Original article

Experience of negative pressure wound therapy over sternal wound healing: A retrospective review

ABSTRACT

Objectives The aim of this study was to retrospectively review the effectiveness of negative pressure wound therapy (NPWT) in sternal wound healing with the use of the validated Bates-Jensen Wound Assessment Tool (BWAT), and explore the role of NPWT over sternal wounds and future treatment pathways.

Methods Data was gathered from patients' medical records and the institution's database clinical management system. Seventeen subjects, who had undergone cardiothoracic surgeries and subsequently consulted the wound care team in one year were reviewed. Fourteen of them were included in the analysis. Healing improvement of each sternal wound under continuous NPWT and continuous conventional dressings was studied. In total, 23 continuous NPWT and 13 conventional dressing episodes were analysed with the BWAT.

Results Among conventional dressing episodes, sternal wound improvement was 2.5–3% over 10 days to 3.5 weeks, whereas 4–5% sternal healing was achieved in 5 days to 2 weeks with sternal wire presence. Better healing at 11% in 1 week by conventional dressing was attained after sternal wire removal. In NPWT episodes, 8–29%, 13–24%, and 15–46% of healing was observed in 2 weeks, 3.5 to 5 weeks and 6 to 7 weeks, respectively. Only 39% wound healing was acquired at the 13th week of NPWT in one subject. With sternal wire present, 6%–29% wound healing progress was achieved by NPWT in 1–4 weeks, and 16–23% wound improvement in 2 to 4.5 weeks by NWPT after further surgical debridement. After sternal wire removal, 6–34% sternal wound healing occurred by continuous NPWT for 1–2 weeks, and maximum healing at 46% after 2.5 weeks of NPWT were observed.

Conclusions Better wound healing was achieved in the NPWT group in comparison to conventional dressings alone. However, suboptimal sternal wound healing by NPWT alone was observed. Removal of sternal wire may improve the effectiveness of NPWT. Successful tertiary closure after NPWT among subjects supports the important bridging role of NPWT in sternal wound healing. Factors causing stagnant sternal wound healing by NPWT alone are discussed.

Keywords Cardiothoracic surgery, sternal wound infection, negative pressure wound therapy.

For referencing Ho WS et al. Experience of negative pressure wound therapy over sternal wound healing: A retrospective review. WCET® Journal 2019; 39(2):9–18

DOI https://doi.org/10.33235/wcet.39.2.9-18

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INTRODUCTION

Establishment of sternotomy wounds is not uncommon among patients undergoing cardiothoracic surgeries. Even with advances in and optimal surgical techniques, as well as infection prophylaxis, the incidence of postoperative deep sternal wound infection (DSWI) has still been variously reported as 0.5–5.0% since 2001[1-7]. Occurrence of postoperative mediastinitis was lower in patients who had undergone coronary artery bypass grafting (CABG) than that of CABG with concomitant valve surgery[3,7]. Sternal dehiscence and delayed sternal wound healing, especially in the presence of DSWI following sternotomy have remained constant, problematic and worrisome complications in cardiothoracic surgeries[8,9].

Risk factors for DSWI have long been studied over the years. The increased risk of DSWI could be resultant from combined

Sterile wound 1

Sternal wound 3

Sternal wound NPWT 1

Sternal wound NPWT 3

cardiac procedures[4-9], prolonged intubation in the intensive care unit (ICU), harvest of bilateral internal thoracic artery grafting, re-operation for bleeding, obesity with body mass index (BMI) >30, diabetes, COPD, PVD and advanced age[6,8,9]. Using the left internal mammary artery, positive wound and blood cultures have been identified as significant risk factors for rewiring failure of post-sternotomy wounds[8]. Preoperative anaemia, presence of chronic viral or bacterial infection over four weeks and active infection at surgical time, previously treated infection within the past year were also predictors of DSWI[5]. The most common pathogens revealed in sternal wounds were *Staphylococcus epidermidis* (CoNS) and *Staphylococcus aureus* (MRSA)[10], in which the latter pathogen was highly associated with increased mortality in DSWI[11]. Like surgical site wound infection (SSWI), delayed and suboptimal sternal wound healing can result from the presence of DSWI.

Multiple and combined conventional wound healing techniques have been adopted in sternotomy wounds for years, for instance, primary closure with or without sternal wire, debridement, wound packing, delayed closure, reconstruction of vascularised soft tissue flaps, open daily irrigation or multiple open dressing changes, or sternal re-wiring[2,3,8,10,11]. However, historical treatments had been reported with prolonged hospitalisation and mortality rates of 40–50%[8,10]. Closed-chest techniques reviewed reportedly showed failure rates of 20–66% with 7–32% mortality rates. The use of continuous irrigation with strong negative pressure ranging between 300 mmHg and 600 mmHg also resulted in treatment failure and mortality rate sustained at 12.5–52% and 7%, respectively, with an increased average length of hospital stay of 56 days. Flap reconstruction was associated with a less than 10% mortality rate in sternal wound healing[9,12]. As a result, conventional surgical treatments still incur complications in sternal wound healing by means of destabilising the sternum, lengthening hospitalisation and developing concomitant infection, which may result in death. While another wound care modality, negative wound pressure therapy (NPWT), has recently emerged as a clinical strategy for treating post-sternotomy mediastinitis and with promising results[3], deciding the most appropriate treatment of sternal wounds, however, is still controversial.

DSWI is a devastating complication of cardiothoracic surgeries that not only impedes wound healing, but also has a mortality rate of approximately 5–47%, despite early diagnosis and treatment. Additional outcomes are prolonged hospitalisation, increased institutional costs as well as an increase in the patients' suffering[2,5,11]. In the United States, a surgical care improvement project (SCIP) was implemented to minimise SSWI and associated cost. The project designated DSWI as a preventable hospital-acquired infection in which no additional treatment reimbursement should be provided in 2008[7].

Multiple studies and reviews supported the promising results of NPWT in reducing the risk of chronic sternal infection, mortality, as well as duration of hospital stay[3,4,10,13]. Complications of wound dehiscence, infection, haematoma and seromas over high-risk surgical incisions which were reduced by NPWT were well supported by evidence[13]. Successful falling C-reactive protein (CRP) level was demonstrated in DSWI by NPWT in nine days. Bacterial counts were significantly reduced in wounds inoculated with MRSA and CoNS in four days. Instead of treating sternal wounds alone by NPWT, adoption of NPWT, followed by delayed primary closure or vascularised muscle flap, were well supported by studies with excellent clinical results[6,10,14]. One study reported 100% wound closure was achieved by NPWT at 14 months' follow-up noted in patients with sternal osteomyelitis, despite flap reconstruction involved in the treatment[14].

Introduction of NPWT is achieved by applying a controlled subatmospheric pressure to the selected wound, through an airtight system of a porous dressing (foam or gauze) and evacuation tube in the wound, covered by an adhesive drape to create an airtight seal. The pore size of dressing (if foam) is approximately 400–600 μm, which allows for equal pressure to be applied to the wound bed. By connecting the tubing to an adjustable vacuum pump with a collection canister, the wound exudate can be withdrawn from the wound and collected[2,9,11]. NPWT assists in exudate removal as well as stabilisation of the chest wall and wound isolation. Wound edge approximation and wound contracture, reduction in oedema, inflammatory modulation, tissue perfusion, angiogenesis, cell proliferation and mitotic activity of skin can be facilitated by NPWT[5,13].

Table 1: Patient characteristics

Table 1 Patient characteristics			
Characteristics		n	Percentage (%)
Age (years): average and range	62.2 [31-82]		
Male		8	57.1
Female		6	42.8
Chest wall abscess		1	7.1
Chronic ischemic / rheumatic heart disease		6	42.9
Ventricular septal defect		1	7.1
Dissecting aortic / thoracic aneurysm		2	14.3
Heart failure +/- left ventricular assistive devices (LVAD) implantation		2	14.3
Ventricular septal defect + post lung transplant		1	7.1
Ischemic heart disease + aortic aneurysm + aortic valve regurgitation		1	7.1
Deep sternal wound infection (DSWI)		10	71.4

Despite the supported advantageous features of NPWT in various wounds, studies of the effectiveness of NPWT alone over sternal wounds and any resulting improvement are limited. Instead, there is clinical evidence of the use of NPWT playing a bridging role within sternal wounds and post-sternotomy mediastinitis prior to surgical closure of these wounds[10,14-16]. With limited clinical evidence and a general lack of consensus on the optimal clinical procedural protocols for the management of sternal wounds with or without DSWI is lacking. This review retrospectively evaluated the outcome of NPWT alone over sternal wound healing and explored the role of NPWT as a future treatment pathway in sternal wound care.

MATERIALS AND METHODS

Data source

Between January and December 2016, there were 17 inpatients who experienced complications with sternal wound healing post-cardiothoracic procedures and who consulted the stoma and wound care team for assistance with wound management. In this retrospective study, data on wound management were retrieved and reviewed from the nursing notes in the patients' medical record and from the institution's clinical management system database.

Subject and sample selection

Three of the 17 inpatients who underwent cardiothoracic procedures and who consulted the wound care team, were excluded in our study. The excluded cases had either undergone NPWT initiated by surgeon with a subatmospheric pressure 10 to 20 mmHg only or consultation with the wound care team was discontinued because of bleeding and organ exposure. These cases were vastly different from other patients who persistently underwent NPWT with a subatmospheric pressure ranging between 80 and 125 mmHg. Sternal wounds among the selected cases were the result of non-closure of acute post-operative surgical wounds, delayed healing surgical dehiscence wounds, and post-incision and drainage of DSWI wounds. In view of the occurrence of re-exploration, surgical debridement or wire removal, discontinuing continuous NPWT, as well as multiple separate sternal wounds being managed by NPWT in the same patient, only those sternal wound episodes that were managed continuously by NPWT or conventional dressings were reviewed and evaluated. Therefore, included in this retrospective study were 23 wound episodes that used continuous NPWT and 13 wound episodes that used conventional dressing therapies.

Outcomes

The outcomes of interest included sternal wound improvement by continuous NPWT and conventional dressing episode. Wound improvement was further evaluated and compared between continuous corresponding wound care episodes with and without further surgical management, for instance, re-exploration, surgical debridement or wire removal.

Table 2: Cardiothoracic and subsequent procedures

Table 2 Cardiothoracic and subsequent procedures		
Procedures	n	Percentages (%)
Incision and drainage	1	7.1
Aortic / mitral Valve replacement	2	14.3
Ventricular septal repair	1	7.1
Aortocoronary / cardiopulmonary bypass	5	35.7
Aortic arch replacement + cardiopulmonary bypass	1	7.1
Valve replacement + aortocoronary and cardiopulmonary bypass	1	7.1
LVAD implantation	1	7.1
Ventricular septal repair + lung transplant	1	7.1
Ventricular septal repair + valve replacement	1	7.1
Single cardiothoracic procedure	10	71.4
Combined cardiothoracic procedures	4	28.6
Single cardiothoracic procedure developed DSWI	7	70.0
Combined cardiothoracic procedures developed DSWI	3	75.0
Sternal wound characteristics and subsequent procedures		
Bone / tendon / organ exposure, or observable bubbling	3	21.4
Wire exposed	1	7.1
Wire removal	6	42.9

Data analysis

Data was extracted from the selected patients' medical record and institution's database. Factors related to the healing progress of sternal wounds were identified and retrieved. Sternal wound healing of each continuous NPWT and conventional dressing episode was assessed and scored with the validated Bates-Jensen Wound Assessment Tool (BWAT) and results tabulated. Components of scoring in BWAT are size, depth, edges, undermining, necrotic tissue type, necrotic tissue amount, exudate type, exudate amount, skin colour surrounding wound, peripheral tissue oedema, peripheral tissue induration, granulation tissue and epithelialisation[17]. Total score before and after continuous treatment was compared and then calculated as a percentage of wound improvement. The percentage change provided the information required to determine sternal wound improvement by each continuous dressing regime. The effect of NPWT, with or without further surgical management, over sternal wound healing was also identified in this review.

RESULTS

Sample characteristics

The 14 subjects included in the study were aged between 31 and 82, with a mean age of 62.2. Six patients were female (42.8%) and 8 were male (57.1%). Of the patients, 71.4% developed a DSWI. Demographic data and clinical characteristics of patients are presented in Table 1. Various cardiothoracic procedures had preceded the occurrence of sternal wounds. Of the subjects, 71.4% underwent single cardiothoracic procedures such as skin abscess drainage, heart valve replacement, ventricular septal defect repair, aorto- or cardiopulmonary bypass, and internal device implantation. Combined procedures involved 28.6% of the cases, which involved aortic valve replacement with cardiopulmonary bypass, valve replacement with coronary artery bypass, ventricular septal defect repair with lung transplant, and ventricular septal defect repair with heart valve replacement. Seven out of 10 subjects (70%) who underwent single cardiothoracic procedures developed a DSWI, whereas three out of four (75%) subjects who underwent combined procedures developed DSWIs. Exposure of internal structures such as sternal bone or tendon, with or without bubbling occurred in 21.4% of the cases. Overall, the cases of wire exposure and wire removal were 7.1% and 42.9% respectively. Details of cardiothoracic procedures undertaken are presented in Table 2.

In this review, a total of 23 NPWT episodes and 13 conventional dressing episodes over sternal wounds were retrospectively

Table 3: Dressing methods

Table 3 Dressing methods					
Dressing strategies for each sternal wound					
Continuous NPWT (n=23)					
Sub atmospheric pressure	n	Percentages (%)	Duration	n	Percentages (%)
-80 to -110mmHg	1	4.3	1 week	2	8.7
-100mmHg	6	26.1	1.5 weeks	1	4.3
-100 to -120mmHg	2	8.7	2 weeks	8	34.8
-100 to -125mmHg	1	4.3	2.5 weeks	3	13.0
-110mmHg	2	8.7	3 weeks	2	8.7
-120mmHg	6	26.1	4 weeks	2	8.7
-125mmHg	5	21.7	4.5 weeks	1	4.3
			6.5 weeks	1	4.3
			7 weeks	2	8.7
			13 weeks	1	4.3
Continuous conventional dressing (n=13)					
Duration				n	Percentages (%)
2 days				4	23.1
3 days				1	7.7
4 days				1	7.7
5 days				1	7.7
1 week				2	15.4
10 days				3	23.1
2 weeks				1	7.7
3.5 weeks				1	7.7

reviewed (Table 3). NPWT was adopted at subatmospheric pressure of 80 to 125 mmHg. The treatment period of an episode of continuous NPWT ranged from 1 to 13 weeks. Within the NPWT group, the wound dressing was performed every 2 to 3 days by the wound care team. The treatment period for continuous conventional dressings ranged from 2 days to 3.5 weeks. Daily dressings were performed in the conventional dressing group.

Sternal wound healing

In this review, healing improvement of each sternal wound was evaluated at the end of each continuous episode of wound care. Additional wound care improvement was identified at the mid-point of the treatment period if the continuous episode of treatment was more than 2 weeks.

Conventional dressing

In the continuous conventional dressing care group, no sternal wound healing was achieved in 2 days to 1 week. Approximately 2.5–3% of sternal wound healing was achieved in 10 days to 3.5 weeks. With the presence of sternal wire, 4–5% of sternal wound healing was noted in 5 days to 2 weeks. No significant impaired healing was noted with the presence of sternal wires by conventional dressing regimes. However, better healing occurred in 11% of sternal wounds after removal of the sternal wire and application of conventional dressings for 1 week. In two different subjects, no significant wound improvement or signs of healing occurred in 2 days of conventional dressing after surgical debridement or wire removal respectively. There was an unsatisfactory healing effect over sternal wounds as the result of using conventional

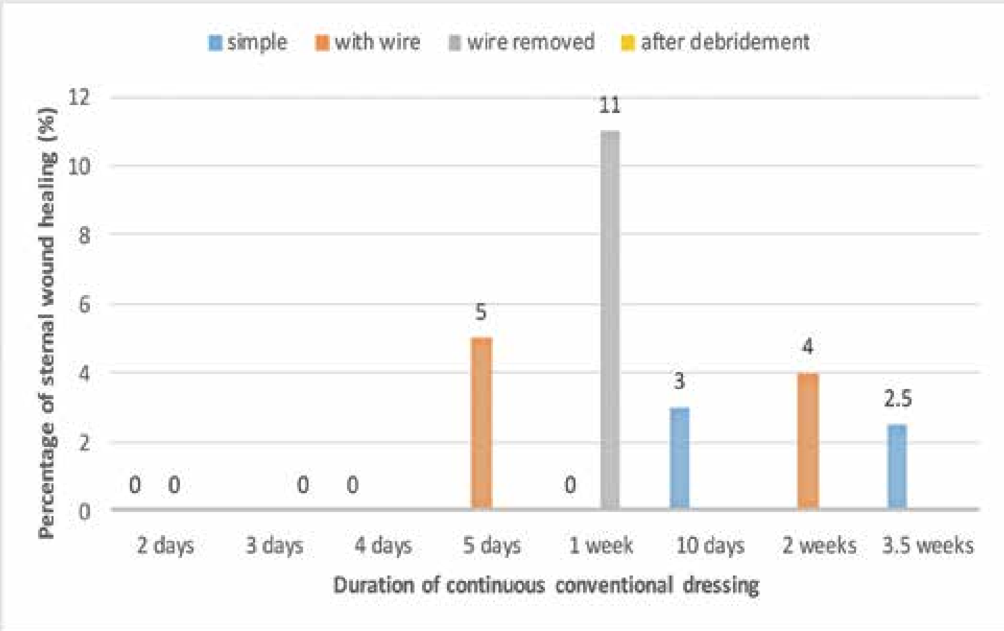

Figure 1: Sternal wound healing by conventional dressing in simple sternal wounds, sternal wounds with wire and wire removal, and after debridement.

dressings. Healing of sternal wound by continuous conventional dressing is summarised in Figure 1.

Negative pressure wound therapy

Among the continuous NPWT episodes, sternal wound healing was achieved in 8–29% of wounds in 2 weeks. With continuous NPWT for 3.5–5 weeks, an average of 13–24% wound healing was achieved. One wound achieved 50% healing within 3 weeks. In longer continuous NPWT periods of 6–7 weeks, only 15–46% of sternal wound healing was attained. A subject demonstrated 39% sternal wound healing after 13 weeks of continuous NPWT. Suboptimal wound healing of sternal wounds by continuous NPWT alone was illustrated in Figure 2.

In the presence of sternal wire, wound improvement of 6–24% was identified in 1–2 weeks of continuous NPWT. A maximum of 29% of sternal wound healing was achieved after 4 weeks' continuous NPWT (Figure 3).

After removal of sternal wires, sternal wound healing by NPWT was slightly improved. Six to 18% of sternal wound healing was observed in 1–1.5 weeks. After 2 weeks of NPWT, an average of 14–34% of sternal wound healing was reached. Zero to 46% sternal wound healing was noted with 2.5 weeks of NPWT. However, an exceptional wound deterioration results of 19.4% wound healing by 2–3 weeks of continuous of NPWT was identified (Figure 4).

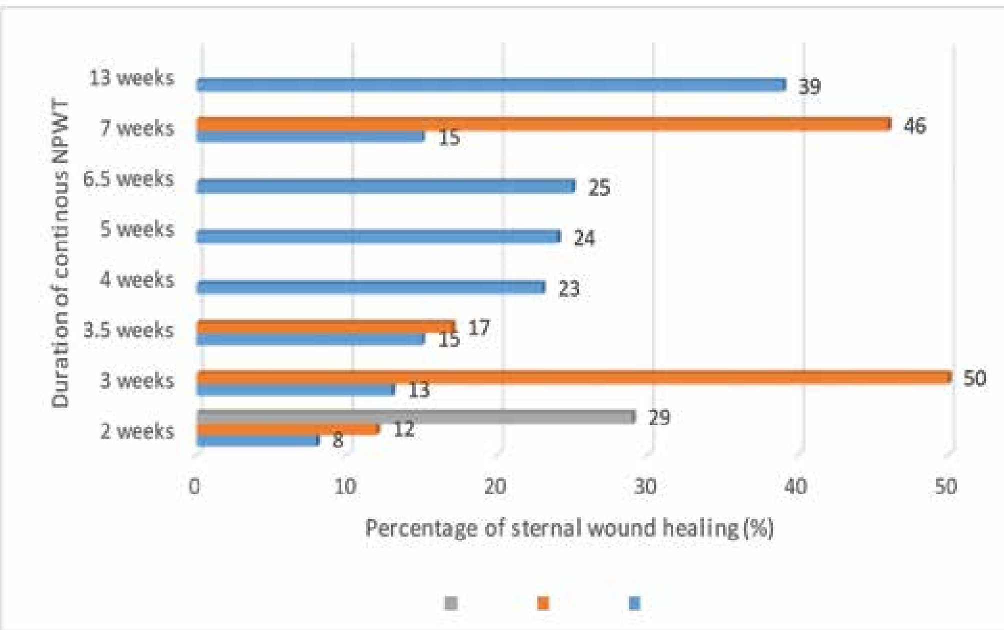

Figure 2: Sternal wound healing by NPWT in simple sternal wounds. Different bars at the same duration represents healing of different sternal wounds under the same continuous NPWT duration.

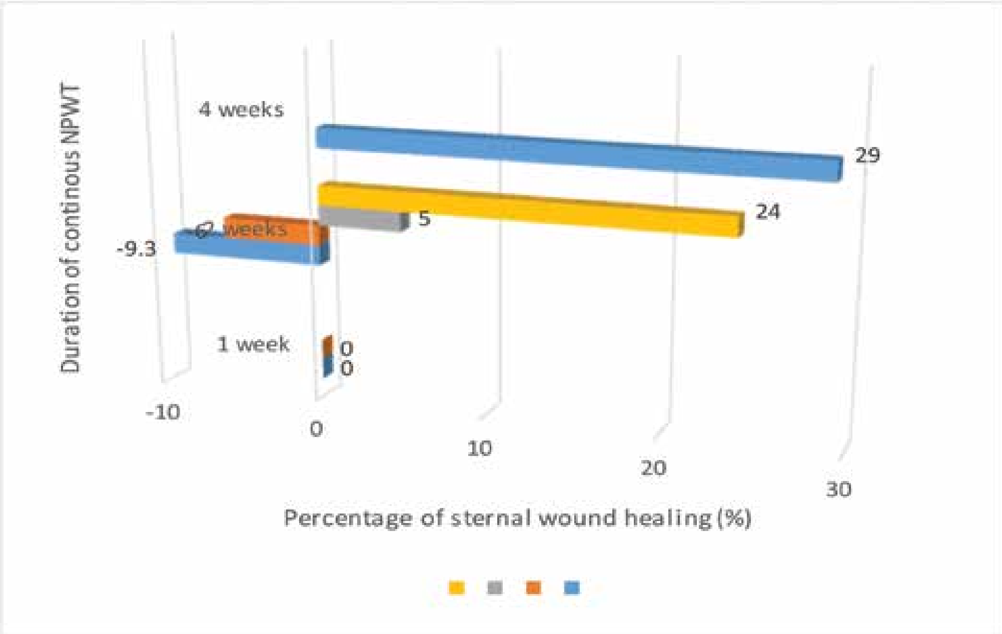

Figure 3: Sternal wound healing by NPWT in sternal wounds with the presence of wire. Different bars at the same duration represent healing of different sternal wounds under the same continuous NPWT duration.

No significant improvements in sternal wound healing were identified after surgical debridement in 3 cases, where sternal wound healing ranged from 16 to 23% with 2 weeks of NPWT, and up to 26% of sternal wound healing by 4.5 weeks of NPWT (Figure 5).

On the whole, suboptimal sternal wound healing was attained by continuous NPWT in this review. The presence of sternal wire could delay sternal healing by continuous NPWT, whereas the removal of sternal wire could improve the NPWT effect over sternal wound healing.

Wound deterioration could also occur, despite NPWT and surgical debridement procedures taking place.

Discontinuation of NPWT

In addition to the interruptions of continuous episodes of NWPT by surgical debridement or wire-removal procedures, NPWT was discontinued for multiple other reasons at the end of wound care management (Table 4). Successful flap reconstruction for sternal wound defect (27.3%) and ideal wound progress suitable for the use of conventional dressing (36.4%) were major reasons of NWPT discontinuation. The surgeon's medical decisions and prescription of therapy (18.2%) and discharge home (18.2%) were other causes for discontinuing NPWT. One subject was still under continuous NPWT sternal wound care at the end of this retrospective review. Apart from wound improvement by NPWT alone, flap

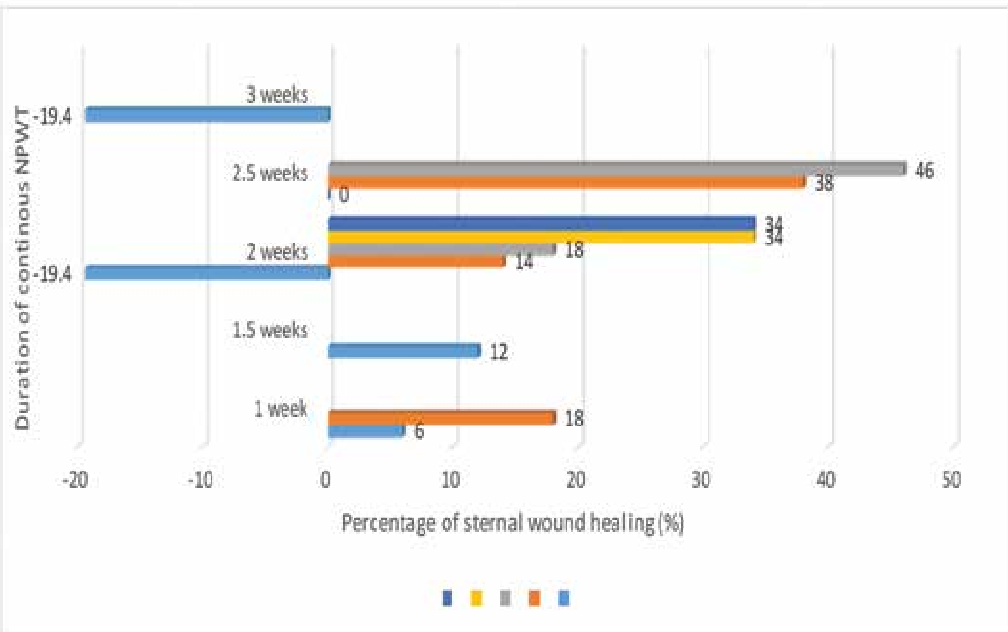

Figure 4: Sternal wound healing by NPWT in sternal wounds with wire removed. Different bars at the same duration represent healing of different sternal wounds under the same continuous NPWT duration.

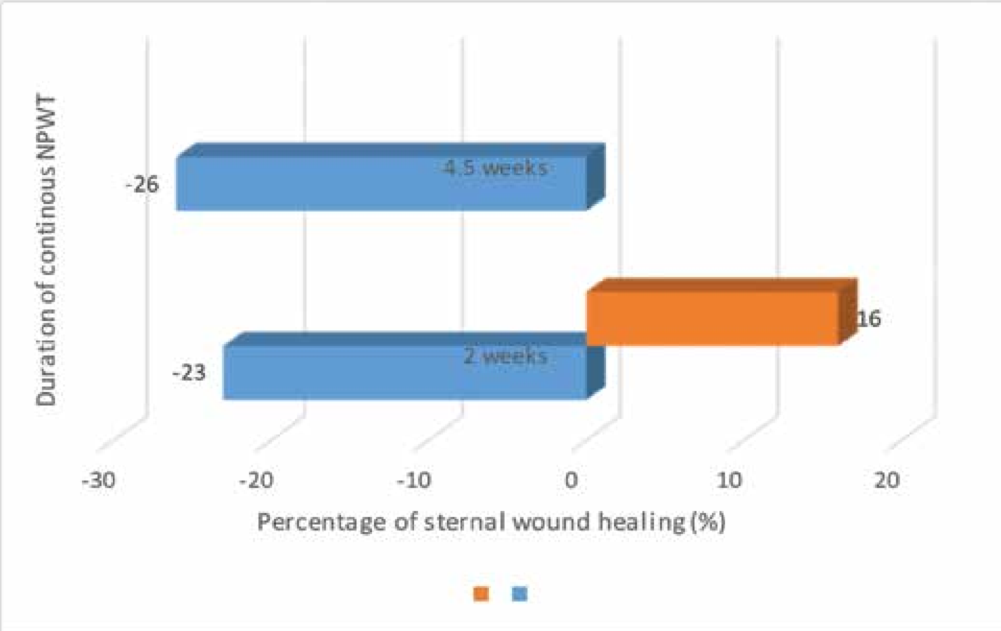

Figure 5: Sternal wound healing by NPWT in sternal wounds after surgical debridement. Different bars at the same duration represents healing of different sternal wounds under the same continuous NPWT duration.

reconstruction after NPWT played a pivotal position in sternal wound healing.

DISCUSSION

As per the literature, post-operative DSWI was comparatively more prevalent in patients who had undergone combined cardiothoracic procedures[4,7]. In this review, no significant difference in DSWI incidence rate was observed between patients who underwent combined cardiothoracic procedure (75%) and those undergone single cardiothoracic procedures (70%). However, as DSWI developed in most of the selected subjects (71.4%) it illustrates its apparent incidence cannot be neglected.

In this review, our findings correlated to previous literature in which conventional dressing did not show significant positive effects on sternal wound healing. Simple sternal gap wounds, or with wire present showed similar unsatisfactory healing outcome under conventional wound care. In this review, only slightly better sternal healing outcomes occurred with the use of conventional wound care after wire removal and surgical debridement. The overall effect of sternal wound healing by

Table 4: Reasons of discontinuing NPWT

Table 4 Reasons of discontinuing NPWT

Reasons	n	Percentage (%)
Wound improvement	4	36.4
Flap reconstruction	3	27.3
Surgeon's decision	2	18.2
Discharge home	2	18.2
Remarks: NPWT was still in progress in 1 subject by the end of this review		

conventional dressing is limited according to the previous literature and our findings.

The application of NPWT has become an evolving wound care modality for the management of sternal wounds in recent years[10,11,14,15]. In this review, and in comparison with conventional wound care, better sternal wound healing outcomes were achieved with the use of NPWT. Nevertheless, the healing achieved by NPWT was suboptimal in sternal wounds. In this review, less than 30% of sternal wound healing was attained by 5 weeks' continuous use of NPWT, and less than 50% of healing was observed in 6–7 weeks' continuous NPWT. With continuous NPWT, deterioration of sternal wound healing still took place in some subjects. NPWT after surgical debridement did not facilitate better healing outcome in some sternal wounds. After sternal wire removal, improved sternal wound healing by continuous NPWT was found to occur in this review.

With prolonged NPWT, instead of complete wound healing stasis of wound healing was common among subjects. Further, the progress of sternal wound healing was slow in the NPWT group.

An analysis of the findings showed that flap reconstruction played an important role as a method of tertiary closure of sternal wounds after the application of NPWT. Despite suboptimal sternal wound healing by NPWT alone, this review supports the bridging role of NPWT in tertiary closure and healing of sternal wounds.

Previously, NPWT has been reported as a safe and reliable wound care option in the presence of DSWI, resulting in higher survival rates and lower failure rates in comparison to conventional dressings. In DSWI, prevention measures should be focused on optimising modifiable clinical factors[3]. Diabetic control, operation time, perioperative thermoregulation and antibiotics coverage are some of the mentioned modifiable clinical factors that can be moderated for minimising DSWI[7]. Bilateral internal thoracic artery grafting, the need for transfusion, emergency operations, previous episodes of stenting and postoperative inotrope usage also predicted higher risk of DSWI after sternotomy[8]. The presence of infection is known to inhibit wound healing. Adopting NPWT can provide benefits in treating DSWI, as well as DSWI-related mortality indirectly, by stabilising the thoracic cage, decreasing bacterial colonisation and wound oedema, promoting microvascular blood flow and granulation tissue formation and minimising exposure to infection[11]. Therefore, despite suboptimal sternal wound healing observed in our review, NPWT still plays an important role in facilitating sternal wound healing progress.

Multiple possible causative factors of suboptimal sternal wound healing have been discussed in the literature. Unsuccessful rewiring has been identified as having a positive relationship with positive wound cultures, positive blood cultures, devascularisation of chest wall after harvesting of left internal mammary artery and bacterial resistance[6,8]. Either local or systemic infection also led to unfavourable sternal wound healing results, even with debridement and rewiring. The likelihood for successful re-closure of infected sternal wounds was 3.3 times higher when three consecutive negative wound culture results were obtained[8]. Prolonged NPWT can stimulate recurrent infection should there be a significant shift of bacterial species. Patient-related factors such as haemodynamic condition and sternal viability, and local environmental factors such as the provision of materials and expertise, also affect NPWT's impact on sternal wound healing[4]. Other factors causing suboptimal sternal wound healing and edge approximation are relatively thin skin with moderate dermal layers covering the chest[18], the forces exerted by the bilateral pectoralis major muscle connecting the sternum[19], persistent respiratory chest wall expansion, presence of foreign bodies such as sternal wires and exposed internal structures in the sternal wound.

In relation to the findings within this retrospective review and possible factors affecting sternal wound healing and suboptimal sternal healing by NPWT alone, it is believed that NPWT benefits sternal wound healing through its bridging role. NPWT helps in pre-conditioning and preservation of the sternum for further surgical debridement and wound healing[9]. This is further supported by a report of delayed sternal plating or bilateral pectoralis major flap reconstruction after NPWT was a safe choice for and resulted in successful reconstruction of sternal wounds with DSWI or sternal dehiscence[20]. Optimal duration of NPWT before reconstruction or further surgical repair promotes growth of granulating tissue, decreases in bacterial load as well as a fall in CRP levels. The use of NPWT still has possible side effects in wound care, such as organ or internal structural damage and bleeding, which also limits the adoption or continuation of NPWT. Careful protection of internal structures such as the heart and vessels by paraffin gauze or wound contact layers is important if NPWT is used[11].

In this retrospective review, successful tertiary closure after NPWT among subjects requiring sternotomy aligns with the consensus of opinion within the literature that NPWT plays an important bridging role in the management of open sternal wounds.

The lack of disclosure of study variable and controls such as the degree of DSWI and simple sternal dehiscence, small sample sizes and retrospective nature of this study has limited our analysis of NPWT effect on sternal wound healing in a definitive way. Studies focusing directly on the effect of NPWT over sternal wound healing only are limited. There is still a need for further studies on the direct effect of NPWT over sternal wound, in larger scale, larger sample size and with better case controls, to yield potentially promising knowledge and significant results. The NPWT effect on infection control, CRP level, and complete wound healing time after NPWT followed by reconstruction among sternal wounds is worthy of future studies. Exploring optimal timing of switching from NPWT to reconstruction or repair of sternal wounds would also benefit sternal wound care in future.

CONCLUSION AND FUTURE PERSPECTIVES

Sternal wound healing is still a challenge for patients who have undergone cardiothoracic surgeries, irrespective of whether there was post-sternotomy mediastinitis, post-operative dehiscence or an open surgical wound. NPWT has been adopted successfully with more advantages than conventional dressings in the management of sternal wounds within the last decade. This retrospective review identified NPWT alone can lead to stagnation in wound healing on sternal wounds. However, as a bridging process to prepare sternal wounds for further flap reconstruction or other tertiary closure methods, NPWT did demonstrate promising functional results in sternal wound healing. Adopting NPWT as a bridge for pre-conditioning sternal wounds, followed by tertiary closure, could become a primary approach for sternal wound care. This viewpoint is supported by prior literature and the current retrospective review. Nevertheless, as previously stated, large-scale studies targeting the direct effect of NPWT over sternal wound healing are still lacking. Optimal timing for discontinuing NPWT and switching to reconstructive surgery should be further studied and explored. For instance, the amount of healthy granulation tissue, normalised CRP or white cell count level after NPWT. In the future, more research and informed understanding are required for developing an evidence-based guideline and clinical pathways on optimal sternal wound care.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

The authors received no funding for this study.

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