e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2023; 15(10); 593-597

Original Research Article

A Study to Assess the Closed Incisional Negative Pressure Wound Therapy at Flap Suture Line: A Retrospective Study

Puja Priyadarshini

Senior Resident, Department of Plastic Surgery, Nalanda Medical College and Hospital, Patna, Bihar, India

Received: 12-07-2023 Revised: 19-08-2023 / Accepted: 11-09-2023
Corresponding Author: Dr. Puja Priyadarshini
Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to assess the closed Incisional Negative Pressure Wound Therapy at Flap Suture Line.

Material & Methods: A retrospective analysis for the duration of 12 months of patients who underwent ciNPWT at the flap suture line was included in the study at department of Plastic Surgery. 30 patients were included in the study.

Results: There were no significant differences between the two groups in terms of patient baseline information such as age, gender, ASA classification, and preoperative laboratory indices (including haemoglobin, alanine transaminase, aspartate transaminase, creatinine, prothrombin time, activated partial thromboplastin time, and D-dimer). Within the NPWT group, all patients obtained scores below 20 score. Conversely, within the Control group, a significant majority of patients demonstrated ASEPSIS scores surpassing 20 score. There was no statistical difference in ADLS scores, LEFS scores, and VAS scores between the two groups.

Conclusion: Closed incisional NPWT decreases the untoward effects of dead space following the reconstruction of complex wounds. The incidence of SSI and wound gaping can be reduced.

Keywords: Closed Incisional Negative Pressure Wound Therapy, Wound Healing, Wound Dehiscence.

Introduction

Flaps play a crucial role in the wound healing of critical wounds in which implants, bone, neurovascular structure, or vital viscera are exposed. [1] Incisional wound healing is an orchestra of biological and molecular events such as cell migration, proliferation and of extracellular matrix storing and remodelling. Certain pathophysiological and metabolic conditions can alter this healing milieu and thereby impair or delay healing. [2] Persistent dead space following flap cover is a frequently encountered challenge. It may lead to a hematoma, seroma, wound infection, and wound dehiscence. Wound dehiscence may be a devastating complication. Wound dehiscence in the postoperative period is an important outcome measure since it impacts the mortality, morbidity, duration of hospital stay.1 Surgical site infection (SSI), anemia, hypoproteinemia, tobacco abuse, diabetes are few of the important suboptimal wound factors which contribute to wound dehiscence. [1]

Risk factors used to asses surgical wounds' post-operative complications risk can be classified as trauma-related (soft tissue injury or fracture, type) surgery-related (incision placement, surgical site contamination, technique, operative time, estimated blood loss) or patient-related (morbid obesity, multiple significant comorbidities, drugs, nicotine abuse). [3]

Methods to close an incision may range from sutures [4] to nitinol staples, adhesive strips, liquid skin adhesive [5] or a combination thereof. The management of clean, closed surgical incisions diversify from preoperative prophylactic precautions as well as microbial sealants, [6] intra-operative devices like prophylactic gentamycin-collagen sponges [7] to post-operative measures. Post-operative measures range from conventional dressing of sterile dry gauzes, [8] debriding agents and topical antimicrobial dressing, to more advanced wound dressings in an effort to stimulate the proliferative phase of wound healing, including hydrocolloids, [8] topical application of autologous blood products, [9] growth factors, [10] cultured skin [11] and Negative Pressure Wound Therapy (NPWT). [12,13,14] Negative pressure wound therapy (NPWT) is one of the proven treatments for wound healing of the suture site. [15,16] NPWT promotes wound healing in the closed suture site by removing fluid from the incisional interspaces,

acting as a splint against distracting forces, protecting from environmental contamination, and promoting upregulation in the expression of vascular endothelial growth factor. [17]

Closed incisional negative pressure wound therapy (ciNPWT) has been well described for groin wounds following vascular surgeries, [18] knee and hip arthroplasties, [19] abdominoplasty incisions, [20] breast surgeries, [21] and abdominal wall reconstruction, [22] morbidly obese woman following cesarean section. [23] To the best of our knowledge application of ciNPWT at flap suture line following soft tissue reconstructive surgery has not been described previously.

The aim of the present study was to assess the closed Incisional Negative Pressure Wound Therapy at Flap Suture Line. [24]

Material & Methods

A retrospective analysis for the duration of 12 months of patients who underwent ciNPWT at the flap suture line was included in the study at department of Plastic Surgery, Nalanda Medical College and Hospital, Patna, Bihar, India. 30 patients were included in the study.

Inclusion Criteria

- Selected high-risk patients who underwent complex reconstruction (pedicled or free flap).
- Patients with soft tissue defects and underlying deep incisional/organ SSI, persistent dead space following flap coverage, chronic osteomyelitis.

Exclusion Criteria

Patients in whom NPWT was used for relieving flap congestion were excluded from the study.

Methodology

Patients also underwent initial debridement and appropriate antibiotic therapy before flap coverage. NPWT was either applied in the operation theater immediately after the flap procedure or within 24 to 48 hours following the procedure. NPWT was applied for patients in whom we anticipated complications of persistent dead space/wound drainage at the recipient site in spite of an appropriate flap cover. The suspicion of dead space was based on clinical examination. Whenever the volume of flap was falling short of the defect's volume, a persistent dead space was diagnosed. The recipient site wound was closed completely with the flap cover in all the patients. The skin suturing was done with longer intervals (1.5–2 cm) to facilitate the effect of NPWT. A 2 to 3 cm wide sponge was cut and applied over the entire suture line adjacent to the flap and connected to the device set at continuous -100 mm Hg pressure. In a patient in whom flap cover was done over the repaired femoral artery, the pressure was set at -50 mm Hg as described by Berger et al.[24] This method allows flap monitoring through the transparent adhesive dressing. The dressing is changed after 3 to 4 days. NPWT dressing was reapplied if there was a suspicion of persistent dead space or edematous flap/surrounding skin. In one of the patients, NPWT was continued for 3 weeks because of persistent lymphorrhoea from the groin wound following femoral artery repair. Once the NPWT was discontinued, regular dressings were done.

Results

Table 1: Basic information, demographic characteristics and laboratory indices of patients

		Control Group, n = 20	NPWT Group, n = 10	p value
Age, year		54.6±8.2	53.4±8.8	0.782
Gender, n (%)				>0.92
Male		14(70)	7(70)	
Female		6(30)	3(30)	
ASA grading				0.336
I		6(30)	0	
II		10(50)	8(80)	
III		4(20)	2(20)	
Operation time, minute		266.4±40.6	284.6±30.6	0.432
Bleeding, mL		378.6±254.6	316.4±158.6	0.568
Pre-operation	HGB, g/L	13.16±16.4	13.50±8.2	0.720
	ALT	23.5±5.8	25.8±7.5	0.264
	AST	23.7±7.6	21.9±3.4	0.560
	Creatinine, μmol/L	66.4±10.5	63.7±8.2	0.840
	PT, s	11.9±0.6	11.8±1.2	0.820
	APTT, s	32.3±2.8	32.0±2.1	0.786
	D-dimer, μg/mL	0.19±0.02	0.22±0.08	0.316
Hospitalization time, day		31.6±19.7	19.4±1.7	0.048

There were no significant differences between the two groups in terms of patient baseline information such as age, gender, ASA classification, and preoperative laboratory indices (including haemoglobin, alanine transaminase, aspartate transaminase, creatinine, prothrombin time, activated partial thromboplastin time, and D-dimer).

Table 2: Postoperative flap manifestations of injured blood supply and wound major complications

	Control Group	NPWT Group	p value
Injured blood supply	9(45)	0	0.055
Epidermal blisters	0	0	
Abnormal color	3(15)	0	0.560
Cold temperature	1(5)	0	1.000
Swelling	5(25)	0	0.550
Major complications	12(60)	0	0.018
Exudation	11(55)	0	0.049
Infection	5(25)	0	0.535
Non-healing	3(15)	0	0.530
Dehiscence ASEPSIS score	1(5)	0	10.001
0–10	1(5)	4(57.2)	
11–20	5(25)	3(42.9)	
21–30	9(45)	-	
31–40	3(15)	-	
>41	1(5)	-	

Within the NPWT group, all patients obtained scores below 20 score. Conversely, within the Control group, a significant majority of patients demonstrated ASEPSIS scores surpassing 20 score.

Table 3: Postoperative assessment of the therapeutic outcome by LEFS, VAS and ADL score

	Control Group	NPWT Group	p value
Preoperative LEFS	52.5±1.8	53.4±1.7	0.384
Postoperative LEFS	48.1±2.6	51.7±1.4	0.004
ΔLEFS score	-2.4±2.1	0.44±0.96	0.007
Preoperative VAS	5.5±0.9	5.3±0.8	0.535
Postoperative VAS	5.0±1.7	6.9±1.1	0.018
ΔVAS score	-0.54±1.8	1.6±0.53	0.001
Preoperative ADLS	69.7±2.6	70.3±2.7	0.640
Postoperative ADLS	71.3±3.1	74.4±2.9	0.048
ΔADLS	1.2±1.8	4.6±2.4	0.003

There was no statistical difference in ADLS scores, LEFS scores, and VAS scores between the two groups.

Discussion

Conventional NPWT is well-known for its role in the management of most of the open acute and chronic wounds. [25] The direct benefits of NPWT are: (a) maintaining moist and warm environment for wound healing provided by the semipermeable adhesive dressing, (b) reducing wound edema by providing pressure gradient between the wound and the suction canister thereby, draining the fluid from the wound bed and the interstitial space, (c) the wound deformation leads to approximation of the wound edges together, skin graft/flap apposition to the wound bed, (d) the wound dehiscence risk is reduced by reduction of lateral strain at the suture site. [26] The tissue deformation is also a stimulus for the remodeling of tissues. [27] The indirect benefits promoting wound healing are augmented blood supply, reduction of inflammation, decreased bacterial burden. [28]

There were no significant differences between the two groups in terms of patient baseline information such as age, gender, ASA classification, and preoperative laboratory indices (including haemoglobin, alanine transaminase, aspartate transaminase, creatinine, prothrombin time, activated partial thromboplastin time, and D-dimer). It is evident that the healing of the flap following the implantation of 3D-printed prostheses is particularly crucial. [29] Firstly, if the flap heals poorly or becomes infected, it can result in the prostheses not being covered. This can greatly affect the patients' limb function and may necessitate further surgery or even amputation. [30,31] Furthermore, long-term treatment can easily lead to psychological problems of patients. The discrepancy between the actual treatment situation and the expected efficacy may cause a serious psychological burden for patients and endanger their mental state. [32,33]

Within the NPWT group, all patients obtained scores below 20 score. Conversely, within the

Control group, a significant majority of patients demonstrated ASEPSIS scores surpassing 20 score. There was no statistical difference in ADLS scores, LEFS scores, and VAS scores between the two groups. Moreover, NPWT enhances blood flow around the wound, and this increased blood supply accelerates the clearance of metabolic waste generated during the cell healing process, while ensuring the provision of nutrients to promote wound healing. [34,35] Negative pressure suction also improves the degree of edema in the surrounding tissues of the wound by promoting lymphatic reflux, increases the formation rate of granulation tissue, and avoids contact between the wound and the external environment, thereby maintaining a relatively sterile wound. [36,37] Additionally, NPWT can reduce the relative displacement of the wound edge and provide a more stable wound healing environment through mechanical stability and appropriate pressure on the wound. [38] Role of NPWT in preventing bacterial migration into the wound following cardiac surgery was hypothesized by Grauhan et al [39] These advantages of ciNPWT are also helpful in a reconstructive surgeon's practice in complicated wounds after flap cover.

Conclusion

Closed incisional NPWT decreases the untoward effects of dead space following the reconstruction of complex wounds. The incidence of SSI and wound gaping can be reduced.

References

1. Shanmugam VK, Fernandez SJ, Evans KK, et al. Postoperative wound dehiscence: predictors and associations. Wound Repair Regen 2015; 23(2):184–190.
2. Orgill D, Bayer L. Update on negative-pressure wound therapy. Plast Reconstr Surg 2011;127(suppl 1S):105S–15.
3. Scalise A, Calamita R, Tartaglione C, Pierangeli M, Bolletta E, Gioacchini M, Gesuita R, Di Benedetto G. Improving wound healing and preventing surgical site complications of closed surgical incisions: a possible role of incisional negative pressure wound therapy. A systematic review of the literature. International wound journal. 2016 Dec;13(6):1260-81.
4. Johnson RG, Cohn WE, Thurer RL, McCarthy JR, Sirois CA, Weintraub RM. Cutaneous closure after cardiac operations: a controlled, randomized, prospective comparison of intradermal versus staple closures. Ann Surg 1997; 226:606–12.
5. Chambers A, Scarci M. Is skin closure with cyanoacrylate glue effective for the prevention of sternal wound infections? Interact Cardiovasc Thorac Surg 2010;10:793–6
6. Towfigh S, Cheadle WG, Lowry SF, Malangoni MA, Wilson SE. Significant reduction in incidence of wound contamination by skin flora through use of microbial sealant. Arch Surg 2008; 143:885–91.
7. Bennett-Guerrero E, Ferguson TB Jr, Lin M, Garg J, Mark DB, Scavo VA Jr, Kouchoukos N, Richardson JB Jr, Pridgen RL, Corey GR. SWIPE-1 Trial Group: effect of an implantable gentamicin-collagen sponge on sternal wound infections following cardiac surgery: a randomized trial. JAMA 2010; 304:755–62.
8. Holm C, Petersen JS, Gronboek F, Gottrup F. Effects of occlusive and conventional gauze dressing on incisional healing after abdominal operations. Eur J Surg 1998; 164:179–83.
9. Khalafi RS, Bradford DW, Wilson MG. Topical application of autologous blood products during surgical closure following a coronary artery bypass graft. Eur J Cardiothorac Surg 2008; 34:360–4.
10. Wu L, Mustoe TA. Effect of ischemia on growth factor enhancement of incisional wound healing. Surgery 1995; 117:570–6.
11. Veves A, Falanga V, Armstrong DG, Sabolinski ML. Apligraf diabetic foot ulcer study. Graftskin, a human skin equivalent, is effective in the management of non-infected neuropathic diabetic foot ulcers: a prospective randomized multicentre clinical trial. Diabetes Care 2001; 24:290–5.
12. Stannard JP, Robinson JT, Anderson ER, McGwin G Jr, Volgas DA, Alonso JE. Negative pressure wound therapy to treat hematomas and surgical incisions following high-energy trauma. J Trauma 2006; 60:1301–6.
13. Atkins BZ, Wooten MK, Kistler J, Hurley K, Hughes GC, Wolfe WG. Does negative pressure wound therapy have a role in preventing post-sternotomy wound complications? Surg Innov 2009;16: 140–6.
14. Stannard JP, Volgas DA, McGwin G III, Stewart RL, Obremskey W, Moore T, Anglen JO. Incisional negative pressure wound therapy after high risk lower extremity fractures. J Orthop Trauma 2012; 26:37–42.
15. Huang C, Leavitt T, Bayer LR, et al. Effect of negative pressure wound therapy on wound healing. Curr Probl Surg 2014; 51:301-31.
16. Scalise A, Calamita R, Tartaglione C, et al. Improving wound healing and preventing surgical site complications of closed surgical incisions: a possible role of incisional negative pressure wound therapy. A systematic review of the literature. Int Wound J 2016; 13:1260-81.
17. Shah A, Sumpio BJ, Tsay C, et al. Incisional negative pressure wound therapy augments perfusion and improves wound healing in a

Swine Model Pilot Study. Ann Plast Surg 20 19;82(4S Suppl 3):S222-7.
18. Hasselmann J, Björk J, Svensson-Björk R, Acosta S. Inguinal vascular surgical wound protection by incisional negative pressure wound therapy: a randomized controlled Trial-INVIPS Trial. Ann Surg 2020;27(1):48–53
19. Nam D, Sershon RA, Levine BR, Della Valle CJ. The use of closed incision negative-pressure wound therapy in orthopaedic surgery. J Am Acad Orthop Surg 2018;26(9): 295–302
20. Abesamis GM, Chopra S, Vickery K, Deva AK. A comparative trial of incisional negative-pressure wound therapy in abdominoplasty. Plast Reconstr Surg Glob Open 2019;7(5):e2 141
21. Matusiak D, Wichtowski M, Pieszko K, Kobylarek D, Murawa D. Is negative-pressure wound therapy beneficial in modern-day breast surgery? Contemp Oncol (Pozn) 2019;23(2):6 9–73
22. Tran BNN, Johnson AR, Shen C, Lee BT, Lee ES. Closed-incision negative-pressure therapy efficacy in abdominal wall reconstruction in high-risk patients: a meta-analysis. J Surg Res 2019;241:63–71
23. Hussamy DJ, Wortman AC, McIntire DD, Leveno KJ, Casey BM, Roberts SW. Closed incision negative pressure therapy in morbidly obese women undergoing cesarean delivery: a randomized controlled trial. Obstet Gynecol 2 019;134(4):781–789.
24. Berger P, de Bie D, Moll FL, de Borst GJ. Negative pressure wound therapy on exposed prosthetic vascular grafts in the groin. J Vasc Surg 2012;56(3):714–720.
25. Capobianco CM, Zgonis T. An overview of negative pressure wound therapy for the lower extremity. Clin Podiatr Med Surg 2009;26(4) :619–631.
26. Wilkes RP, Kilpad DV, Zhao Y, Kazala R, McNulty A. Closed incision management with negative pressure wound therapy (CIM): biomechanics. Surg Innov 2012;19(1):67–75.
27. Nishimura K, Blume P, Ohgi S, Sumpio BE. Effect of different frequencies of tensile strain on human dermal fibroblast proliferation and survival. Wound Repair Regen 2007;15(5):64 6–656.
28. Mouës CM, Vos MC, van den Bemd GJ, Stijnen T, Hovius SE. Bacterial load in relation to vacuum-assisted closure wound therapy: a prospective randomized trial. Wound Repair Regen 2004;12(1):11–17.
29. Verhelle N, Van Zele D, Liboutton L, Heymans O. How to deal with bone exposure and osteomyelitis: an overview. Acta orthopae -dica belgica. 2003 Dec 1;69(6):481-94.
30. Mathes SJ. The muscle flap for management of osteomyelitis. New England Journal of Medicine. 1982 Feb 4;306(5):294-5.
31. Ju J, Li L, Zhou R, Hou R. Combined application of latissimus dorsi myocutaneous flap and iliac bone flap in the treatment of chronic osteomyelitis of the lower extremity. Journal of Orthopaedic Surgery and Research. 2018 Dec; 13:1-9.
32. Tajsiç N, Winkel R, Hoffmann R, Husum H. Sural perforator flap for reconstructive surgery in the lower leg and the foot: a clinical study of 86 patients with post-traumatic osteomyelitis. Journal of plastic, reconstructive & aesthetic surgery. 2009 Dec 1;62(12):1701-8.
33. Egeler SA, De Jong T, Luijsterburg AJ, Mureau MA. Long-term patient-reported outcomes following free flap lower extremity reconstruction for traumatic injuries. Plastic and Reconstructive Surgery. 2018 Mar 1;141 (3):773-83.
34. Wackenfors A, Sjögren J, Gustafsson R, Algotsson L, Ingemansson R, Malmsjö M. Effects of vacuum-assisted closure therapy on inguinal wound edge microvascular blood flow. Wound repair and regeneration. 2004 Nov;12(6):600-6.
35. Atkins BZ, Tetterton JK, Petersen RP, Hurley K, Wolfe WG. Laser Doppler flowmetry assessment of peristernal perfusion after cardiac surgery: beneficial effect of negative pressure therapy. International wound journal. 2011 Feb;8(1):56-62.
36. Eisenhardt SU, Schmidt Y, Thiele JR, Iblher N, Penna V, Torio-Padron N, Stark GB, Bannasch H. Negative pressure wound therapy reduces the ischaemia/reperfusion-associated inflammatory response in free muscle flaps. Journal of plastic, reconstructive & aesthetic surgery. 2012 May 1;65(5):640-9.
37. Morykwas MJ, Argenta LC, Shelton-Brown EI, McGuirt W. Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. Annals of plastic surgery. 1997 Jun 1;38(6):553-62.
38. Wilkes RP, Kilpad DV, Zhao Y, Kazala R, McNulty A. Closed incision management with negative pressure wound therapy (CIM) biomechanics. Surgical innovation. 2012 Mar; 19(1):67-75.
39. Grauhan O, Navasardyan A, Hofmann M, Müller P, Stein J, Hetzer R. Prevention of poststernotomy wound infections in obese patients by negative pressure wound therapy. J Thorac Cardiovasc Surg 2013;145(5):1387–1392.