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Vacuum Assisted Closure Versus Conventional Surgical Techniques in Treatment of Post-Sternotomy Mediastinitis

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ABSTRACT

Background: In cardiac surgery patients, post-sternotomy mediastinitis, also known as deep sternal wound infection (DSWI), is a major cause of postoperative morbidity and mortality. Negative pressure wound therapy (NPWT), also known as vacuum assisted closure (VAC) dressing, is one therapeutic alternative that offers the following advantages: regulation of fluid drainage, reduction of local edema, and bacterial load reduction, and early development of granulation tissue by angiogenic stimulation. By acting topically with a low complication rate, offering greater comfort to the medical team and patient, and reducing hospitalization time, antibiotic usage, and dressing changes, this therapy has become an important and efficient method for fighting infection in complex wounds.

Objective: To evaluate the effectiveness and clinical outcome of vacuum‑assisted closure (VAC) therapy in the treatment of post-sternotomy mediastinitis in comparison with conventional treatment.

Patients and methods: This study was conducted in National Heart Institute (NHI), Egypt. Patients were hospitalized from March 2019 to March 2020. It included patients with post-sternotomy mediastinitis treated with conventional therapy and VAC divided in two groups each group contained 30 patients.

Results: The duration of VAC therapy was 7.42±2.23 days. Mean hospital stay after VAC therapy was 12.18±1.92 days. Twenty-two (92%) patients were treated successfully. At the end of VAC therapy, the mean reduction in wound size was 31.7%. The mean granulation tissue formation was 59%.

Conclusion: VAC is a safe, reliable, and relatively new option for the treatment of DSWI after cardiac surgery. VAC is an alternative to conventional treatment in wound healing strategy in post-sternotomy mediastinitis.

Keywords: Conventional treatment, DWSI, Post-sternotomy mediastinitis, Conventional treatment, VAC.

INTRODUCTION

Post-sternotomy mediastinitis (PSM) also called Deep Sternal Wound Infection (DSWI) is a rare but potentially fatal complication of cardiac surgery done through median sternotomy. Direct wound contamination, contiguous extension from adjacent structures, descending head and neck necrotizing infections, or blood-borne routes may all cause surgical site infections (SSI)[(1)]. The prevalence of mediastinitis in the analyzed studies is between 0.4 and 4.0%[(2)]. Pre-surgical, surgical, and post-surgical risk factors are all linked to mediastinitis[(3)]. Pre-surgical variables include older age, male gender, malnutrition, obesity, smoking, diabetes mellitus (DM) and other diseases[(3, 4)], as well as chronic renal failure (CRF)[(5)]. Postoperative risk factors include prolonged hospital stay and length of stay in Intensive Care Units (ICU), bleeding, respiratory, nephrological and gastrointestinal complications, and the need for surgical reintervention, as well as tracheostomy and sternal instability [(3, 6)]. Several risk factors have been linked to the development of mediastinitis, but they differ between institutions, highlighting the need for research in various hospitals. It is also important to confirm the bacteriological diagnosis, which is usually confirmed by the presence of Staphylococcus aureus or Staphylococcus epidermidis, which accounts for 70% to 80% of cases [(7)].

Laboratory and radiology are confirmatory testing for the clinical diagnosis. Widening of the mediastinum, mediastinal air–fluid levels, pneumomediastinum, and pleural effusion are all radiographic anomalies that can be seen on a chest radiograph. Dehiscence, fluid collections, wire displacement, and retrosternal collection are some of the CT findings [(8)]. PSM patients were treated conservatively until the early 1960s, with antibiotics and gradually minimal drainage, or by open dressing of the exposed sternotomy wound until it was closed with granulation tissue (open packing) [(9)]. Alternative surgical conceptions were reviewed due to unsatisfactory treatment outcomes and improvements in surgical procedures, including surgical revision with debridement, open dressing, and secondary closure, with or without reconstruction with vascularized soft tissue flaps such as the greater omentum or pectoral muscles [(10)]. In the late 1990s, vacuum-assisted closure (VAC) systems were implemented as a novel therapeutic wound healing process. Vacuum-assisted closure increases microcirculation and speeds tissue granulation by allowing bacteria, debris, and exudates to drain continuously. The sternal wound edge is stabilized

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and approximated by the foam's mass filling effect. Several studies have shown that VAC has a clinical impact similar to conventional closed drainage or open packing, with improvements in sternal wound healing, reinfection rates, ICU stay duration, and probably mortality [11, 12].

The aim of this study was to evaluate the clinical outcome of patients with post-sternotomy mediastinitis treated with either conventional treatment or VAC treatment.

PATIENTS AND METHODS

This study is a prospective nonrandomized study conducted on 60 patients with post-sternotomy mediastinitis in Cardiac Surgery Department, National Heart Institute (NHI), Egypt in the period from March 2019 to March 2020. All the patients in the study were adults their age range (35- 65). According to the Centers for Disease Control and Prevention (CDC), criteria, post-sternotomy mediastinitis was described as having (I) organisms cultured from mediastinal tissue or fluid acquired during a surgical operation or needle aspiration, (ii) evidence of mediastinitis seen during a surgical operation or histopathological examination, or (iii) at least one of the following symptoms with no other known cause: fever (>38.8°C), chest pain, or a rash [13, 14].

Inclusion criteria: Adult male or female patients with age ranging from 35 to 65 years old who underwent cardiac surgeries for the first time through median sternotomy approach and who met the diagnostic criteria for post-sternotomy mediastinitis.

Exclusion criteria: Patients who were outside the age range (35 to 65 years old), Redo cases and patients who underwent cardiac surgery through other approaches than median sternotomy.

All patients were subjected to the following: demographic and clinical data including (history of any medical diseases, full clinical examination, vital signs, and body examination) were collected using a questionnaire.

Routine preoperative investigations including, complete blood count, random blood sugar, liver function test, kidney function test, coagulation profile.

Ethical approval:

The study was approved by the Ethics Board of National Heart Institute and an informed written consent was taken from each participant in the study.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation).

Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

The demographic data of the patients are shown in table 1.

Table (1): Patient demographic and clinical data

Variable	Outcome
Gender	
Male	32 (53.34%)
female	28 (46.66%)
Age	
(mean± SD)	48.7±8.05
Range	(35- 65)
DM	(51.66 %)
Obesity	(58.33%)
hypertension	(36.66 %)
Heart failure	(41.6%)

There was no significant difference between the two groups as regard some chronic diseases, obesity and surgical re-exploration (Table 2).

Table (2): Conventional treatment group versus VAC treatment group regarding to DM, obesity, hypertension, chronic obstruction pulmonary diseases, surgical chest re-exploration, and heart failure

	Conventional treatment group (N= 30)	VAC treatment group (N= 30)	P-value
DM	14 (46.66%)	15 (50 %)	0.796
Obesity	14 (46.66%)	21 (70 %)	0.067
Hypertension	10 (33.33%)	12 (40%)	0.592
Chronic obstructive pulmonary diseases	18 (60%)	20 (66.66%)	0.592
Surgical chest re-exploration	5 (16.66 %)	9 (30 %)	0.222
Heart failure	12 (40%)	13 (43.33 %)	0.793

Table 3 summarizes the comparison between the results of VAC and conventional treatment. The duration of VAC therapy was 7.42 ± 2.23 days. Mean hospital stay after VAC therapy was 12.18±1.92 days.

Table (3): Conventional treatment group versus VAC treatment group regarding to mortality rate, re-infection rate, in-hospital stay, and healing

	Conventional treatment group (N= 30)	VAC treatment group (N= 30)	P. value
Mortality rate N (%)	4 (13.33%)	1 (3.33%)	0.161
Reinfection rate N (%)	7 (23.33%)	2 (6.67%)	0.071
In-hospital stay N (%)	12 (40 %)	5 (16.67%)	0.045
Healing N (%)	6 (20 %)	8 (26.67 %)	0.542

DISCUSSION

Infection of the sternotomy wound is a potentially devastating and sometimes lethal complication following cardiac surgery. The mortality rate varies between 19% and 29% in different series of adult cardiac surgical patients [(15)]. VAC therapy is a novel wound healing method. With this method, several advantageous features of conventional treatment are combined [(16)]. VAC treatment allows open drainage that continuously absorbs the exudate with simultaneous stabilization of the mediastinal cavity and isolation of the wound[(17)]. Comparison of VAC efficacy to conventional treatment for DSWI has been the focus of many studies and VAC was recommended as a destination therapy or as a bridge prior to sternotomy wound closure in case of DSWI [(18)].

Our study shows that DM is common in patients with DSWI and mediastinitis (51.66% of patients were diabetic). This agrees with a study conducted by **Schroeyers *et al.*** [(19)] in which the incidence of diabetes was 51%. Similar findings were found in a retrospective study conducted by **Simek *et al.*** [(20)] in which the incidence of diabetes was 59% and **Farghaly *et al.*** [(21)] reported that the incidence of diabetes in DSWI patients was 53.3%.

Our study shows that obesity is common in patients with DSWI (58.33% of patients were obese). This agrees with a study conducted by **Farghaly *et al.*** [(21)] reported that the incidence of obesity in DSWI patients was 70%. Similar findings were found in a study conducted by **Deniz *et al.*** [(22)] in in which 70% of patients were obese. Also, hypertension was reported in (36.66 %) and heart failure (41.6%) in our study population. **Risnes *et al.*** [(23)] reported that diabetes, obesity, chronic obstructive pulmonary disease and age were important independent risk factors for mediastinitis.

Surgical chest re-exploration is a risk factor for DSWI as it increases bacterial inoculation and multiplication, either from repeated interventions or exposure of the open wound to the environment **Douville *et al.*** [(24)]. Our study shows that the incidence of chest re-exploration was (30%) in patients treated with VAC. Also, chronic obstruction pulmonary diseases were reported in (66.66%).

The duration of VAC therapy was 7.42±2.23 days. This result is comparable to a study conducted by **Fleck *et al.*** [(25)], which showed the mean ± SD, time of VAC therapy to be 11 ± 8 days. Another study conducted by **Sjögren *et al.*** [(11)], showed the mean ± SD, VAC therapy duration to be 11.9 ± 9.0 days. In our study the mean ± SD, duration of VAC therapy until the final procedure was 12.7 ± 6.26 (range: 4–27) days. In our study the mean hospital stay after VAC therapy was 12.18±1.92 days. In our study complete healing could be achieved in eight of the 30 patients (26.66%) who were with DSWI and were managed only with the VAC device until the wound became clean. Our study demonstrates that VAC reduces intensive care stay and mortality. VAC therapy can be implemented in a domiciliary setting, with increasing mobilization and physical and emotional wellbeing of patients [(26)].

The mortality rate in our study was (3.33%) in patient with VAC therapy, while in patients with conventional treatment it was (13.33%). This is in agreement with a study conducted by **Domkowski *et al.*** [(27)], in which hospital mortality was 3.7% (four patients). Two of these patients underwent vascular flap and succumbed to multisystem organ failure, whereas the other two received only wound vacuum therapy following debridement and succumbed to overwhelming sepsis. This is comparable to a study conducted by **Simek *et al.*** [(20)] in which one (3%) patient suffering from DSWI died of multiple organ failure on the 24th postoperative day, despite achieving negative bacteriological cultures during the therapy. In our study the healing rate in patients treated with VAC was (26.66%), while in patients treated with conventional therapy was (20%) without a significant difference. Finally, VAC therapy should be considered as a first-line treatment for DSWI. On the basis of its clinical success and supported by the results of this study, we believe that VAC therapy is the most effective treatment for DSWI and mediastinitis.

CONCLUSION

Vacuum-assisted closure incorporates the benefits of traditional surgical procedures with the benefits of therapeutic negative pressure. VAC therapy has been approved for the treatment of post-sternotomy mediastinitis because it is safe, reliable, and its use is now becoming more widespread in the cardiac surgery community.

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