RESEARCH ARTICLE

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Use of Negative Pressure Wound Therapy as the only tool of treatment for mediastinitis post cardiac surgery not as abridge

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ABSTRACT **Background:** After heart surgery, mediastinitis is a serious complication that has an incidence rate of between 0.25 and 5 percent. **Aim**: to evaluate the length of hospital stay, the mortality rate, and the rate of sternal re-infection in patients treated with negative pressure wound therapy (NPWT) versus conventional therapy for post-sternotomy mediastinitis. **Methods:** We examined 78 patients who had post-sternotomy mediastinitis following heart surgery in the past. NPWT was used to treat 40 patients in a group, whereas conventional therapy was used to treat 38 patients. **Results:** Regarding primary cardiac surgery (mostly coronary artery bypass grafting) and preoperative data (EuroScore), there were no significant differences between the two groups. When compared to standard treatment, NPWT therapy was observed to lower the death rate ($P = 0.005$) and the sternal re-infection rate ($P = 0.008$). **Conclusions:** When compared to traditional treatment, NPWT for post-sternotomy mediastinitis shows promising clinical outcomes, including a decrease in the mortality and sternal re-infection rates. The first-line treatment for deep sternal wound infections is NPWT, according to these findings.

KEYWORDS post-sternotomy mediastinitis, negative pressure wound therapy, sternal re-infection, mortality rate, hospital stay duration

1. INTRODUCTION

Deep sternal wound infection (DSWI), sometimes referred to as mediastinitis, is a potentially lethal side effect that occurs 1–5% of the time after median sternotomy. Patients with DSWI have an associated death rate that varies between 10 and 47% which is twice as high as the rate for patients without mediastinitis [1].

Gram-positive and gram-negative bacteria as well as fungi are the microbiological causes of infections in the sternum. Staphylococcal species are still among the most frequent culprits. One of the important pathogens in postoperative infections after heart surgery has been identified as coagulase negative staphylococci (CONS) [2].

DSWI is diagnosed in a clinical manner. DSWI is suggested by leukocytosis, fever, and dehiscence of the sternal wound. A positive sternal click upon examination may indicate sternal nonunion. Computed tomography (CT) of the chest is the primary imaging support that helps determine the depth of dehiscence [1].

There are two different ways that sternal wound infections arise. Either sternal instability and subsequent skin collapse follow ostemyelitis in a localized area of the bone with little to no outward symptoms. According to other theories, infection starts with sternal instability, which is followed by skin deterioration and external bacterial contamination [3].

The most effective method for accelerating wound healing is still up for debate. Post-sternotomy mediastinitis can be surgically treated in a variety of ways. These consist of primary closure, negative pressure wound therapy (NPWT), revision using open dressings, and reconstruction using vascularized soft tissue flaps (such as those from the pectoral muscle or omentum) [4].

For post-sternotomy mediastinitis, established traditional therapies include surgical debridement, drainage, irrigation, greater omentum transposition, and repair using a muscle flap, such as the pectoral muscle. These conventional therapeutic approaches reduce the death rate after mediastinitis [5].

A new treatment option for post-sternotomy mediastinitis is negative pressure wound therapy (NPWT). The idea is to apply controlled suction to a sealed, airtight wound in order to create negative pressure. As a result of the constant vacuum, superfluous fluid and debris are drained, wound oedema is eliminated, the number of bacteria is decreased, granulation tissue production is improved, and sternal stability is increased [6].

Based on available bone stock and sternum stability viability, the authors classified post-sternotomy mediastinitis. The sternum of Types 1 and 2 is quite stable, but the sternum of Types 3 and 4 is unstable. For Type 1 (extremely stable sternum and little bone loss), NPWT is advised. Two meta-analyses and two systematic reviews (Class I, Level B) provide strong support for the application of NPWT therapy [7].

2. MATERIAL AND METHODS

This study is a retrospective analysis of 74 individuals who had surgery at Zagazig University Hospitals between 2016 and 2021 for post-sternotomy mediastinitis. Up until 2006, patients with post-sternotomy mediastinitis were treated with conventional treatment. This includes the removal of the sternal wire, drainage and irrigation (for three to four weeks following surgery), transposition of the bigger omentum, and surgical debridement. (if feasible), and sternum stabilization. After surgical debridement, removal of all sternal wires, and irrigation, we have been using NPWT for patients with severe sternal wound infections since 2006. Multiple layers of paraffin gauze shield the right ventricle's surface. The first layer of polyurethane foam is placed between the sternal borders, and then a second layer is fitted over it and secured to the surrounding skin. A transparent adhesive drape is used to close the wound, and the evacuation tube is connected to a constant vacuum source (125 mmHg). Every two to four days, the wound filler is changed in the operating room, and any required re-debridement and re-irrigation are also performed. Every time, mediastinal swabs are collected for microbiological examination. When leucocytes and C-reactive protein levels drop and there are no further signs of a microbial infection, NPWT is terminated.

2.1 Statistical analysis

Laboratory tests, outcome assessments, basic clinical examinations, and data collected over time are all coded, entered, and analyzed using Microsoft Excel software. The Statistical Package for the Social Sciences (SPSS version 20.0) software was then used to analyze the data. Depending on the type of data, the following tests were run to see if the differences were significant: quantitative data is represented by mean ± SD, whereas qualitative data is represented by numbers and percentages. Chi square Test ($\chi 2$), fisher test was utilized to investigate the relationship and comparison of two qualitative variables. t-Test and Mann Whitney (MW) were employed to compare quantitative variables with normal and non-normal distributions in two groups (for parametric data and non-parametric vs.). A P-value of < 0.05 was regarded as statistically significant, and a two-tailed test result of <0.001 was deemed highly significant.

3. RESULT

There was no statistically significant difference between NPWT groupand conventional groupas regardsome demographic data (p>0.05) (Table 1). The NPWT group and the conventional group did not differ statistically significantly in terms of Euro Score, risk factors, or surgical type. (p>0.05) (Table 2). The NPPWT group and the traditional group did not differ statistically significantly in terms of detection time, type, or culture. (p>0.05) (Table 3).

TABLE 1. Demographic data among the studied groups

Variable	NPWTgroup (N=38)		Conventional group (N=40)		t-test	P-value
Age (years):						
· Mean ± SD	60.7± 5.2		58.5± 6.6		1.7	0.101
· Range	52-70		45-70			
Variable	N	%	N	%	χ^2	P-value
Sex:						
· Male	16	42.1	22	55	1.3	0.269
· Female	22	57.9	18	45		

Data is displayed as mean ± standard deviation or as a number (percentage). Mann Whitney (MW) and chi-square (χ^2) tests were employed. At p<0.05, bolded values indicate statistical significance.

TABLE 2. Risk factors and Euro Scoreamong the studied groups

Variable	NPWT group (N=38)		Conventional group (N=40)		t-test	P-value
Euro Score:						
· Mean ± SD	2.3± 1.5		1.9± 1.6		1.04	0.301
· Median	2.1		1.4		(MW)	
· Range	1.09-7.6		0.09-7.9			
Variable	N	%	N	%	χ^2	P-value
Risk factors:						
· Obese	24	63.2	24	60	Fisher	0.819
· Diabetes	36	94.7	34	85		0.264
· CKD	6	15.8	2	5		0.149
· COPD	4	10.5	6	15		0.738
· ESRD	0	0	2	5		0.494
Type of surgery:						
· CABG+ MVR	2	5.3	0	0	8.1	0.091
· CABG+ AVR	2	5.3	0	0		
· CABG	32	84.2	34	85		
· Pericardiectomy	2	5.3	2	5		
· MVR	0	0	4	10		

TABLE 3. Data among the studied groups

Variable	NPWT group (N=38)		Conventional group (N=40)		t-test	P-value
Time of detection (days):						
· Mean ± SD	11.8± 4.5		13.7± 7.4		-1.4	0.181
· Median	12		12		(MW)	
· Range	20-Jul		30-Jul			
Variable	N	%	N	%	χ^2	P-value
Type:						
· II	2	5.3	2	5	1.5	0.469
· III	24	63.2	20	50		
· IV	12	31.6	18	45		
Culture:						
· Negative	12	31.6	14	35	2.6	0.644
· MSRA	12	31.6	12	30		
· Candida albican	2	5.3	0	0		
· ECOLI	4	10.5	6	15		
· pseudomonas	8	21.1	8	20		

There was a very statistically significant difference (p<0.001) between the NPWT and conventional groups in relation to the time of intervention. The NPWT and conventional groups did not differ statistically significantly in terms of concurrent surgery. (p>0.05) (Table 4). The NPPWT group and the conventional group differed significantly (p<0.001) in terms of healing duration, re-infection, ICU stay, and mortality. There was a statistically significant difference in fate ($p<0.05$) between the NPWT and conventional groups, with the NPWT group performing better (Table 5). Ten (25%) of the cases were transferred to NPWT. Of these, two cases (20%) did not recover and died from septic shock (Table 6).

TABLE 4. Operative data among the studied groups

	NPWT group		Conventional group			
Variable	(N=38)		(N=40)		t-test	P-value
Time of intervention (days of detection):						
· Mean ± SD	1± 0		6.3± 3.1		-10.04	0.000*
· Median	1		7		(MW)	(HS)
· Range	1-Jan		17-Jan			
Variable	N	%	N	%	χ^2	P-value
Concomitant surgery:						
· No	38	100	36	90	4	0.135
· OMENTAL FLAP	0	0	2	5		
· RECTUS M FLAP	0	0	2	5		

TABLE 5. Outcome dataamong the studied groups

	NPWT group		Conventional group			
Variable	(N=38)		(N=40)		t-test	P-value
Duration of healing(days):						
· Mean ± SD	36.5± 17.2		20.2± 20.5		3.8	0.000*
· Median	37		16		(MW)	(HS)
· Range	0-65		0-60			
Hospital stay(days):						
· Mean ± SD	26.6± 11.3		31.4± 16.7		-1.5	0.146
· Median	24		29		(MW)	
· Range	Jul-60		14-70			
ICU stay(days):						
· Mean ± SD	2.9± 5.2		8.2± 6.6		-3.5	0.000*
· Median	0		7		(MW)	(HS)
· Range	0-20		0-20			
Variable	N	%	N	%	χ^2	P-value
Fate:						
· Healed	34	89.5	12	30	29.6	0.009*
· Not healed	4	10.5	28	70		(S)
Re-infection:						
· No	32	84.2	14	35	63.8	
· Recurrent	4	10.5	22	55		0.000*
· STERNOTOM SINUS	2	5.3	4	10		(HS)
Mortality:						
· No	34	89.5	28	70	16.5	0.000*
· Yes due to septic shock	4	10.5	12	30		(HS)

TABLE 6. Outcome of cases Shifted to NPWT

Variable	N= (10)	%
Number of cases	10	25
Healing:		
· Not- healed	2	20
· Healed	8	80
Mortality:		
· No	8	80
· Yes (due to septic shock)	2	20

4. DISCUSSION

A more recent form of treatment that helps stabilize the sternum and encourage wound granulation is negative-pressure wound therapy, which was first used in the late 1990s. Abu Omara and associates [4]. Three patients with a severe sternal infection were the first to successfully receive NPWT, according to Obdeijn et al. [8] in 1999. Since then, a large number of studies have been released that offer more convincing empirical support for the application of NPWT in the management of mediastinitis.

According to Kimberly et al. [1], For patients who are too seriously ill to bear the stress of reconstructive surgery and operational debridement, NPW therapy may be the only available option. According to several investigations to far, VAC has demonstrated excellent efficacy in treating sternal wound infections. Tang et al. reported full sternal wound healing by VAC [9]. In our study, ten patients (25%) from the convetional group experienced recurrent mediastinitis and failed to heal. These patients were moved to the NPWT group and received vacuum therapy until eight of them (80%) recovered completely, with just two cases passing away from septic shock.

Risk factors include critical preoperative condition, CABG (especially with one or both ITA), diabetes mellitus, obesity, and other preoperative comorbidities, according to Gardlunda et al. [10]. In reference to Petzina et al. [5] With the exception of obesity, preoperative statistics for the NPWT group and the conventional group were comparable. The group that received standard treatment had a significant percentage of obese patients. The majority of patients in both groups underwent CABG or CABG plus valve operations as their initial surgical procedure. Regarding Euro Score, risk factors, surgical type, Considering demographic factors including age and sex, our study's NPWT group and the conventional group did not significantly differ from one another. According to Gardlunda et al. [10] about half of postoperative mediastinitis cases were caused by coagulase negative Staphylococcus, making it the most prevalent infection. MRSA and pseudomonas were the most prevalent infections in both groups in our investigation.

According to our study, 40 patients were able to have a primary closure, whereas 4 patients (10%) required plastic reconstructive surgery since the sternal bone could not be salvaged (2 omental transposition and 2 pectoral flap). In the traditional group, we began regular dressings for a few days (6.3 ± 3.1 days) before primary closure, whereas in the NPWT group, we began therapy with vacuum as soon as mediastinitis was discovered.

There were differences in the median amount of time it took for the groups to recover (36 days for the NPWT group and 16 days for the conventional group), but not in the median length of hospital stay (24 days for the NPWT group and 29 days for the CONVENTIONAL group). As stated by Domkowski et al. [11], The NPWT group's length of hospital stay after the operation for mediastinitis was generally less than that of the conventional therapy group (NPWT group 42 days _ 15.4 versus 51 days _ 26.7), and mediastinal infection was discovered between 8 and 34 days after the original cardiac procedure. The duration of hospitalization for mediastinitis was 27/12 days.

According to FLEK, the recurrence rates for the pre-NPWT and NPWT groups were 34 and 85%, respectively. with reference to Petzina et al. [5] Only two patients in the NPWT group had re-infection of the sternal wound, compared to nine in the traditional group. The high rate of recurrences in our study, which included 22 patients (55%) and 4 instances with sternotomy sinus (10%) in the conventional group, was partially caused by the presence of MRSA in the culture medium. On the other hand, the NPWT group had a recurrence rate of 2 instances (5.3%) and 4 cases (10.5%) with sternotomy sinus.

As stated by Petzina et al. [5], After receiving treatment for poststernotomy mediastinitis, the NPWT group's in-hospital mortality rate was considerably lower than that of the conventional group (NPWT group 5.8% and conventional therapy group 24.5%); Kirsh et al. [12] demonstrated that a mortality rate of roughly 35% was observed in cases of mediastinitis following cardiac surgery. According to Domkowski et al. [11] there were four deaths (3.7%). Multisystemic organ failure was identified as the cause of death for two of these patients who had vascular flap surgeries (one pectoral flap and one omental transposition). Due in part to delayed referrals to our facility, the other two died of overwhelming sepsis after receiving just wound vacuum care following debridement. The conventional group in our study had a mortality rate of 12 cases (30%), whereas the NPWT group had a mortality rate of 4 instances (10.5%). Two of these cases were transferred from the conventional group to the NPWT group when the healing process failed. Septic shock-induced multi-organ failure is the primary cause of death.

According to Malmsjö et al. [13] and our study, one of the major benefits of the VAC system is that it stabilizes the splinted sternum, allowing the patient to be mobilized while the VAC is in place. This effectively reduces the hazards of immobilization, including thrombosis, pneumonia, and muscle atrophy. However, according to our research, the primary drawback of NPWT is its unflattering appearance as a result of secondary intention scarring.

5. RECOMMENDATION

Our strict policy of early recognition and aggressive treatment with opening the entire wound allowed us to improve our previous recurrence rate in NPWT of sternal wounds, unlike other wounds that require consideration of the potential effects on the heart, bypass grafts, thoracic stability, and respiratory function. The best way to prevent problems with the use of the VAC system in clinical practice is to ensure that everyone involved in treating sternal wound infections receives the proper training. Fortunately, by following this approach, we have not yet experienced any serious adverse events connected to NPWT; however, we are particularly aware that right ventricular rupture may happen during NPWT.

6. CONCLUSION

With the introduction of NPWT in recent years, the treatment of sternal wound infections has greatly improved. Specifically, the high recurrence rates can be decreased, and NPWT aids in the preservation of the sternal bone. However, especially in a large volume facility like ours, strict guidelines for treating patients with wound infections must be set and followed in order to provide the best outcome with high survival and a low probability of therapeutic failure.

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