International Journal of Clinical Medical Research

# 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

Juliette Louis 1, Béatrice Alain1

Correspondence:
Béatrice Alain
Jean Minjoz Hospital,
3 Bd Alexandre Fleming,
25000, Besançon,
France
Email:
beatrice.alain1234@outlook.com

1 Jean Minjoz Hospital, 3 Bd Alexandre Fleming, 25000 Besançon, France

Volume number 2
Issue number 5
Pages 191-197

10.61466/ijcmr2050005

Received: 01.07.2024
Accepted: 25.09.2024
Published: 27.09.2024
0nline: 01.10.2024

**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.

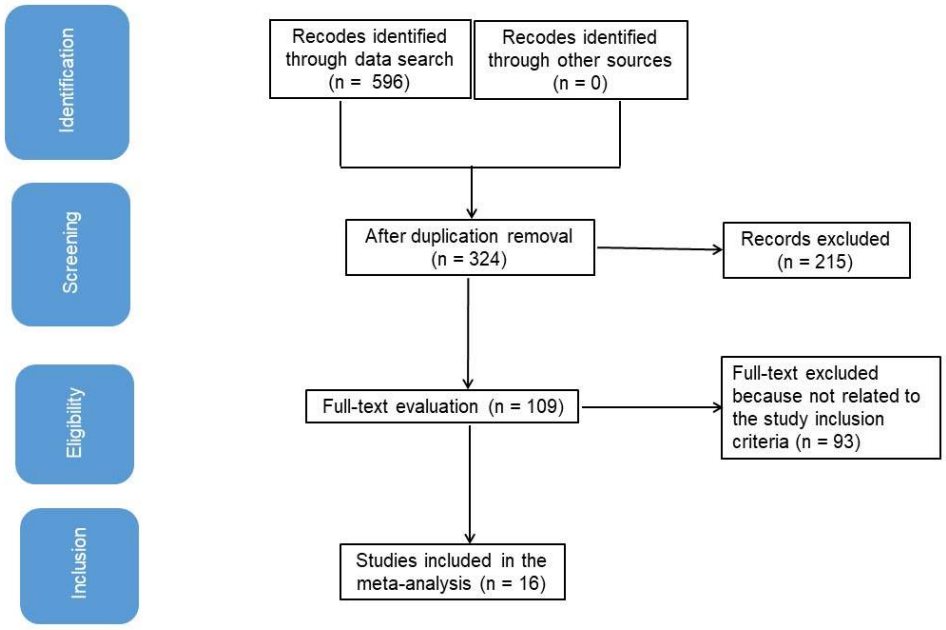


Figure 1. Schematic diagram of the examination procedure

### 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"<br>#2 "conventional therapy" OR "split-thickness skin"<br>#3 #1 AND #2 |
| **Embase** | #1 'grafting surgery' /exp OR 'negative-pressure wound therapy'<br>#2 'conventional therapy'/exp OR 'split-thickness skin'/<br>#3 #1 AND #2 |
| **Cochrane library** | #1 (grafting surgery):ti,ab,kw (negative-pressure wound therapy):ti,ab,kw (Word variations have been searched)<br>#2 (conventional therapy):ti,ab,kw OR (split-thickness skin):ti,ab,kw (Word variations have been searched)<br>#3 #1 AND #2 |
| **Pubmed** | #1 "grafting surgery"[MeSH] OR "negative-pressure wound therapy"[All Fields]<br>#2 "conventional therapy"[MeSH Terms] OR "split-thickness skin"[All Fields]<br>#3 #1 AND #2 |
| **OVID** | #1 "grafting surgery"[All Fields] OR "negative-pressure wound therapy" [All Fields]<br>#2 "conventional therapy"[ All fields] OR "split-thickness skin"[All Fields]<br>#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 |
| Moisidis, 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.

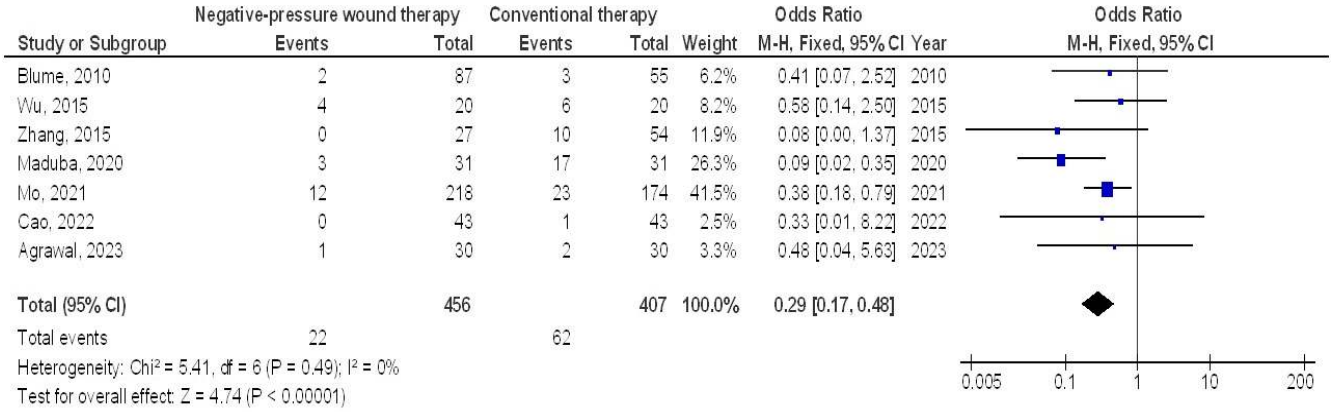


Figure 2. The effect's forest plot of the negative-pressure wound therapy compared to conventional therapy on wound infection rate in split-thickness skins after grafting surgery subjects.

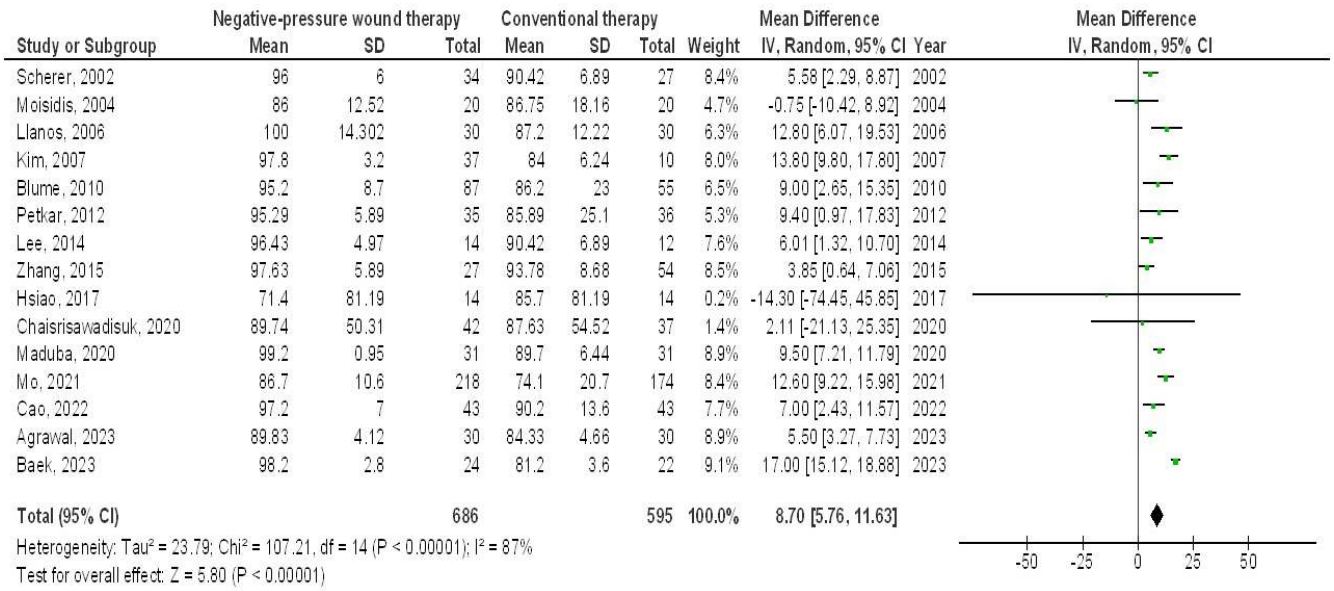


Figure 3. The effect's forest plot of the negative-pressure wound therapy compared to conventional therapy on graft take rate in split-thickness skins after grafting surgery subjects.

**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.

**References**

1. A. Hjort and F. Gottrup *Cost of wound treatment to increase significantly in Denmark over the next decade.* Journal of wound care **19**(5): p. 173-184 (2010).

2. R. Khan, D. Fick, F. Yao, et al. *A comparison of three methods of wound closure following arthroplasty: a prospective, randomised, controlled trial.* The Journal of Bone & Joint Surgery British Volume **88**(2): p. 238-242 (2006).

3. S.F.-y. Hsiao, H. Ma, Y.-H. Wang, et al. *Occlusive drainage system for split-thickness skin graft: a prospective randomized controlled trial.* Burns **43**(2): p. 379-387 (2017).

4. L.C. Argenta and M.J. Morykwas *Vacuum-assisted closure: a new method for wound control and treatment: clinical experience.* Annals of plastic surgery **38**(6): p. 563-577 (1997).

5. M.J. Morykwas, L.C. Argenta, E.I. Shelton-Brown, et al. *Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation.* Annals of plastic surgery **38**(6): p. 553-562 (1997).

6. D.H. Song, L.C. Wu, R.F. Lohman, et al. *Vacuum assisted closure for the treatment of sternal wounds: the bridge between debridement and definitive closure.* Plastic and reconstructive surgery **111**(1): p. 92-97 (2003).

7. L.A. Scherer, S. Shiver, M. Chang, et al. *The vacuum assisted closure device: a method of securing skin grafts and improving graft survival.* Archives of Surgery **137**(8): p. 930-934 (2002).

8. E. Moisidis, T. Heath, C. Boorer, et al. *A prospective, blinded, randomized, controlled clinical trial of topical negative pressure use in skin grafting.* Plastic and reconstructive surgery **114**(4): p. 917-922 (2004).

9. S. Llanos, S. Danilla, C. Barraza, et al. *Effectiveness of negative pressure closure in the integration of split thickness skin grafts: a randomized, double-masked, controlled trial.* Annals of surgery **244**(5): p. 700 (2006).

10. E.K. Kim and J.P. Hong *Efficacy of negative pressure therapy to enhance take of 1-stage allodermis and a split-thickness graft.* Annals of plastic surgery **58**(5): p. 536-540 (2007).

11. P.A. Blume, J.J. Key, P. Thakor, et al. *Retrospective evaluation of clinical outcomes in subjects with split-thickness skin graft: comparing VAC® therapy and conventional therapy in foot and ankle reconstructive surgeries.* International wound journal **7**(6): p. 480-487 (2010).

12. K. Petkar, P. Dhanraj, and H. Sreekar *Vacuum closure as a skin-graft dressing: a comparison against conventional dressing.* European Journal of Plastic Surgery **35**: p. 579-584 (2012).

13. K.T. Lee, J.K. Pyon, S.Y. Lim, et al. *Negative-pressure wound dressings to secure split-thickness skin grafts in the perineum.* International Wound Journal **11**(2): p. 223-227 (2014).

14. F. Zhang, K.-Y. Lv, X.-C. Qiu, et al. *Using negative pressure wound therapy on microskin autograft wounds.* Journal of Surgical Research **195**(1): p. 344-350 (2015).

15. C.-C. Wu, K.-Y. Chew, C.-C. Chen, et al. *Antimicrobial-impregnated dressing combined with negative-pressure wound therapy increases split-thickness skin graft engraftment: a simple effective technique.* Advances in skin & wound care **28**(1): p. 21-27 (2015).

16. C.C. Maduba, U.U. Nnadozie, V.I. Modekwe, et al. *Split skin graft take in leg ulcers: conventional dressing versus locally adapted negative pressure dressing.* Journal of Surgical Research **251**: p. 296-302 (2020).

17. S. Chaisrisawadisuk, W. Tangjatuporn, and A. Chuangsuwanich *The The Effect of Gauze-Based, Negative-Pressure Wound Dressing on Skin Graft Survival: A Comparative Study.* The Bangkok Medical Journal **16**(2): p. 153-153 (2020).

18. R. Mo, Z. Ma, C. Chen, et al. *Short-and long-term efficacy of negative-pressure wound therapy in split-thickness skin grafts: A retrospective study.* Annals of Palliative Medicine **10**(3): p. 2935-2947 (2021).

19. X. Cao, Z. Hu, Y. Zhang, et al. *Negative-Pressure Wound Therapy Improves Take Rate of Skin Graft in Irregular, High-Mobility Areas: A Randomized Controlled Trial.* Plastic and Reconstructive Surgery **150**(6): p. 1341-1349 (2022).

20. N. Agrawal *Comparative study of outcomes between application of negative pressure wound therapy to split skin graft versus split skin graft immobilized by traditional bolster dressing.* International Surgery Journal **10**(8): p. 1317-1324 (2023).

21. S. Baek and J.H. Park *Negative Pressure Wound Therapy (NPWT) after Hybrid Reconstruction of Occipital Pressure Sore Using Local Flap and Skin Graft.* Medicina **59**(7): p. 1342 (2023).

22. A. Liberati, D.G. Altman, J. Tetzlaff, et al. *The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration.* J. Clin. Epidemiol. **62**(10): p. e1-e34 (2009).

23. J.P. Higgins, S.G. Thompson, J.J. Deeks, et al. *Measuring inconsistency in meta-analyses.* Bmj **327**(7414): p. 557-560 (2003).

24. D.F. Stroup, J.A. Berlin, S.C. Morton, et al. *Meta-analysis of observational studies in epidemiology: a proposal for reporting.* JAMA **283**(15): p. 2008-2012 (2000).

25. A. Gupta, A. Das, K. Majumder, et al. *Obesity is Independently Associated With Increased Risk of Hepatocellular Cancer–related Mortality.* American journal of clinical oncology **41**(9): p. 874-881 (2018).

26. C. Collaboration *RoB 2: A revised Cochrane risk-of-bias tool for randomized trials.* Available at (Accessed December 6, 2019): bias/resources/rob-2-revised-cochrane-risk-bias-tool-randomized-trials (2020).

27. S. Sheikhbahaei, T.J. Trahan, J. Xiao, et al. *FDG-PET/CT and MRI for evaluation of pathologic response to neoadjuvant chemotherapy in patients with breast cancer: a meta-analysis of diagnostic accuracy studies.* The oncologist **21**(8): p. 931-939 (2016).

28. R.K. Singh *A meta-analysis of the impact on gastrectomy versus endoscopic submucosal dissection for early stomach cancer.* Int. J. Clin. Med. res. **1**(3): p. 88-99 (2023).

29. C.M. Mouës, M.C. Vos, G.J.C. Van Den Bemd, et al. *Bacterial load in relation to vacuum-assisted closure wound therapy: a prospective randomized trial.* Wound repair and regeneration **12**(1): p. 11-17 (2004).

30. E. Yusuf, X. Jordan, M. Clauss, et al. *High bacterial load in negative pressure wound therapy (NPWT) foams used in the treatment of chronic wounds.* Wound repair and regeneration **21**(5): p. 677-681 (2013).

31. M.W.S. Ho, S.N. Rogers, J.S. Brown, et al. *Prospective evaluation of a negative pressure dressing system in the management of the fibula free flap donor site: a comparative analysis.* JAMA Otolaryngology–Head & Neck Surgery **139**(10): p. 1048-1053 (2013).