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**Original Research Article**

# Comparative study of outcomes between application of negative pressure wound therapy to split skin graft versus split skin graft immobilized by traditional bolster dressing

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## ABSTRACT

**Background:** SSG is a versatile technique used for the reconstruction of wounds. The conventional techniques like traditional bolster dressing (TBD) to secure graft have been in use since the long time for the management of these wounds. NPWT is an effective advanced therapy which increase graft take by providing negative pressure to seal the space and provide persistent and uniform pressure.
**Methods:** 60 patients were enrolled in the study. In the TBD group (30 patients) a bolster was placed on the graft which was made using a nonadherent dressing. In the NPWT group (30 patients) the SSG was secured using circumferential staples, followed by placement of VAC dressing with continuous negative pressure. Percentage of graft take assessed on 5$^{th}$, 7$^{th}$ and 9$^{th}$ postop day.
**Results:** Graft take on day 5$^{th}$ with NPWT group was 83.16±4.1% and in TBD group was 78.12±3.76%. On day 7$^{th}$ with NPWT group was 89.83±4.12% and in TBD group was 84.33±4.66%. On Day 9th with NPWT group was 96.33±5.3% and in TBD group was 92.67±5.24%. In NPWT group, mean Post SSG days were 9.9±0.61days. In TBD group, mean Post SSG days were 13.03±1.4 days.
**Conclusions:** Our study suggest that Application of NPWT on SSG is beneficial in terms of better graft take, lesser infection, shortened post graft hospital stays and less no who needs for redo SSG and it is particularly useful anatomically challenging sites.

**Keywords:** NPWT, SSG, Traditional bolster dressing

## INTRODUCTION

Acute wounds progress through a complex series of biochemical and cellular events described as the phases of wound healing: Hemostasis, inflammation, proliferation, and remodeling.[1]

Wounds requiring reconstruction are usually large with extensive soft-tissue loss.[2] A skin graft is a segment of dermis and epidermis that is separated from its blood supply and donor site and transplanted to another recipient site on the body. The integration of these grafts to the recipient area consists of 3 phases: plasmatic imbibition (during first 24 hours), inosculation phase(starts after 48 hours) and capillary in growth phase until blood flow established from 4$^{th}$ to 7$^{th}$ day.

Grafting of skin originated in India among the kumhar's/potter's about 3000 years ago.[3] Skin grafting were described in the mid-to-late 19$^{th}$ century, including Reverdin's use of the pinch graft in 1869; Ollier's and Thiersch's uses of the split-thickness graft in 1872 and 1886, respectively; and Wolfe's and Krause's use of the full-thickness graft in 1875 and 1893, respectively. Around the world, Brown and McDowell reported using

thick split thickness grafts (0.01-0.022-inch) for the treatment of burns in 1942.[4]

***Bolster dressing***

Bolster dressings are traditionally applied to splint the graft to the wound bed. In this technique a bolster is placed on the graft. This bolster is typically made using a nonadherent dressing layered on top with a soft, pliable, and absorbent material such as cotton balls or sterile gauze. NPWT has been advocated as a potential solution to some of these issues.[5-7]

***Negative pressure wound therapy (NPWT)***

NPWT also known as VAC (vacuum assisted closure) is one of the newest methods of dealing with complicated healing.[8] The technology consists of the application of a dressing, usually foam or gauze, on the wound, which is then connected through tubing to a vacuum pump. The area is sealed with an adhesive film and the pump delivers a controlled negative pressure across the wound bed. NPWT is the application of sub atmospheric pressure to a wound to remove exudate and debris, via an integrated system consisting of a suction pump, separate exudate collection chamber, and dressing, over specific wound.

The aim of NPWT is to facilitate wound healing, promote granulation of the wound bed using a negative pressure of 60-125 mmHg on the wound bed.

The vacuum draws out fluid from the wound, reduces soakage from the wound, reduces bacterial load, increases blood flow and promotes growth of the granulation tissue. The dressings used for the technique include open-cell foam dressings and gauze, sealed with an occlusive dressing intended to contain the vacuum at the wound site.

Sub atmospheric pressure technique (VAC) has become popular in use since it was originally described by Morykwas et al.[9] Combination of both SSG and negative therapy may result in increased wound healing rates and has become a well-recognized procedure for skin graft application and immobilization. However, the benefit of perioperative TNP application to SSG and, indeed, the mechanisms whereby TNP exerts its effects remain contentiously debated.[10,11]

Negative pressure wound therapy (NPWT) has revolutionized the management of open wounds by mechanisms of bacteria clearance, moisture elimination, oedema reduction, and angiogenesis stimulation and result in a substantial decrease in wound surface area in a porcine model.[12]

The present study was being planned to see the percentage of graft take, wound infection, hospital stay and need for redo SSG.

## METHODS

***Study design***

The study was a comparative study carried out at Command Hospital (western command) Chandimandir on patients presenting to or referred to this hospital who will meet the inclusion criteria. A total of 60 patients were enrolled in the study after a written informed consent. The patients were divided into the control group (split skin graft immobilized by traditional bolster dressings.) and study group (split skin graft immobilized by negative pressure wound therapy.

***Randomization***

Randomization was done using computer generated numbers.

***Study period***

Study took place from 1st March 2019 to 29th February 2020.

***Ethical approval***

Ethical approval taken from the Ethical committee at Command hospital, Chandimandir under Chairmanship of Brigadier (Dr.) RDS Ahluwalia.

***Inclusion criteria***

Patient of any age group with wound which was amenable to wound debridement and SSG cover. Wound size >25 $cm^2$

***Exclusion criteria***

Wounds with exposed major blood vessels or those in which hemostasis has not been achieved. Hemodynamically unstable patients. Wounds in patients who have vascular injury or those with signs of ischemia. Immunosuppressed patients or patients with significant co morbidities impairing wound healing. Grossly infected wounds.

***Technique***

Patients who meet the inclusion criterion were enrolled into the study. They were explained about the study by means of discussions.

Informed and written consent was taken from the enrolled patients or the parents of minors for the study. The patient details, any known comorbidities, etiology and duration of the wound were noted. Detailed history of the disease and wound was taken followed by thorough general examination, systemic examination and local examination of wound. Investigations according to the

disease aetiology was done and results was recorded in the proforma.

Initial debridement of wound will be done surgically followed by dressing of betadine-saline. Once healthy bed of granulation is seen, SSG was applied. After SSG was laid, patients were divided into the control group [SSG immobilized by traditional bolster dressings (TBD)] and study group (SSG immobilized by NPWT).

In the traditional bolster dressing group, the SSG was secured to the recipient site using bolster dressing. In this technique a bolster is placed on the graft.[21,22] This bolster is typically made using a nonadherent dressing layered on top with a soft, pliable, and absorbent material such as cotton balls or sterile gauze. Based on the location of the injury, bed rest, a sling, or a splint was used to keep the area immobilized.[23,24]

In the NPWT group, the SSG was secured to the recipient site using circumferential staples, followed by placement of a nonadherent dressing.[25,27] The VAC sponge was cut to match the contour of the wound and secured to the surrounding skin. Continuous negative pressure was ensured by connected tubing through a vacuum pump in form of a portable unit (VAC Ulta; KCI International, San Antonio, TX) and the suction pressure would be kept at -125 mmHg.[28] During the postoperative period, the affected area was immobilized. Creation of effective negative pressure confirmed by watching of collapsed foam and absence of any gushing sound of air leak.[29,30]

The dressings in both groups were opened and percentage of graft take assessed in presence of senior plastic surgeon on 5th postoperative day and further on 7th and 9th day. Wound examined and details of wound were noted in the proforma and photographs were taken.

### *Statistical analysis*

Data analysis was performed using statistical analysis tool SSPS statistics. Categorial data was reported as percentage. Comparison of categorial data was done with the help of Chi Square or fisher's exact test. A two side p value less than 0.05 was considered significant.

## RESULTS

Study titled "compare outcomes between application of negative pressure wound therapy (NPWT) to split skin grafts versus split skin graft immobilized by traditional bolster dressings (TBD)" was conducted at Command Hospital, Chandimandir on 60 patients from 1st March 2019 to 29th February 2020.

**Table 1: Summary characteristics of the study.**

| Characteristics | NPWT | Traditional bolster dressing | P value |
|---|---|---|---|
| **N (total =60)** | 30 | 30 | 1 |
| **Age (years)** | 52.73 | 45 | 0.106 |
| **Sex (male/female)** | 24/06 | 22/08 | 0.541 |
| **Diabetes** | 13.33% | 6.67% | 0.39 |
| **Mean days of admission (days±SD)** | 14.1±4.28 | 18.63±8.57 | 0.006 |
| **Post SSG duration of stay (days±SD)** | 9.9±0.61 | 13.03±1.4 | 0.001 |
| **Grafted area ($cm^2$) (mean±SD)** | 105.63±22.4 | 80.55±18.66 | 0.14 |
| **% of graft take at 5th day follow-up (%±SD)** | 83.16±4.1% | 78.12±3.76% | 0.014 |
| **% of graft take at 7th day follow-up (%±SD)** | 89.83±4.12% | 84.334.66% | 0.026 |
| **% of graft take at 9th day follow-up (%±SD)** | 96.33±5.3% | 92.67±5.24% | 0.038 |
| **Complications in graft failure** | 6.67% | 13.33% | 0.019 |
| **Need for redo SSG** | 6.67% | 10% | 0.046 |

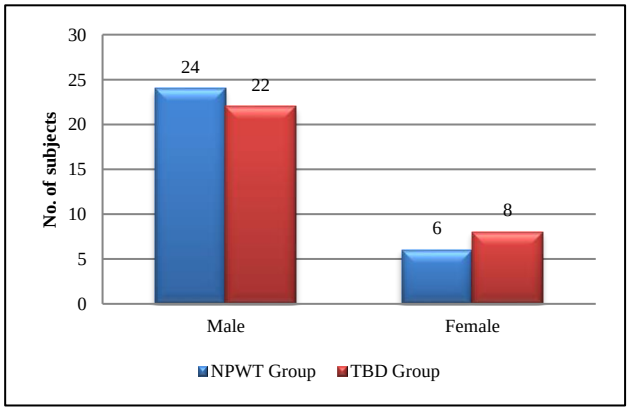


**Figure 1: Gender profile.**

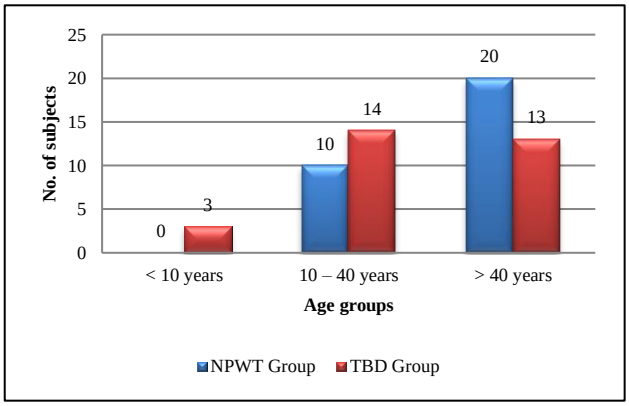


**Figure 2: Age profile.**

***Demography***

In NPWT group, there were 2 subjects <10 years, 15 subjects within 10-40 years and 13 subjects >40 years. In TBD group, there were 3 subjects <10 years, 14 subjects within 10-40 years and 13 subjects >40 years. There was no statistical difference between the groups in age distribution and hence both groups were comparable.

In INPWT group, there were 24 males and 6 females. In TBD group, there were 22 males and 8 females. Chi square test was applied and p value of 0.541 (>0.05) was derived indicating no statistical difference between the groups.

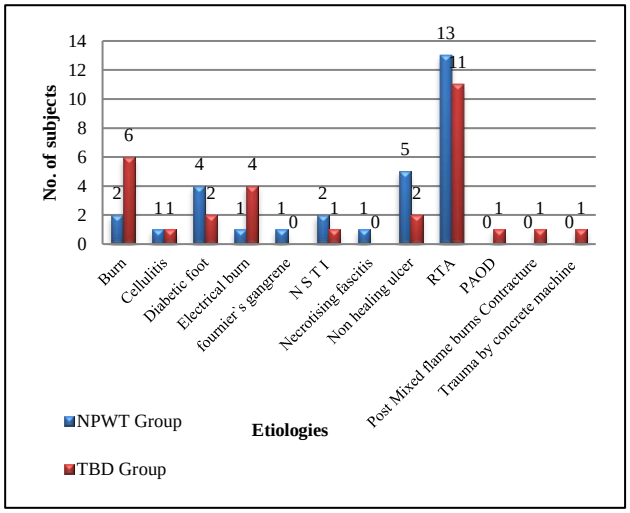


**Figure 3: Etiology distribution.**

Chi square test was applied and p value of 0.422 (>0.05) was derived indicating no statistical difference between the groups.

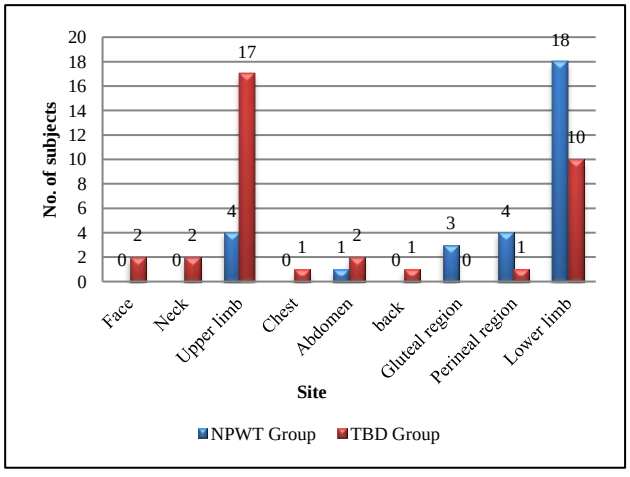


**Figure 4: Site of wound.**

Chi square test was applied and p value of 0.06 (>0.05) was derived indicating no statistical difference between the groups

***Graft uptake***

In present study, graft take on day 5th with NPWT group was 83.16±4.1% and graft take by TBD group was 78.12±3.76%. P value of 0.014 (<0.05) was derived indicating statistical difference between the groups.

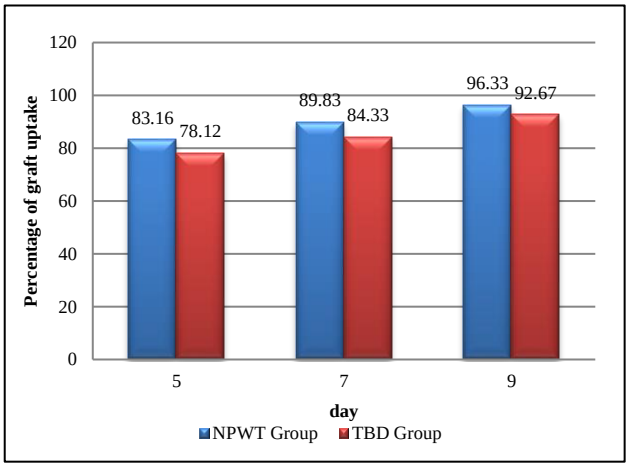


**Figure 5: Graft uptake.**

Graft take on day 7th with NPWT group was 89.83±4.12% and graft take by TBD group was 84.33±4.66%. P value of 0.026 (<0.05) was derived indicating statistical difference between the groups.

Final graft take on day 9th with NPWT group was 96.33±5.3% and graft take by TBD group was 92.67±5.24%. P value of 0.038 (<0.05) was derived indicating statistical difference between the groups.

***Post-split skin graft days***

In present study, In NPWT group, mean post SSG days were 5.6±1.2 days. In TBD group, mean post SSG days were 7.4±1.4 days. P value of 0.03 (<0.05) was derived indicating statistical difference between the groups.

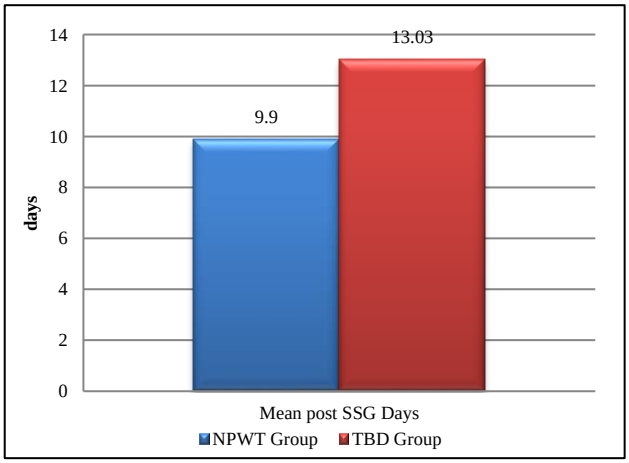


**Figure 6: Number of post SSG stay.**

In NPWT group, mean Post SSG days were 9.9 days. In TBD group, mean Post SSG days were 13.03 days. t test was applied and p value of 0.001 (<0.05) was derived indicating statistical difference between the groups.

***Need for redo split skin graft***

In present study, 6.67% of cases required redo SSG in NPWT group and 10% of cases required redo SSG in TBD group. In a study by Llanos et al, SSG with vacuum therapy had revision rate 8.5% and SSG with traditional dressing had revision rate 14%.

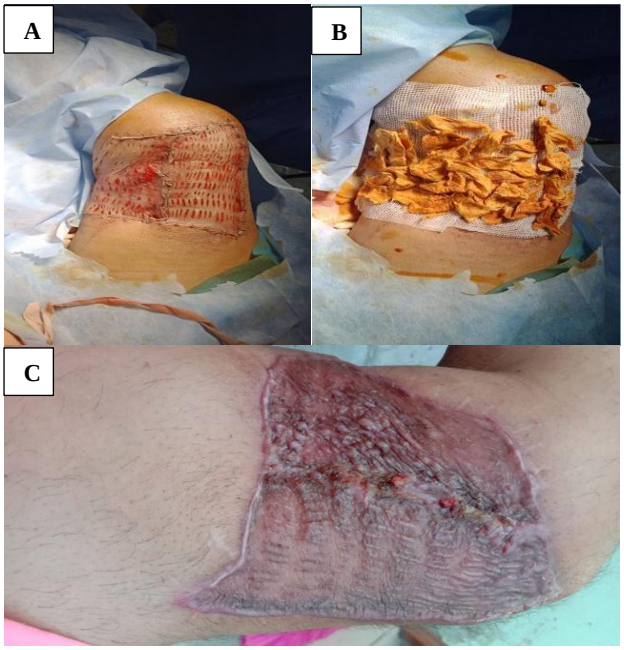


**Figure 7: SSG bolstered with traditional bolster dressing: A) SSG applied over wound; B) SSG bolstered with traditional bolster dressing; C) final look on wound on 9th day.**

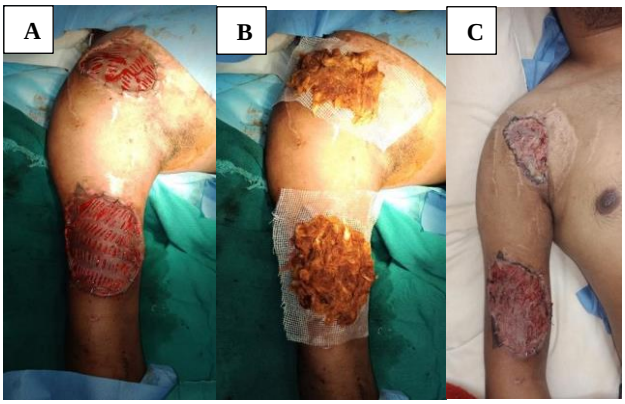


**Figure 8: SSG bolstered with traditional bolster dressing: A) post RTA wound after applying SSG; B) SSG secured with traditional bolster dressing; C) 3rd look on SSG on 9th day.**

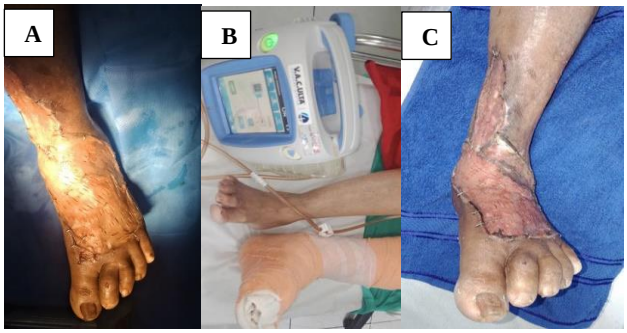


**Figure 9: SSG bolstered with NPWT VAC dressing: A) look of wound after SSG; B) SSG bolstered with NPWT VAC machine; C) 3rd look of SSG with NPWT on 9th day.**

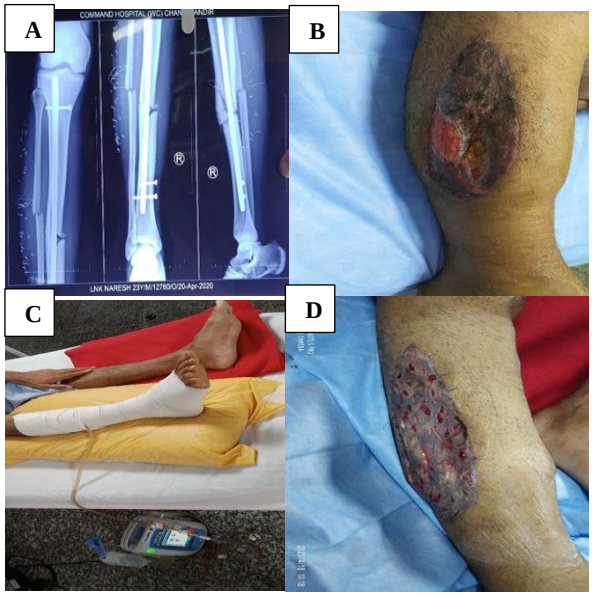


**Figure 10: SSG bolstered with NPWT VAC dressing: A) A case of # shaft tibia, fibula right leg; B) look of wound with SSG; C) SSG bolstered with NPWT through VAC machine; D) 3rd look of SSG with NPWT on 9th day.**

## DISCUSSION

This study was conducted at Command Hospital, Chandimandir on 60 patients from 1st March 2019 to 29th February 2020.

In NPWT group, there were 10 subjects within 10-40 years and 20 subjects >40 years. In TBD group, there were 3 subjects <10 years, 14 subjects within 10-40 years and 13 subjects >40 years.

Chi square test was applied and p value of 0.76 (>0.05) was derived indicating no statistical difference between the groups.

***Graft uptake***

In present study, graft take on day 5th with NPWT group was 83.16±4.1% and graft take by TBD group was 78.12±3.76%. Graft take on day 7th with NPWT group was 89.83±4.12% and graft take by TBD group was 84.33±4.66%. Final graft take on day 9th with NPWT group was 96.33±5.3% and graft take by TBD group was 92.67±5.24%.

In a study by Petkar et al, final graft take by NPWT group was 95.5±4.33 % and graft take by TBD group was 86.7±6.71%. [31]

Study by Moisidis et al observed that at 2 weeks, wounds that received a topical negative pressure dressing had a greater degree of epithelialization in six cases (30 percent), the same degree of epithelialization in nine cases (45%), and less epithelialization in five cases (25%) compared with their respective control wounds, Although the quantitative graft take was not significant, the qualitative graft take was found to be significantly better with the use of topical negative pressure therapy ($p<0.05$). Topical negative pressure significantly improved the qualitative appearance of split-thickness skin grafts as compared with standard bolster dressings.[32]

Scherer LA observed that VAC group required significantly fewer repeated STSGs [1 (3%) versus 5 (19%); p=0.04). Two additional graft failures occurred in the no-VAC group. Study concluded that data suggesting a negative-pressure dressing over an STSG site may improve overall graft survival, as measured by fewer episodes of repeated grafting.[33]

Pyo et al observed that VAC therapy reduced graft loss and improved graft success rate due its close contact ability. The patient was satisfied with the ease of dressing and handiness. In addition, patients and medical staff have satisfactory results due to increased mobility during hospitalization.[34]

Blackburn et al and Argenta et al found that it is a useful than bolster dressing in sites which are difficult.[6,35] Argenta et al also reported that there is better and faster engraftment of Integra over exposed tendon, bone, joint, and bowel with use of VAC.[35]

Hence, present study observations corroborate with findings of other contemporary studies in its finding that graft take was significantly higher in NPWT group than in TBD group.

***POST-split skin graft days***

In present study, In NPWT group, mean post SSG days were 5.6±1.2 days. In TBD group, mean post SSG days were 7.4±1.4 days.

In a study by Petkar et al, Post SSG days were 8±1.48 days in NPWT group and 11±2.2 days in TBD group after surgery. Each of these differences was found to be statistically significant ($p<0.001$).[36]

Hence, result of present study was comparable with other studies in the observation that post SSG days were shorter for NPWT group.

***Duration of hospital stay***

In present study, total hospital stay in NPWT group was 13.47±4.3 days, where as in TBD group it was 16.9±5.8 days. P value of 0.01 (<0.05) was derived indicating statistical difference between the groups.

Study by Llanos et al observed that total length of stay was 13.5 days (range, 11-22 days) in the NPC group versus 17 days (range, 10-31 days) in the control group (p=0.010). This difference maintained its statistical significance ($p<0.001$).[37]

Hence, result of present study was comparable with other studies in the observation that hospital stay days were shorter for NPWT group.

A study by Hynes et al concluded that split-thickness skin grafts in combination with negative pressure dressings were the most effective and appropriate means of treating axillary defects such as severe hidradenitis suppurativa following their surgical excision.[38]

***Complications***

In present study, 1 graft developed infection and 1 graft developed seroma in NPWT group. In TBD group, 2 graft developed seroma and 2 graft developed infection. There was statistically significant difference between the groups.

In a study by Petkar et al, no complications were observed in the NPWT group where as in TBD group, 3 cases of graft infection were noted. In a study by Saiiq et al, no complications were observed in the NPWT group where as in TBD group, 2 cases of graft infection were noted.[36]

Present study corroborates the findings of majority of other studies by demonstrating a better adherence of the graft to the bed leading to less complication in NPWT group.

***Need for redo split skin graft***

In present study, 6.67% of cases required redo SSG in NPWT group and 10% of cases required redo SSG in TBD group.

In a study by Llanos et al, SSG with vacuum therapy had revision rate 8.5% and SSG with traditional dressing had revision rate 14 %.[37]

Result of present study concurs with the findings of other studies in that need for redo procedure was significantly less in NPWT group when compared to TBD group.

Limitation of the study was that this study was a single centre study.

## CONCLUSION

Application of negative pressure wound therapy on split skin graft is beneficial in terms of better graft uptake, lesser infection, shortened post graft hospital stays and shorter hospital stays. Need for redo SSG is reduced in negative pressure wound therapy on split skin graft. The findings from present study suggests that negative pressure wound therapy dressing speeds up the process of graft take and it is particularly useful when the graft site is anatomically challenging, the graft bed is highly contoured, and the grafting conditions seem less-than-ideal for complete graft take. So, this study advances knowledge and understanding in the field of negative pressure wound therapy in terms of better graft uptake and less complications.

### *Recommendations*

This study recommends for more use of NPWT in terms of better graft uptake and less complications and the need for such local studies and hence allow more meaningful comparison of results in local population. Study also recommends the conduct of a multicentre local study to confirm and improve upon result.

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