provided education about negative pressure wound therapy (vacuum device) (definition, its benefits, indications, and its effect on wound healing).
- Patients in the study group were interviewed twice a week from 8 A.m to 12 P.m to perform dressing using negative pressure wound therapy. The technique of dressing was:
- Hand washing& preparing the equipment used in dressing.
- - Prepare the patient and place him in the suitable position that facilitates dressing.
- Wear gloves& removing the old dressing and discard it after assessing it for colour, amount, Oder of discharge.
- Change gloves, after that alcohol hand rub and wear sterile gloves.
- Clean the wound through washing with normal saline for good visualisation and assessing the wound.
- Squeeze the wound to clean from pus cells and then make debridement for any dead tissue using sterile artery and scissor.
- Washing the wound with normal saline solution 0.9%. Then dry the wound using sterile dressing
- The wound and the area around the wound were cleaned under aseptic technique with normal saline solution 0.9%.
- A double layer of polyethylene sheets was held firmly in place over the wound. It intended to equalize the negative pressure across the entire wound surface. The cover creates an airtight seal over an open wound and the pump applies the negative pressure.
- Wound dressing aided in transferring pressure from the pump to the wound itself.
- The researcher assessed wound healing for the subjects included in the study after 1 week, 2 weeks and 3weeks.
- Treatment was initiated when the patients hospitalized. Wound healing was considered when discharge ceased, good circulation and the wound surface closed.
- Telephone number of the researcher was given to the participants in the study to communicate and ask

questions about their care at any time.

- Control group who used conventional moist wound dressing during this study.
- All patients underwent detailed clinical examination and relevant investigations and the wounds were assessed, measured with sterile gauze that measured by a ruler placed beside the wound

Evaluation phase

- Evaluation of all patients of both groups was carried out to assess effect of Negative Pressure Therapy on wound healing among patients with diabetic foot ulcer by using all instruments.
- Evaluation of the study group was done using instrument II (Bates-Jensen Wound Assessment Tool) at day 7th , 14th , 21st of the intervention to determine the degree of wound healing.
- Evaluation of the control group was done using instrument II Bates-Jensen Wound Assessment Tool at day 7th, 14th, 21st to determine the degree of wound healing.
- This phase took about 15-20 minutes for each subject.
- The comparison was done between both groups to determine the effect of Negative Pressure Therapy on wound healing among patients with diabetic foot ulcer.
- Photographic pictures took at the end of the first week, two weeks and three weeks to evaluate the healing process for both groups. Healing compared among both groups.

Statistical Analysis

The data collected were tabulated & analysed using SPSS software (statistical package for the social science) statistical package version 26 on IBM compatible computer. Two types of statistics were done:

- **Descriptive statistics**: were expressed as mean and standard deviation (X+SD) for quantitative data or number and percentage (No & %) for qualitative data.
- **Analytic statistics**:

1) Pearson Chi-square test ($\chi 2$): Used to study association between two qualitative variables.

2) Fisher`s Exact Test: Used to study association between two qualitative variables when one of the cells has expected countless than 5.

3) Student t- test (parametric test): Used for comparison between two independent groups of normally distributed quantitative variables.

4) Mann-Whitney test (non-parametric test): Used for comparison between two independent groups of not normally distributed quantitative variables.

5) ANOVA test (parametric test): Used for comparison between more than two independent groups of normally distributed quantitative variables.

6) Kruskal-Wallis test (non-parametric test): Used for comparison between more than two independent groups of not normally distributed quantitative variables.

7) Repeated-Measures ANOVA: Used when we had a single line of data for each participant, with the repeated measures entered as separate variables on that same line (used for

comparison between more than two related groups of normally distributed quantitative variables).

8) Spearman correlation: Used for quantitative variables that were not normally distributed or when one of the variables is qualitative.

P-value at 0.05 was used to determine significance regarding:

- P-value > 0.05 to be statistically insignificant.
- P-value ≤ 0.05 to be statistically significant.
- P-value ≤ 0.001 to be highly statistically significant.

Results

Table 1: Distribution of both study and control groups according to their social characteristics. The table shows that there was no statistically significant difference between the study and control groups regarding all socio-demographic characteristics.

Figure 1: Comparison of Bates-Jensen wound assessment scores between the study &control group of the subjects studied. This figure shows that, the mean BWAT score of study group decreased from (50.50± 8.67 to 37.03± 11.09 to 19.96 ± 9.04 at first, second and third week respectively) with highly statistically significant difference (P value <0.001). Also, mean BWAT score of control group decreased from (50.73 ± 8.63to 48.96 ± 9.83to47.43 ± 11.18at first, second and third week respectively) with no statistically significant difference (P value >0.05). There was highly statistically significant difference (P value <0.001) on comparison of mean BWAT scores of first week with second week, that of first week with third week and that of second week with third week either in the study or the control groups.

Table 2: comparison of wound healing rate among the study and control group. This table shows that, at first week, none of patients in either the study or control groups had healed resolved wound. At second week, 3 (10.0%) of the study group had healed resolved wound compared to 0 (0.0%) of the control group with no statistically significant difference (P value 0.076). At third week, 26 (86.7%) of the study group had healed resolved wound compared to only 2 (6.7%) of the control group with high statistically significant difference (P value 0.0001).

Figure (2): Correlation between Age of the study group patients and their Bates-Jensen wound assessment scores. This figure shows that there is significant positive correlation between patients` age & their BWAT scores assessed at first, second and third week (P value >0.05).

Figure 3: Reveals Correlation between diabetic foot ulcer of the study group patient and their BWAT scores. This figure shows that, there is significant positive correlation between patients' diabetic foot ulcer & their BWAT scores assessed at first, second and third week (P value = 0.001).

Table (1): Distribution of both study and control groups regarding their socio-demographic characteristics

Socio-demographic characteristics	Studied groups (n=60)				χ2	P value
	Study group (n=30)		Control group (n=30)			
	No.	%	No.	%		
Age (years):						
Mean ± SD	45.37±7.526		44.28±7.452		t- test =	0.685
Range	25 – 54		28 – 55		0.037	
Age categories (years):						
20 – < 30 years	2	6.7	3	10.0		
30 – <40 years	8	26.7	6	20.0	0.520	0.914
40 – <50 years	14	46.6	15	50.0		
50 -55 years	6	20.0	6	20.0		
Sex:						
Male	14	46.7	13	43.3	0.067	0.795
Female	16	53.3	17	56.7		
Marital status:						
Single	6	20.0	3	10.0		
Married	23	76.7	24	80.0	3.021	0.388
Divorced	0	0.0	2	6.7		
Widowed	1	3.3	1	3.3		
Educational level:						
Illiterate	3	10.0	3	10.0		
Read and write	9	30.0	8	26.7	0.424	0.980
Primary	8	26.7	10	33.3		
Secondary	6	20.0	6	20.0		
Higher education	4	13.3	3	10.0		
Occupation:						
Working	24	80.0	22	73.3	0.373	0.542
Not working	6	20.0	8	26.7		
Type of occupation:						
Administrative work	6	20.0	4	13.3		
Handwork	8	26.7	10	33.3	3.542	0.315
Housewife	10	33.3	6	20.0		
Others	0	0.0	2	6.7		
Place of residence:						
Rural	16	53.3	18	60.0	0.606	0.436
Urban	14	46.7	12	40.0		
Income:						
Enough	6	20.0	10	33.3	1.364	0.243
Not enough	24	80.0	20	66.7		

Figure 1: Comparison of Bates-Jensen wound assessment scores between the study &control group of the studied subjects

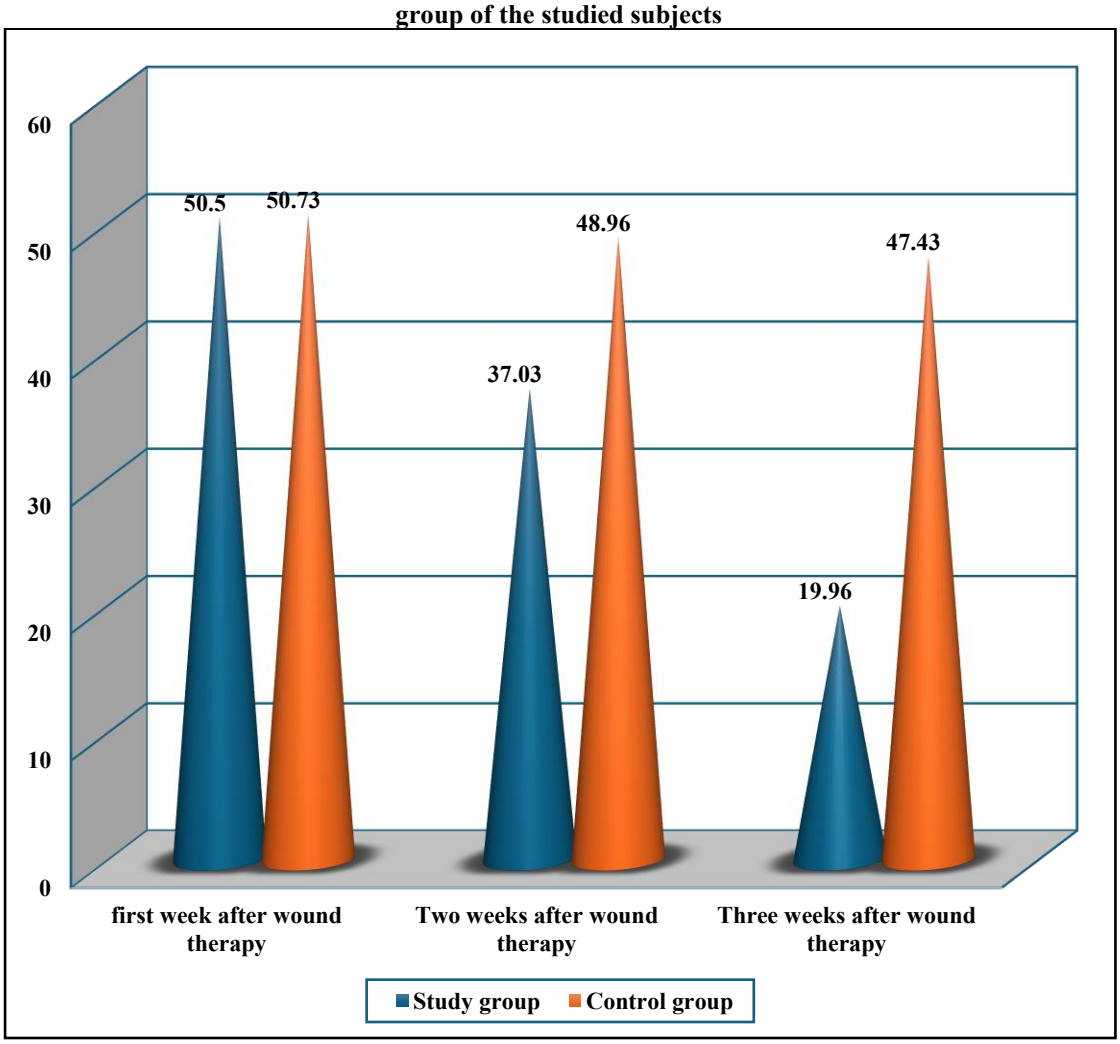


Table (2): Comparison of wound healing rate among the study and control group

Healing Rate	Studied groups				χ2	P value
	Study group (n=30)		Control group (n=30)			
	NO.	%	NO.	%		
First week:						
Healed resolved wound	0	0.0	0	0.0	NS	NS
Not healed	30	100.0	30	100.0		
Second week:						
Healed resolved wound	3	10.0	0	0.0	3.158	0.076
Not healed	27	90.0	30	100.0		
Third week:						
Healed resolved wound	26	86.7	2	6.7	9.25	0.0001
Not healed	4	13.3	28	93.3		HS

Figure (2): Correlation between Age of the study group patients and their Bates-Jensen wound assessment scores.

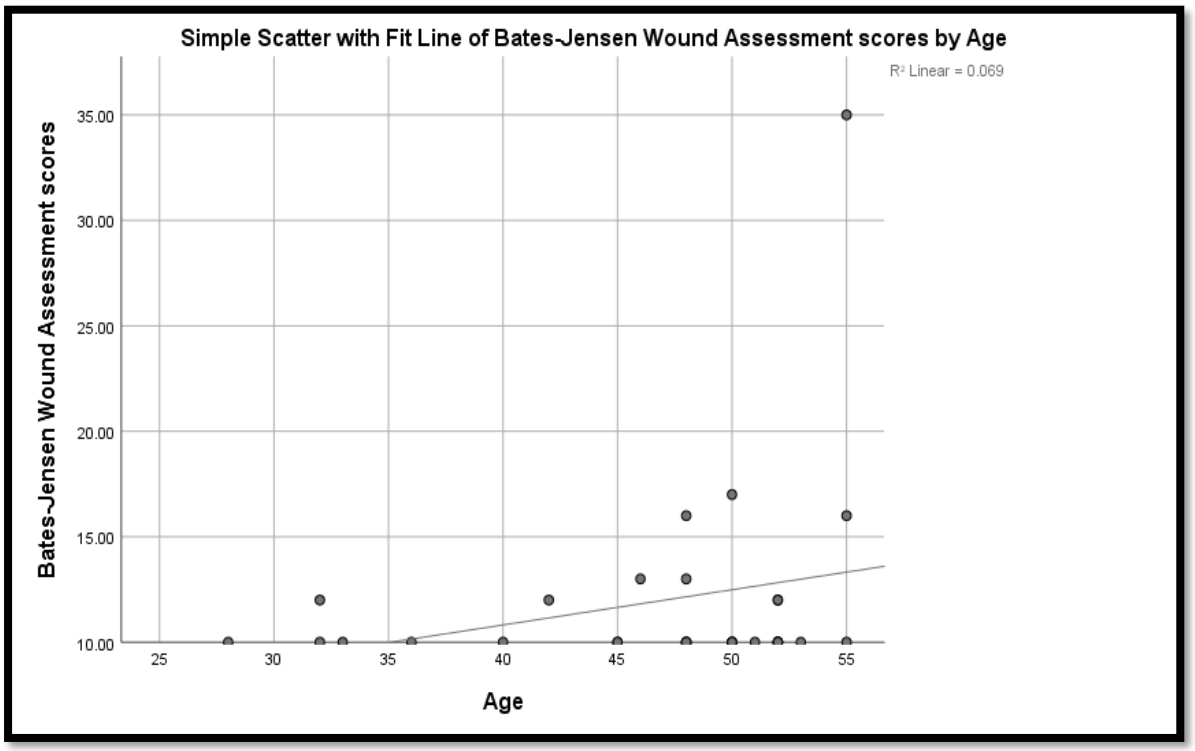
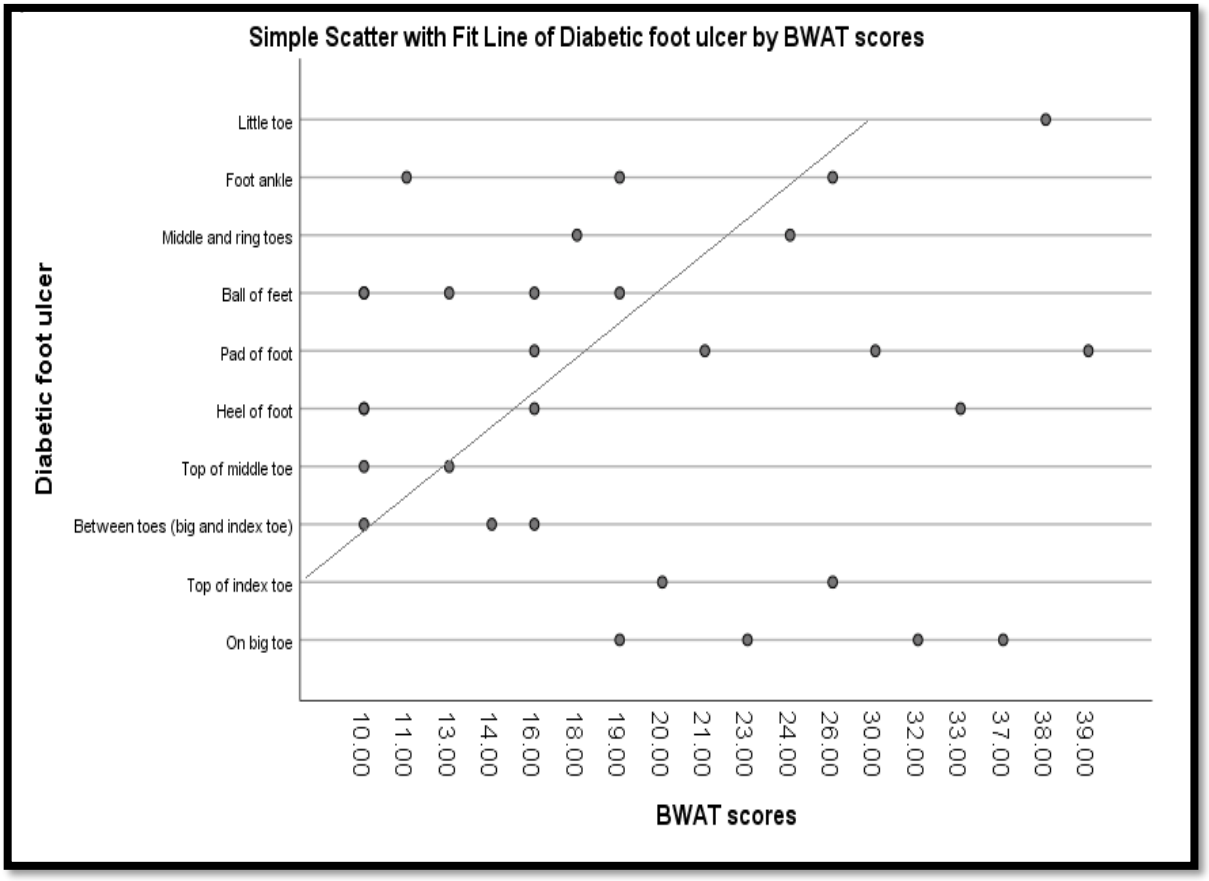


Figure (3): Correlation between diabetic foot ulcer of the study group patient and their BWAT scores



Discussion

Diabetic foot disease is one of the most serious complications of diabetes and is a huge burden for patients and the healthcare system. The management of DFUs is considered a major issue for vascular surgeons, especially for bigger and deeper wounds, as they take a long time to heal and put the patient at risk of recurrent infections and major amputation. The principal elements for managing DFUs include the debridement of necrotic and infected tissues; treatment of infection; revascularisation, if needed; offloading, when necessary; and wound dressings. Wound care is a prevalent and often challenging responsibility. Dressing is an essential component of wound management. Throughout history, dressing techniques have been consistently assessed and analyzed because of their importance in facilitating wound healing and potential effectsNPWT has been shown to be effective and safe in multiple randomised controlled studies James, et al ;(2019).

This result may be interpreted on the basis that most families in rural areas have some factors that expose them to infection sources such as walking bare foot, This may expose their feet to harm and lead to the development of foot ulcers, poor sanitation and lack of access to health services and This result may be interpreted that most families in rural areas delayed in seeking medical care routinely or made any screening tests due to a lack of awareness.

As regard length of stay in hospital, it was demonstrated that nearly one third of both groups had previous hospitalization and length of stay was more than three days in one quarter of the study group and minority of the control group. The result was incongruent with (Seol et al ;2024) who reported that length of hospital stay was longer than five days in for minority both groups This may be related to the different commitment or follow up of the patients with the needed instructions or treatment and regimen of the disease related to the disease. Also, it depends on many other factors.

Regarding Bates-Jensen wound assessment scores, the research findings illustrated that there were no statistically significant difference between the study and the control groups at the first week (p value 0.917) and there were highly statistically significant difference between the study and the control groups regarding mean total BWAT scores assessed at second and third week (p value <0.001).These results was in the same direction with Gupta et al;(2023), who reported a significant decrease in BWAT score after 48 h of NPWT application indicated that The Bates-Jensen Score, significantly decreased from 32.59 to 23.5 after the first NPWT session, the average post-NPWT score when compared with pre-NPWT score had a mean reduction of about 3.4 which was clinically discernible and statistically significant confirming the NPWT device's safety and effectiveness for managing complex wounds.

On the other hand, Liu et al; (2018) who disagreed with these findings and

concluded that there is some low certainty evidence that NPWT increases the number of wounds healed compared with traditional dressings, and may reduce the time it takes wounds to heal. From the researcher point of view, this may be explained on the basis of the study group who received the intervention make the difference in wound healing that begin to appear after two weeks from the application of NPWT that improve dermal blood flow through vasomotor mediators leads to wound contraction and size reduction removes excess wound fluid that not only reduces edema but also enhances local blood and nutrient flow. A higher total score of Bates-Jensen wound assessment tool (BWAT) indicated a more severe wound condition

Regarding domains of Bates-Jensen wound assessment scores (BWAT), the present study showed that significantly improvement in all domains as size, depth, necrotic tissue type and amount , exudate type and amount , granulation tissue and epithelialization and in the total score than control group in first , second and third week. This finding was in accordance with the current finding was in same line with Gupta et al; (2023), who stated that there was reduction in necrotic area in the range of one to twenty five percent in the studied patients, thus implying that the necrotic profile significantly declines after forty eight hours of negative pressure wound application.

Also, Bishara et al ;(2021) who support the current findings that the use of NPWT enabled a significantly higher proportion of patients to reach complete ulcer healing in a shorter time and led to a significant reduction in all wound assessment variables. It can be explained on the basis that NPWT induces hypoperfusion to the tissue vicinity to the wound, especially prominent the subcutaneous tissue, resulting in minimal ischemic tissue damage. This is why the application of lower negative pressure is more beneficial when treating diabetic wounds.

Regarding association between socio-demographic characteristics of the study group patients and their Bates-Jensen wound assessment scores, the results concluded that gender, residence, marital status, occupation, and income did not significantly influence their BWAT scores at any point first, second, or third week. Abed El Aziz (2024) who stated that there were no significant relation between gender, residence, marital status, educational level, occupation & monthly income and wound healing. From the researcher point of view, this may be due to that physiology of the wound healing not affected with those factors.

Regarding correlation between Age of the study group patients and their Bates-Jensen wound assessment scores the current study showed that there is significant positive correlation between patients` age & their BWAT scores assessed at first, second and third week. This is consistent with Bonifant & Holloway ;(2019) who revealed that increasing age effect on the healing process of the wound and impaired it. This finding is also congruent with Upton., (2020) who reported that there

are many different impacts of age-related concerns on wound healing in the acute trauma setting, including frailty, malnutrition, pre-existing medical conditions and clinician practices.

From the researcher point of view, the patient age has impact effect of length of stay this may be related to that the younger age has good physical status than older patient and this affect positively on accelerating the healing process of wounds and discharge from the hospital faster than older ones. Another point of view from the researcher, this may be attributed to the effect of the age on the process of wound healing; age appears to impact collagen remodeling and deposits. A diminished blood supply reduces the extracellular matrix and delays tissue approximation hence effect on the BWAT scores.

Regarding to the correlation between patients' diabetic foot ulcer& their BWAT scores , the study revealed that there is significant positive correlation between patients' diabetic foot ulcer & their BWAT scores assessed at first, second and third week. A reduction in the BWAT score is indicative of reduction in diabetic foot ulcer and vice versa, This finding was consistent with Zens et al; (2020) who acknowledged the benefits of NPWT in enhancing wound closure, decrease diabetic foot ulcer and healing outcomes that correlated positively with the score of BWAT. Furthermore, Liu et al; (2017) & El-den et al; (2021) confirmed NPWT's practical effectiveness, that improved health outcomes as it reduce the wound size, and accelerate healing due to its rapid healing of diabetic foot ulcers which reduce the score of BWAT. From the researcher point of view, this is attributed to faster removal of infectious material, better preparation of granulated wound bed, more rapid healing and reduction in the score of BWAT.

The application of treatment of DFUs with NPWT offer the advantages of faster removal of infectious material, better preparation of the granulated wound bed and more rapid healing, therefore reducing the risk of major amputation. From the forgoing discussion it can be concluded that the application of negative pressure wound therapy improves and accelerate wound healing.

In conclusion, the study findings support the hypothesis that patients managed with NPWT experience better healing processes compared to those who receive conventional wound management. NPWT demonstrated superior morphological parameters for diabetic foot ulcers and facilitated a shorter healing period compared to conventional dressing techniques. This study highlights the importance of expanding the use of NPWT in diabetic foot wound management to accelerate healing and mitigate complications.

Conclusions

Based on the findings of this study, it can be concluded that:

- Negative pressure wound therapy (NPWT) exhibits more rapid wound healing and accelerated it. In addition to its effect in treating infected diabetic foot ulcers (DFUs) as NPWT proved to increase healing rate of

ulcers, along with reducing ulcer size, rapid elimination of wound odor, reduce the amount of exudates, sterilize the wounds from microbes ,improves all domains of Bates-Jensen wound assessment scores(BWAT),and improve the granulation and epithelialization of the wound, and reducing major and minor amputations among study group than control group.

- Overall, negative pressure wound therapy was safe and effective, cost–benefit didn't cause any side effects, thus decrease length of hospital stay.

Recommendation:

Based on the findings of the current study, the following recommendations are derived and suggested:

Negative pressure wound therapy should be used as an alternative therapy for wound healing as it safe, cost effective, accelerate wound healing, decrease length of hospital stay for patients with diabetic foot ulcer. Replication of the study using larger population from different geographical areas to help for generalization of the results.

Training sessions for health care professionals: Organize workshops and training for health care providers to ensure they understand the latest techniques and best practices for implementing NPWT effectively. Launch community awareness programs to educate residents about NPWT, its benefits, indications, and how it works. This can help clarification of the treatment, encourage those in need to seek care.

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