



International Journal of Surgery Science

E-ISSN: 2616-3470

P-ISSN: 2616-3462

© Surgery Science

www.surgeryscience.com

2020; 4(4): 151-156

Received: 16-08-2020

Accepted: 19-09-2020

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A comparative study of the uptake of skin graft between patients receiving negative pressure wound therapy/vacuum dressing and conventional petroleum jelly gauze dressing following split skin grafting

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DOI: <https://doi.org/10.33545/surgery.2020.v4.i4c.552>

Abstract

NPWT is a novel method which has been developed to enhance wound healing. The suction therapy has shown by many studies to augment local blood flow by increasing the levels of mediators like IL 6, IL 8 and VEGF and enhancing neovascularization. Bearing these concepts in mind, NPWT following skin grafting has been advocated. The following study is a comparative study between graft uptake time and percentage of graft uptake among patients receiving NPWT following skin grafting and patients receiving conventional petroleum jelly dressing following split skin grafting. There was a statistically significant difference in the healing of the skin graft between the two groups. The patients receiving NPWT had their staples removed earlier and had a better uptake. There were similar results even after the subjects were stratified into diabetics, hypertensives and smokers.

Keywords: Split skin grafting, negative pressure wound therapy, graft uptake

Introduction

A wound can be defined as a break in the continuity of any structure, either internal or external caused by physical means [20]. Following a wound, healing can occur either by primary or secondary intention. Primary intention occurs when there are clean wounds with approximated edges as occurs following suturing of a laceration or surgery. Healing by secondary intention occurs when the defect is much larger, and the division of mesenchymal cells cannot fill the defect. The wound which heals by secondary intention usually takes a longer duration of time and is associated with substantial scar formation and thinning of epidermis [21, 29].

Split thickness skin grafting is used to cover a wound healing by secondary intention to enhance epithelialisation. The history of skin grafting dates back to 500 BC when individuals of the Indian tile maker caste who repaired amputated noses (which were a capital punishment at that time), using skin grafts [1].

The uptake of a split thickness skin graft depends on the size of the wound, condition of the wound bed and the overall condition of the patient. Studies have shown that the failure rate is higher in diabetic patients, smokers, malnutrition, anaemia and presence of infection. The basic physiology of graft uptake involves 3 stages –

Phase of plasma imbibition

Phase of inosculation

Phase of neovascularisation

The above mentioned co morbidities affect these processes with neovascularisation being affected the most [29].

Negative Pressure Wound therapy (NPWT) is a novel method which has been developed to enhance wound healing. NPWT involves application of a sealed dressing connected to a suction apparatus [48]. The suction therapy has shown by many studies to enhance local blood flow by increasing the levels of mediators like IL 6, IL 8 and VEGF [49, 59]. Studies have also shown the suction therapy also causes compression of local tissues and capillaries which lead to release of nitric oxide, which causes vasodilation and enhanced local blood flow. All these factors enhance the chances of wound healing [59].

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Bearing these concepts in mind, NPWT following skin grafting has been advocated. Many studies have shown better graft uptake and lesser failure rates. Very few studies assess the time to graft uptake. There is paucity of data among the local population regarding NPWT and skin grafting. The following study is a comparative study between graft uptake time or healing time and percentage of graft uptake among patients receiving NPWT following skin grafting and patients receiving conventional petroleum jelly dressing following split skin grafting.

Aims and objectives

- To compare the healing of Split Thickness Skin Grafting in patients receiving Negative Pressure Wound Therapy (NPWT)/Vacuum Dressing (VAC) following split skin grafting and patients receiving conventional petroleum jelly dressing
- The end points of the study
- Time to staple removal
- Percentage of graft uptake
- Hospital Stay

Materials and Methods

The sample size was calculated based on the prevalence of diabetic foot. The study duration was between January 2019 and December 2019. 20 patients received NBWT between January and June 2019. The subjects were carefully chosen based on their eligibility and after satisfying all the inclusion criteria. Subjects receiving NPWT first had a layer of petroleum Jelly gauze placed over the graft and then foam placed over it. Foam was placed in Operation Theater, immediately after securing the graft with staples and ensuring the foam is confined strictly to the graft area, as application of suction over intact skin can cause excoriations and macerations. The graft was secured using staples in all subjects of the study. The foam was kept in place using cellophane which extended about 3-4 cms from the margin of the wound. This application of cellophane helped maintain the closed seal system needed for suction therapy to work. The closed seal foam dressing was superimposed using antimicrobial surgical drapes (IOBAN). In the region of the middle of the graft a small defect was made in the foam dressing and the suction tubing for the vacuum therapy was connected. Negative pressure wound therapy was started after checking for leaks. Negative pressure therapy was continued for a period of 3-5 days depending on the amount of material sucked into the canister. The dressing was removed after 3- 5 days and the condition of the graft and uptake was assessed. The decision to remove staples was done based on clinical assessment of the quality of uptake. The percentage of graft uptake was calculated as ratio of the surface area of the wound covered by graft to the surface area of the original wound.

Subjects for the group receiving conventional petroleum Jelly dressing were chosen from patients getting skin grafting from July 2019 to November 2019. The subjects in this group were closely matched to the NPWT group. This group received the conventional petroleum Jelly dressing after skin grafting which was removed after five days. The same principles for staple removal and calculating graft uptake used in the NPWT group were followed in this control group as well.

Study design: This is a comparative study of healing of skin graft using negative pressure wound therapy and conventional petroleum Jelly dressing

Study duration: November 2018 to November 2020

Study location: JSS Medical College hospital

Sample size 40

20 received negative pressure wound therapy

20 received conventional petrol dressing

Inclusion criteria

All patients undergoing skin grafting aged more than 18 years.

Graft size more than 5x5cms

Exclusion criteria

Patients who refused NPWT

Patients younger than 18 years of

Any contraindication to negative pressure wound therapy

Exposed blood vessel

Osteomyelitis

Patients with bleeding disorders

Presence of slough in wound bed

Statistical analysis and results

The sample size was 40. 20 patients received NPWT and 20 patients received conventional wound dressing with petroleum jelly gauze.

Statistical Analysis was done using SPSS. A p value of < 0.05 was considered significant. The baseline characteristics are tabulated below

Table 1: Shows Characteristic NPWT Group Conventional Dressing Group and P Value

| Characteristic | NPWT Group | Conventional Dressing Group | P Value |
|--------------------------------|------------|-----------------------------|---------|
| Age (Years) | 51.4 | 50.35 | 0.64 |
| Diabetic Patients | 12 | 9 | 0.34 |
| Hypertensives | 8 | 13 | 0.113 |
| Smokers | 16 | 13 | 0.88 |
| AVERAGE Hba1c | 10.1 | 10.3 | 0.6 |
| Average Bp | 150/90 | 160/70 | 0.8 |
| Average Hb% | 10.8 | 10.6 | 0.288 |
| Wound Size (Cms ²) | 270.31 | 290.52 | 0.02 |

The baseline characteristics were compared using a T test. Except for wound size, there was no statistically significant difference in the average age, HbA1c, BP and Hemoglobin. The prevalence of diabetes mellitus, hypertension and smoking was compared using χ^2 test, which showed no significant difference between the 2 groups.

Results

This is a comparative study between uptake of a skin graft in patients receiving negative wound suction therapy and patients receiving conventional petroleum Jelly dressing following skin grafting. The sample size is 40 with twenty patients in each limb. The two groups were matched for age with the mean age of the NPWT group being 51.4 years and the mean age of the conventional dressing group being 50.35 years, with no statistically significant difference in the age of the subjects between the two groups. 60% of patients in the NPWT group are diabetic and 45% of patients receiving conventional dressing are diabetic. There was no significant difference in the prevalence of diabetes between the two groups. There were 8 hypertensive patients in the NPWT group which came up to 40% and 13 Hypertensive patients in the group which received conventional petroleum Jelly dressing which came up to 65%. There is no

statistically significant difference in the number of hypertensive patients between the two groups. There were 16 smokers in the NPWT group and 13 smokers in the group receiving conventional petroleum jelly dressing with no statistically significant difference between the two groups with respect to prevalence of smoking.

The average HbA1c which is a marker for diabetes control was 10.1 in diabetic patients receiving NPWT and 10.32 among the diabetic patients receiving conventional petroleum Jelly dressing. There was no statistically significant difference in the HbA1C of diabetic patients between the two groups. The average hemoglobin was 10.8 in the group receiving NPWT and was 10.6 in patients receiving conventional dressing, with no significant difference between the two groups. The average blood pressure among the hypertensive patients receiving NPWT was 150/90 and 160/70 among patients receiving conventional wound dressing. The groups were matched for blood pressure as well. The size of the wounds was calculated as the maximum surface area (LxB) in cm² and was also matched for both the groups.

There was a statistically significant difference in the healing of the skin graft between the two groups. The group receiving NPWT following skin grafting had their staples removed earlier than the patients who received conventional petroleum Jelly dressing. The patients receiving NPWT had their staples removed after a mean period of 3.9 days after surgery. The group receiving conventional petroleum jelly dressing had their staples removed after a mean period of 6.6 days. There was also a statistically significant difference in the percentage of graft uptake between the two groups.

The mean percentage of graft uptake in the NPWT group was 98% and was 89.8% in the group receiving conventional petroleum jelly dressings.

The groups were further stratified into patients with diabetes hypertension and patients who were smokers. There was a statistically significant difference in the graft healing among the stratified groups. Among the diabetic patients the mean number of days to staple removal was lesser and there was a higher percentage of graft uptake in the patients receiving NPWT. A similar result was seen in hypertensive patients and smokers.

This study shows that negative pressure wound therapy following skin grafting has better graft uptake and faster healing. Patients who received negative pressure wound therapy required fewer dressings, were discharged earlier, had a shorter duration of hospital stay and required lesser follow ups. Patients who received NPWT received on an average, 2 dressings following removal of the vacuum dressing whereas patients who did not receive NPWT received a mean 4 dressings after the first postoperative dressing. Patients receiving NPWT had a mean hospital stay of 6 days. Patients receiving conventional dressing had a mean duration of hospital stay of 10 days. Patient in the NPWT came for a single follow up and required no further dressing, whereas patients receiving conventional dressing required on an average 3 follow ups.

Discussion

The usefulness of negative pressure wound therapy following skin grafting has been proved by many studies.

However, most of the studies assess graft failure, mean duration of hospital stay and focus more on diabetic foot wounds. This study investigates the duration of healing of the graft and percentage of graft uptake which are markers of graft healing. This study attempts to analyze graft uptake in smokers and hypertensive patients as well. Smoking and hypertension can

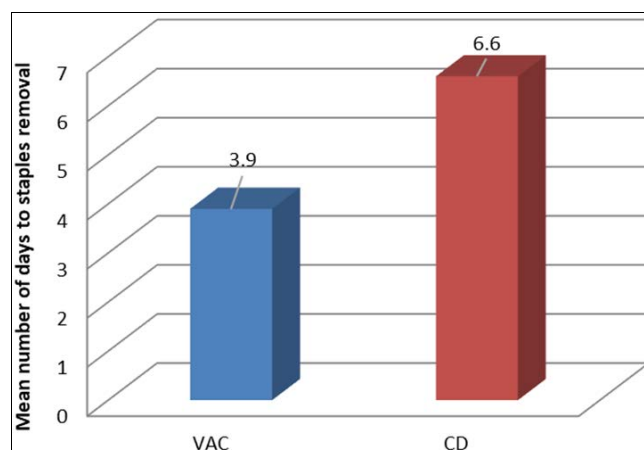
affect neo - vascularization and wound healing. This study shows a better graft uptake and faster healing of the graft when negative pressure therapy is used. This study assesses the graft uptake following NPWT in the local population while most of the published literature was conducted in the West. The study also stratifies the patients based on co morbidities and even among diabetics, hypertensive patients and smokers there is a better graft uptake after negative pressure wound therapy is used. This study proves that negative pressure wound therapy has better healing of the skin graft across co morbidities. The study population has been controlled for factors which affect wound healing like diabetic status, smoking, hemoglobin levels, hypertension and sterility of the wound bed. The average surface area of the wound in both the groups is almost equal.

However, this study is not without drawbacks. This study is a comparative study and the subjects were not randomized. Hence it will be difficult to rule out a selection bias. The sample size is relatively small, and a larger sample size would have improved the power of the study. However, we have tried to overcome the above issues by stratifying patients based on co morbidities and having matched groups for comparison. The percentage of graft uptake was calculated by measuring the length and the breadth of the uptake while more objective methods like using a platometer are available. The study is not powered to investigate the graft failure rates. A limiting factor for the widespread use of negative pressure wound therapy is the cost of the materials needed. Cheaper alternatives are also available like using simple foam and connecting the foam to wall suction. There have been studies which have shown equivalent results between negative pressure wound therapy and the above system.

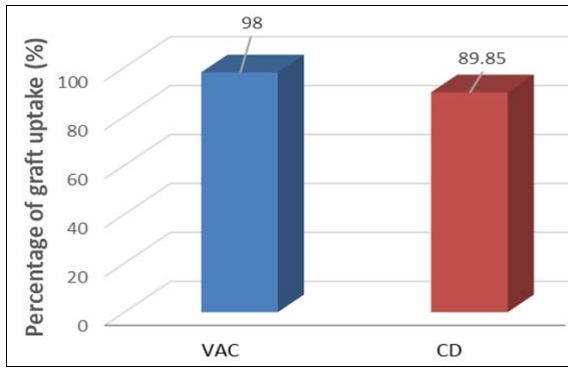
We have tried to overcome most of the drawbacks by having matched controls and by stratifying the patients based on factors which affect wound healing. This study can serve as a base and can open opportunities for future studies with a larger sample size and by using randomization techniques to eliminate any bias.

Conclusions

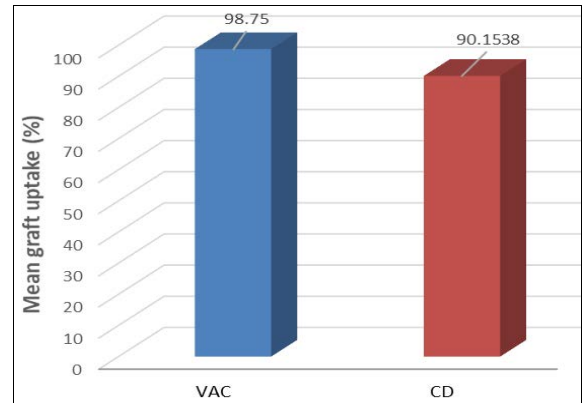
1. Negative Pressure Wound Therapy is superior to conventional dressing following skin grafting with faster healing and better graft uptake.
2. The effectiveness of VAC therapy spreads across co morbidities like Diabetes Mellitus and Hypertension as well as in smokers
3. Patients receiving NPWT have a shorter hospital stay, require fewer dressings and fewer follow ups



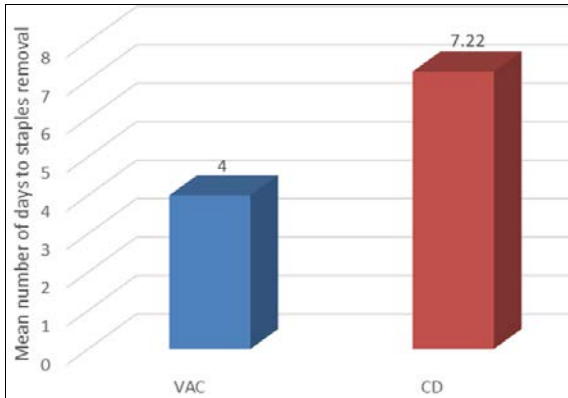
Graph 1: Chart comparing number of days to removal of staples used to secure graft $p < 0.001$



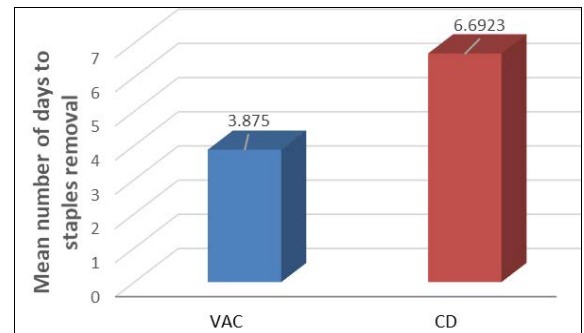
Graph 2: Chart comparing percentage of graft uptake between patients receiving npwt and conventional dressing $p < 0.001$



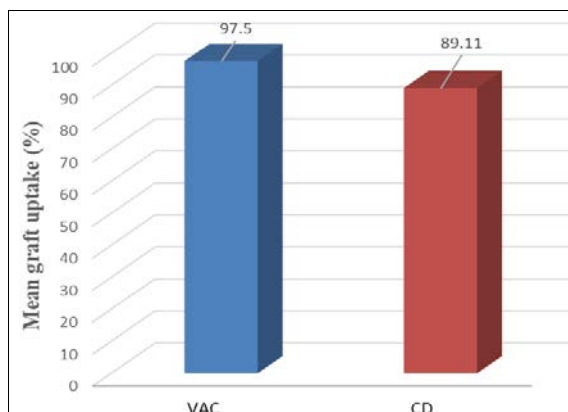
Graph 6: Chart comparing percentage of graft uptake between patients receiving npwt and conventional dressing in patients with hypertension $p < 0.001$



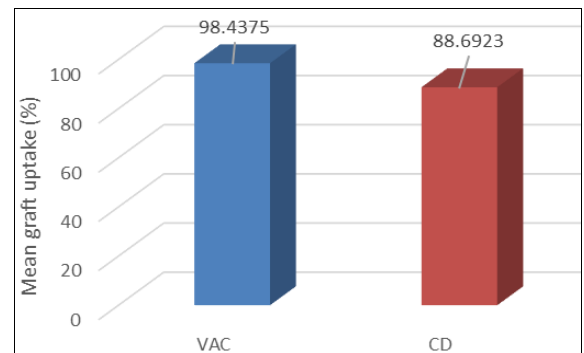
Graph 3: Chart comparing number of days to removal of staples used to secure graft in patients with diabetes mellitus $p < 0.001$



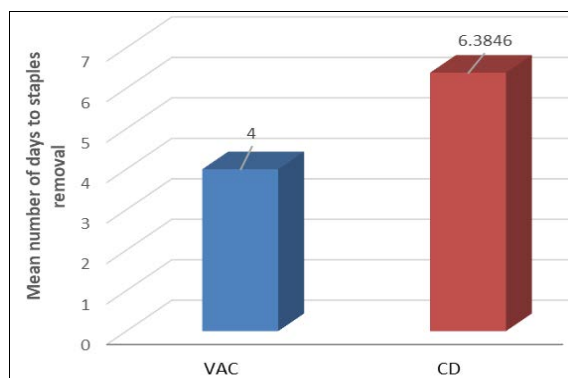
Graph 7: Chart comparing days to staple removal between patients receiving npwt and conventional dressing among smokers $p < 0.001$



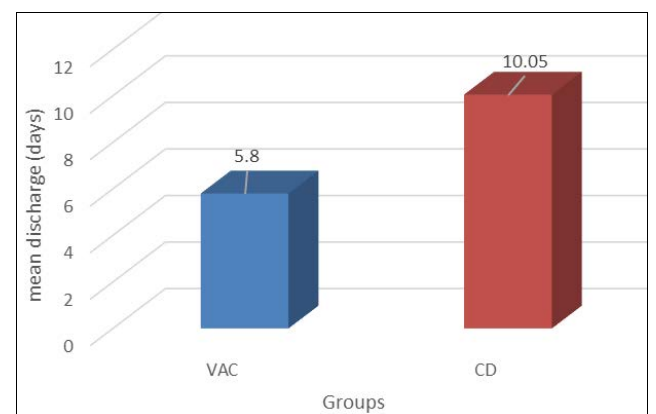
Graph 4: Chart comparing percentage of graft uptake between patients receiving npwt and conventional dressing in patients with diabetes mellitus $p < 0.001$



Graph 8: Chart comparing percentage of graft uptake between patients receiving npwt and conventional dressing among smokers $p < 0.001$



Graph 5: Chart comparing days to staple removal between patients receiving npwt and conventional dressing in patients with hypertension $p < 0.001$



Graph 9: Chart comparing hospital stay between patients receiving npwt and conventional dressings $p < 0.001$

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