

ORIGINAL ARTICLE

Incisional negative pressure wound therapy in reconstructive surgery of poststernotomy mediastinitis

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Key words

Failure of treatment; Incisional negative pressure wound therapy; Poststernotomy mediastinitis; Redon drains

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Abstract

The efficacy of negative pressure wound therapy in the treatment of poststernotomy mediastinitis has been revealed in many reports. The present retrospective observational study examined the efficacy of incisional negative pressure wound therapy in the reconstructive surgery of poststernotomy mediastinitis. We retrospectively examined 1034 consecutive patients, who underwent median sternotomy in the period between October 2013 and September 2015. Mediastinitis developed in 21 patients (2%), who subsequently underwent surgical reconstruction. We applied incisional negative pressure wound therapy (iNPWT) after primary closure of the wound over redon drains in ten patients (iNPWT + redon group). In 11 patients, only redons were used (redons only group). We observed the time between the introduction and removal of redon drains, hospital stay until final wound closure and the rate of failure of treatment. Failure of treatment is defined as the need for further surgical reconstruction. In the iNPWT + redon group, the duration of redon drainage therapy was 6.9 ± 5.2 days versus 13.36 ± 11.58 in the redons only group. Hospital stay was 11.4 ± 8.6 versus 101.64 ± 89.2 , and failure of treatment was 10% versus 45.5%, respectively. The primary results of this study appear to support the beneficial effect of iNPWT after radical wound reconstruction.

Introduction

Since its introduction by Julian in 1957, median sternotomy has been the main approach in major cardiac operations (1). The healing of this wound depends on factors such as respiration and interfragmentary motion between the incised sternal sides because of biomechanical reasons. Infection of the mid-line sternotomy site may also be deep enough to involve the sternal bone and the underlying mediastinal structures, leading to poststernotomy mediastinitis (PSM). The treatment of this complication is still controversial, and some reports emphasise that a great amount of effort should be taken to prevent it rather than to treat it (2,3). During the course of treatment, the failure of reconstruction remains a determinant factor of long-term survival after reconstructive surgery. This may indicate that a more radical intervention is needed in order to treat this severe complication, which may result in a higher mortality rate. To prevent failure of reconstruction, aggressive surgical debridement is mandatory; however, other preventive measures can be used to reduce the rate of failure after surgical treatment.

Key Messages

- the trend of treating poststernotomy mediastinitis (PSM) shifted from conservative sternal preserving procedures towards more aggressive reconstructive surgical solutions requiring plastic surgical interventions to reconstruct wounds after radical debridement
- The aim of this retrospective observational study is to evaluate the effect of applying iNPWT (incisional negative pressure wound therapy) after reconstructive surgery of PSM; we examined the time between introduction and removal of redon drains, hospital stay until final wound closure and the failure of treatment
- the primary results appear to support the beneficial effect of iNPWT after radical wound reconstruction as an additional measure in preventing the failure of PSM treatment

Measures taken to facilitate the obliteration of dead spaces are of great significance in promoting wound healing after surgical reconstruction. To our knowledge, the effect of incisional negative pressure therapy (iNPWT) has not yet been investigated in reconstructive surgery of PSM.

The aim of this retrospective observational study is to evaluate the effect of applying iNPWT after reconstructive surgery of PSM in order to accelerate and improve the healing process, focusing on the time of redon drainage, hospital stay and final wound closure.

Methods

In our department, we retrospectively examined 1034 consecutive patients, who underwent different cardiac surgical procedures through median sternotomy in the period between October 2013 and September 2015. PSM, as defined by the Centre of Disease Control (CDC) (4), developed in 21 patients (2%). All patients underwent the same perioperative antibiotic prophylaxis regime. Twenty-one patients, who developed PSM, were treated with different reconstructive surgical procedures. One-stage reconstruction, debridement and resuture were performed in 11 patients, while two-stage reconstruction was used in ten patients. In the latter group, open-wound negative pressure therapy was applied as a bridge to final reconstruction. We applied iNPWT after primary closure of the wound over redon drains in ten patients (iNPWT+redon group). In this group, two patients underwent one-stage and eight patients two-stage reconstruction. Redon drains were placed far from the skin incision so that they could be removed without interfering with the iNPWT dressing. In 11 patients, iNPWT was not applied, and only redons were used (redons only group). In both groups, redon drains were removed when daily secretion dropped below 30 ml. Incisional negative pressure over the wound was generated using the Vivano System (Hartmann Ltd., Budapest, Hungary) (Figure 1). This system is built from a paraffin-soaked silicone mesh to avoid direct vacuum suction of the skin, which may lead to skin necrosis. Ten-cm-wide polyvinyl alcohol wet white foam is applied on the silicone mesh along the length of the surgical incision, and then, the foam is covered by an adherent hydrophilic film to avoid air leakage. This dressing is connected to the vacuum generator unit applying a vacuum of no more than -80 mmHg, according to the manufacturer's instructions. The dressing was changed twice during the 10-day period of therapy, and after 10 days, the dressing was removed. The wound was physically examined to evaluate the presence of dehiscence, tension of sutures, development of seroma, hyperaemia or any other unwanted wound-healing disturbances. When the wound healed, the skin sutures were removed, and the wound was covered using a sterile gauze for a further 3 days, and thereafter, the patient was discharged. Data were collected from the department's data records and were statistically analysed.

Statistical methods

Statistical analysis was performed by SPSS for Windows 9.0 software. For the comparison of data, a chi-squared test and Student's *t*-test were applied. If the test of equality of variances

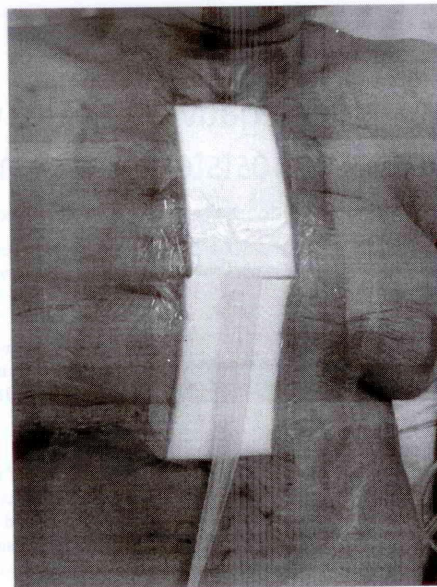


Figure 1 iNPWT (incisional negative pressure wound therapy) with white foam.

(Levene test) had been significant, the Kruskal–Wallis test were used. Any difference was regarded statistically significant if *P* value was less than 0.05. The results are displayed in the form of %, mean \pm standard deviation or box-plot where medians in the 25–75% and 2.5–97.5% percentile ranges were depicted.

We examined the time between introduction and removal of redon drains, hospital stay until final wound closure and the failure of treatment. Failure of treatment is defined as the need for further surgical reconstruction.

Results

The 21 patients who developed PSM and were treated with different reconstructive procedures were examined retrospectively. No patient was excluded. The follow-up period lasted from 1 up to 24 months (mean 9 ± 7 months). Two patients died, one because of sudden cardiac death and the other because of sepsis. In the latter, the wound culture was positive for methicillin-resistant staphylococcus aureus (MRSA).

Ten patients were treated with iNPWT immediately after the surgical reconstruction. Redon drains were used to evacuate any wound secretions. In this group, two patients underwent debridement and sternal rewiring in a one-stage reconstruction. Eight patients underwent bilateral pectoral flap-plasty after aggressive sternal and soft tissue debridement in a two-stage reconstruction. In one patient, we performed a lower hemisternectomy because of excessive sternal osteomyelitis. In the other group (redons only), wounds were closed primarily over

Table 1 Anamnestic and operative data

	iNPWT	Control	P
Age (years)	61.2 ± 8.7	63.6 ± 8.6	0.562
Gender (M/F)	8/2	6/5	0.217
Obesity (BMI > 30) (%)	60.0	27.7	0.130
DM (n, %)	70.0	54.5	0.466
COPD (%)	50.0	45.5	0.835
PAOD (%)	30.0	18.8	0.525
Acute procedure (%)	20.0	36.4	0.407
CABG (%)	90.0	90.9	0.943
LIMA (%)	80.0	72.7	0.696
Operation time (minutes)	213 ± 111	183 ± 51	0.429
RBC transfusion (U)	3.2 ± 4.7	1.3 ± 1.4	0.241
Failure of treatment (%)	10	45.5	0.072
Drainage time (day)	6.9 ± 5.2	13.3 ± 11.6	0.122

BMI, body mass index; CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; F, female; LIMA, left internal mammary artery; M, male; PAOD, peripheral arterial obliterative disease; RBC, red blood cell.

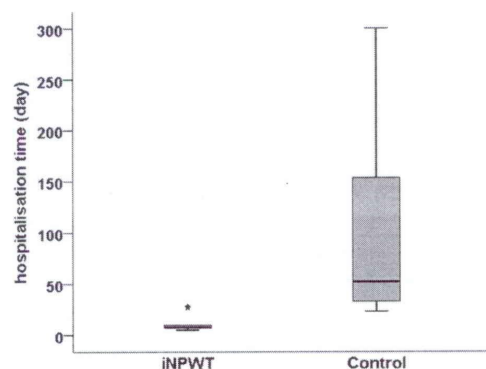


Figure 2 Hospitalisation time in the two groups (box-plot, Kruskal–Wallis test: $P < 0.001$). iNPWT, incisional negative pressure wound therapy.

redon drains without the use of iNPWT. Past medical and peri-operative data of the two groups are shown in Table 1.

There was no difference between the two groups regarding age, gender or risk factors. There was no statistically significant difference between the duration of redon drainage and the rate of failure of treatment. Nevertheless, these two parameters proved to be lower in the iNPWT + redon group. Hospitalisation time was shorter in the iNPWT + redon group, and the difference between the two groups proved to be statistically significant ($P < 0.001$) (Figure 2).

Discussion

The optimal treatment of PSM is still controversial. However, the trend of treating this condition appears to have shifted from the previous conservative sternal preserving procedures towards more aggressive reconstructive surgical solutions. This is based on an aggressive sternal debridement, even at

the expense of partial or total sternectomy (5). This treatment policy has led to the need of plastic surgical interventions to reconstruct wounds after radical debridement. Negative pressure wound therapy (NPWT) has been applied in clinical practice since 1997, and its advantages in promoting wound healing have been documented in many reports (6,7). In the last few years, a variation of NPWT use appeared in the plastic surgical literature, where better wound-healing results were reported if NPWT was applied on wounds, which were closed by primary intention (8). Recently, iNPWT has been applied in primary cardiac surgeries in high risk patients (9). To the best of our knowledge, this retrospective observational study is the first study that tries to assess the effect of iNPWT on the wound-healing process after reconstructive surgery of PSM.

We observed a shorter redon drainage time in the iNPWT + redons group. We assume that decreasing amounts of drainage may be related, among many other factors, to the state of dead spaces in the area of reconstruction. The shorter period of redon drainage may illustrate the extent of the obliteration of dead spaces after reconstruction, which may be the result of vacuum effect exerted on the wound surface. The shorter hospital stay indicated less complications regarding wound dehiscence and the development of seroma, which may be the result of the vacuum effect in reducing oedema and improving the microcirculatory conditions. Only one patient needed surgical reintervention in the iNPWT + redon group compared to five patients in the redons only group.

Two patients died during their hospital stay in the redons only group; however, this was related to the failure of treatment. In the follow-up period, survival was 100% in the iNPWT + redon group, and computed tomographyscans revealed no signs of inflammation of the mediastinal structures.

The limitations of this study are that it is retrospective; the sample size is small; and the follow-up period is short. Therefore, no further conclusions can be drawn.

Nevertheless, the primary results appear to support the beneficial effect of iNPWT after radical wound reconstruction as an additional measure in preventing the failure of PSM treatment. In our opinion, the advantages and the effects of this new therapeutic modality need to be further investigated.

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