

A meta-analysis examining the effects of traditional therapy versus negative-pressure therapy on wound infection and graft take rates in skin with split thickness after grafting surgery

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Abstract

Backgrounds

The purpose of the meta-analysis was to evaluate and compare the effects of negative-pressure wound therapy (NPWT) with conventional therapy (CT) on wound infection and graft take rates in split-thickness skin (STS) after grafting surgery (GS).

Methods

The results of this meta-analysis were analyzed, and the odds ratio (OR) and mean difference (MD) with 95% confidence intervals (CIs) were calculated using dichotomous or contentious random or fixed effect models. For the current meta-analysis, 16 examinations spanning from 2002 to 2023 were included, encompassing 1301 people with STSs after GS.

Results

NPWT had a significantly lower wound infection (OR, 0.29; 95% CI, 0.17-0.48, $p < 0.001$), and higher graft take rate (MD, 8.70; 95% CI, 5.76-11.63, $p < 0.001$) compared to CT in STSs after GS subjects.

Conclusions

The examined data revealed that NPWT had a significantly lower wound infection and a higher graft take rates compared to CT in STSs after GS subjects. However, given that several examinations had a small sample size, consideration should be given to their values.

Keywords: grafting surgery; negative-pressure wound therapy; conventional therapy; split-thickness skin

Introduction

Soft tissue covering for skin defect wounds continues to be a difficult treatment issue for burn and traumatic injury patients. Postoperative problems can result in a worse quality of life, an extended hospital stay, and higher healthcare costs.¹ Because of this, the technique for covering wounds has grown in significance, particularly in orthopedic surgery.² A basic method frequently employed in the restoration of major skin defects is split-thickness skin (STS) grafting. Investigating the best approach to concealing the grafted skin and increasing the graft take rate is crucial. Three stages are necessary for the grafted skin to survive: maturation, revascularization, and serum imbibition.³ The most important and susceptible to outside influences is revascularization. The soft tissue bed, the covering technique, and the graft thickness are the factors that determine the outcome of a skin graft. Shear pressures at the interface, hematoma formation beneath the graft, and infection of the grafted skin are the major reasons for skin graft loss. A second surgery is required to correct the wound bed if there is a significant loss of area in the grafted skin. Traditional recipient site care therapy for postoperative patients often involves a layer of petroleum and cotton gauze for protection, along with a tie-over dressing approach.

The drawbacks of using traditional skin grafting methods include shearing of the interface, which would reduce the skin's ability to survive in the bed, and inferior grafts because of hematomas beneath the grafted skin. Using cotton gauze and the tie-over technique, standard dressings are employed to achieve drainage of the hematoma and immobilization. However, wrapping and stabilizing the skin transplant with this traditional procedure is cumbersome and inefficient. Regular changes of petroleum gauze and saline-moistened gauze are necessary to keep the grafts moist. Patients may experience discomfort during dressing changes, which can also add to the medical staff's burden. For split-thickness grafts, negative-pressure wound therapy (NPWT) has been suggested as a viable substitute for traditional dressing. Morykwas and Argenta first described the effectiveness of NPWT.^{4, 5} Furthermore, wound beds have been prepared for flap closure grafting using NPWT.⁶⁶⁶⁶⁶⁶⁶ Vacuum-assisted closure (VAC), which applies negative pressure to the wound surface to compress soft tissues and enhance irrigation, is the foundation of negative pressure closure. The use of NPWT over skin grafting has been documented in several studies, some of which have had positive outcomes.^{3, 7-21} A meta-analysis combining all this research to contrast the NPWT with the traditional dressing method did not, however, exist. The current investigation was carried out to close this gap and offer substantiated responses to the queries concerning the split-thickness graft skin cover.

Method

Design of the examination

The meta-analyses were assessed using a predefined procedure and included in the epidemiological declaration. Numerous databases, including OVID, PubMed, the Cochrane Library, Embase, and Google Scholar, were consulted for the purpose of gathering and analyzing data. These datasets were used to gather analyses that contrasted and assessed the impact of NPWT on wound infection and graft take rates in STS after grafting surgery ((GS)).²²

Data pooling

In STS following GS, NPWT was found to provide several clinical outcomes as compared to conventional therapy (CT). Wound infection and graft take rates were the primary outcomes of the inclusion parameter in these studies. Language constraints were not taken into consideration while choosing which study to include or screening potential participants. The number of volunteers recruited for the investigations was not limited in any way. Since reviews, editorials, and letters don't offer an opinion, we didn't incorporate them into our synthesis. Figure 1 depicts the full examination identification procedure in its entirety.

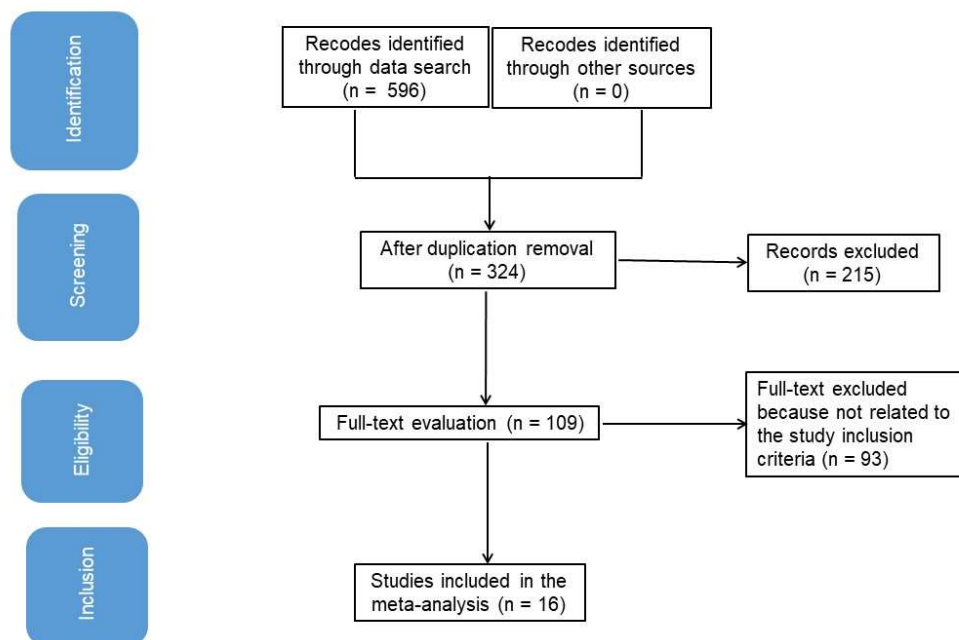


Figure 1. Schematic diagram of the examination procedure

Eligibility of included studies

The effect of CT, either beneficial or detrimental, on the clinical results of STS following GS is being investigated. The sensitivity analysis only included papers that discussed how interventions impacted the frequency of STS following GS. Sensitivity and subclass analyses were performed using comparisons between the various subtypes and the interventional groups.

Inclusion and exclusion criteria

Information sources

The entire research is represented in Figure 1. The literature was embedded into the research when the inclusion criteria were met :

1. The investigation was observational, prospective, retrospective, or RCT research.
2. Subjects with STSs after GS
3. The intervention was NPWT.
4. The research appraised the effect of effects of NPWT in STSs after GS participants

Inclusion criteria:

For a study to be considered for the meta-analysis, it had to meet the following requirements: it had to compare the effects of NPWT in STSs after GS participants. The outcome's expression must be included in the output in order for statistical analysis to be utilized.

Exclusion criteria:

Research having a non-comparative design was not included. In addition, the present assessment did not contain any letters, books, reviews, or book chapters.

Identification of studies

The PICOS principle was used to develop and specify a protocol of search techniques, ²³ which states: P (population) individuals with STSs after GS; NPWT was the "intervention" or "exposure"; C (comparison): the comparison between NPWT and CT. O (outcome): wound infection and graft take rates; S (design of the examination): the intended assessment was limitless.. ²⁴

Using the keywords and related terms listed in Table 1, we conducted a comprehensive search of the pertinent databases through September 2023. Reviews were conducted on all publications that were part of a reference management programme, including abstracts and titles, as well as any research that did not link the type of treatment to clinical outcomes. In addition, two authors evaluate papers to identify pertinent exams.

Table 1. Database Search Strategy for inclusion of examinations

Database	Search strategy
Google Scholar	#1 "grafting surgery" OR "negative-pressure wound therapy" #2 "conventional therapy" OR "split-thickness skin" #3 #1 AND #2
Embase	#1 'grafting surgery' /exp OR 'negative-pressure wound therapy' #2 'conventional therapy'/exp OR 'split-thickness skin'/ #3 #1 AND #2
Cochrane library	#1 (grafting surgery):ti,ab,kw (negative-pressure wound therapy):ti,ab,kw (Word variations have been searched) #2 (conventional therapy):ti,ab,kw OR (split-thickness skin):ti,ab,kw (Word variations have been searched) #3 #1 AND #2
Pubmed	#1 "grafting surgery"[MeSH] OR "negative-pressure wound therapy"[All Fields] #2 "conventional therapy"[MeSH Terms] OR "split-thickness skin"[All Fields] #3 #1 AND #2
OVID	#1 "grafting surgery"[All Fields] OR "negative-pressure wound therapy" [All Fields] #2 "conventional therapy"[All fields] OR "split-thickness skin"[All Fields] #3 #1 AND #2

Screening of studies

The criteria used to reduce the amount of data included the examination and personal features presented in a standard format, the first author's last name, the examination's time and year, the nation in which it was conducted, gender, the population type that was recruited for the examination, the total number of individuals, qualitative and quantitative evaluation methods, demographic information, and clinical and treatment characteristics. ²⁵ The potential for bias in each test as well as the caliber of the methods employed in the tests selected for additional analysis were examined by two reviewers who remained anonymous. The methods used for each examination were objectively reviewed by two reviewers. ²⁶

Statistical analysis

In the present meta-analysis, dichotomous or continuous random- or fixed-effect models were used to estimate the odds ratio (OR) and mean difference (MD) with a 95% confidence interval (CI). ²³ The I2 index was determined (in percent), and it has a range of 0 to 100. ²⁵ Increased heterogeneity is indicated by higher I2 values, whereas a lack of heterogeneity is indicated by lower I2. When I2 was 50% or more, the random effect was selected; if I2 was less than 50%, the fixed effect was selected. ²⁷ The first investigation's findings were categorized as part of the

subcategory analysis, as was previously described. Using Begg's and Egger's tests for quantitative analysis, publication bias was evaluated and determined to be present if $p > 0.05$. An analysis with two tails was used to calculate the p-values. Graphs and statistical analysis were created with Jamovi 2.3.²⁸

Results

Following an assessment of 596 relevant papers, 16 papers that were released between 2002 and 2023 were included in the meta-analysis since they matched the inclusion criteria.^{3, 7-21} Table 2 summarizes the findings of these investigations. 1301 people with STSs after GS were in the used studies' starting point, 706 of them utilized NPWT and 595 of them utilized CT.

Table 2. Characteristics of studies

Study	Country	Total	NPWT	Conventional therapy
Scherer, 2002 ⁷	USA	61	34	27
Moisisdis, 2004 ⁸	Australia	40	20	20
Llanos, 2006 ⁹	Chile	60	30	30
Kim, 2007 ¹⁰	Korea	47	37	10
Blume, 2010 ¹¹	USA	142	87	55
Petkar, 2012 ¹²	India	71	35	36
Lee, 2014 ¹³	Korea	26	14	12
Zhang, 2015 ¹⁴	China	81	27	54
Wu, 2015 ¹⁵	Taiwan	20	20	0
Hsiao, 2017 ³	Taiwan	28	14	14
Maduba, 2020 ¹⁶	Nigeria	62	31	31
Chaisrisawadisuk, 2020 ¹⁷	Thailand	79	42	37
Mo, 2021 ¹⁸	China	392	218	174
Cao, 2022 ¹⁹	Poland	86	43	43
Agrawal, 2023 ²⁰	India	60	30	30
Baek, 2023 ²¹	Korea	46	24	22
	Total	1301	706	595

NPWT had a significantly lower wound infection rate (OR, 0.29; 95% CI, 0.17-0.48, $p < 0.001$) with no heterogeneity ($I^2 = 0\%$), and a higher graft take rate (MD, 8.70; 95% CI, 5.76-11.63, $p < 0.001$) with high heterogeneity ($I^2 = 87\%$) compared to CT in STSs after GS subjects, as revealed in Figures 2 and 3.

The quantitative Egger regression test and the visual interpretation of the effect's forest plot did not reveal any evidence of examination bias ($p = 0.87$). It was discovered that the majority of relevant examinations had low practical quality and were impartial in their selective reporting.

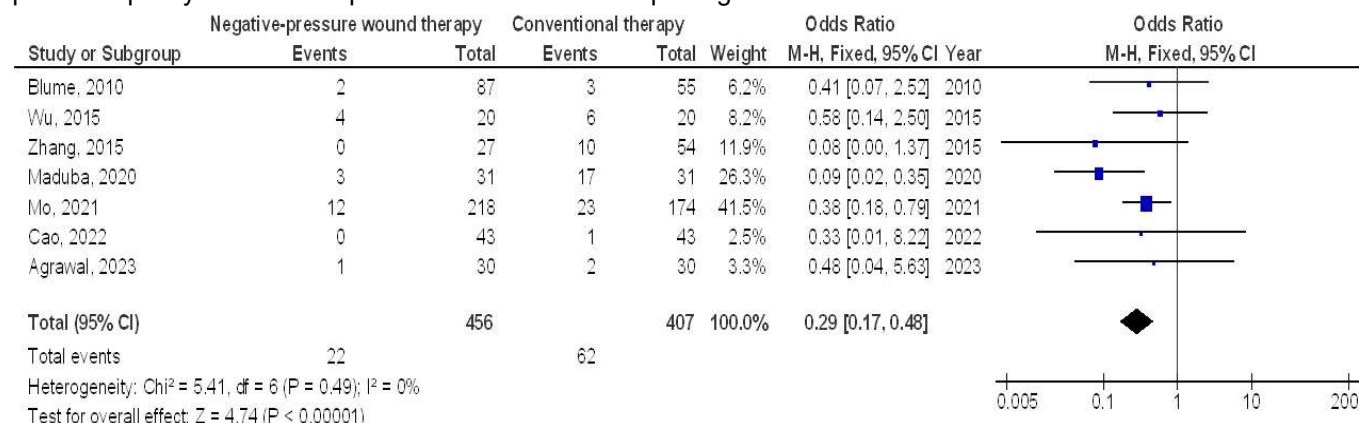


Figure 2. The effect's forest plot of the negative-pressure wound therapy compared to conventional therapy on wound infection rate in split-thickness skins after grafting surgery subjects.

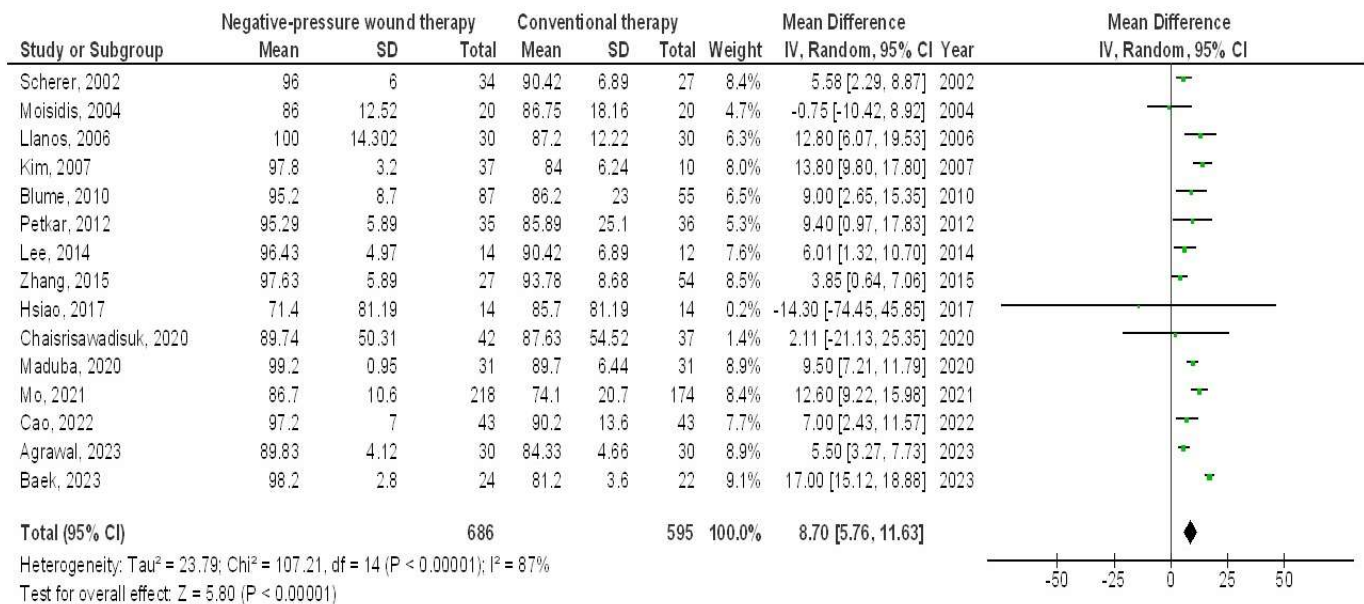


Figure 3. The effect's forest plot of the negative-pressure wound therapy compared to conventional therapy on graft take rate in split-thickness skins after grafting surgery subjects.

Discussion

For the current meta-analysis, 16 exams from 2002 to 2023 were included; of these, 1301 people with STSs after GS were in the used studies' starting point, and 706 of them utilized NPWT and 595 of them utilized CT. The sample size was 20-392 people.^{3, 7-21} The examined data revealed that NPWT had a significantly lower wound infection, and higher graft take rates compared to CT in STSs after GS subjects. However, given that some examinations included a small sample size (14 of 16 ≤ 100) attention should be given to its values.

One of the most significant variables that affect the rate of skin transplant acceptance and length of hospital stays is wound infection. The subcutaneous hematoma formation risk is decreased by the constant negative pressure environment that NPWT offers. Shear force can be lessened and the skin can be held firmly in place by the negative pressure that exists between the wound bed and the NPWT. When compared to CT, prior microbiology studies showed that NPWT was unable to reduce the bacterial load.²⁹ Furthermore, even though the foam was regularly replaced, there was a higher level of bacteria led by NPWT in both acute and chronic wounds.³⁰ Reoperations, which extend hospital stays, are corrective actions taken after the initial skin transplant failed. In contrast to traditional therapy, NPWT increases graft take rate and decreases the incidence of wound infection that causes reoperation. A 10-year study of 142 patients who underwent STS transplant surgery was carried out by Blume et al. According to the findings, NPWT patients had a lower likelihood of requiring a second operation.¹¹ According to Scherer's research,⁷ there was a 16% decrease in the reoperation rate between the NPWT group and the CT group. According to Ho et al., the cost of reoperation was over \$1,000 whereas a five-day course of NPWT treatment came in at \$400.³¹ This finding suggests that hospitalization costs can be decreased for patients by applying the NPWT correctly based on their condition.

The meta-analysis included the following limitations: There might have been an assortment bias because some of the studies that were chosen for the meta-analysis were not included. The removed study, however, did not meet the requirements to be included in the meta-analysis. Furthermore, the data was required to ascertain whether factors such as age, gender, and ethnicity affected the outcome. The aim of the meta-analysis was to investigate the effects of NPWT versus CT on wound infection and graft take rates in patients with STS following GS. It's probable that the use of inaccurate or insufficient data from a previous study exacerbated bias. The main reasons for discrimination were probably the individual's age, gender, ethnicity, and nutritional state. Unintentional changes in values could arise from incomplete data and unreported investigations.

Conclusions

The examined data revealed that NPWT had a significantly lower wound infection, and higher graft take rate compared to CT in STSs after GS subjects. However, given that some examinations included a small sample size (14 of 16 ≤ 100) attention should be given to its values.

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