Prevention of poststernotomy wound infections in obese patients by negative pressure wound therapy

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Objective: The majority of wound infections after median sternotomy in obese patients are triggered by the breakdown of skin sutures and subsequent seepage of skin flora. The purpose of this study was to evaluate negative pressure wound dressing treatment for the prevention of infection. We hypothesized that negative pressure wound dressing treatment for 6 to 7 days applied immediately after skin closure reduces the numbers of wound infections.

Methods: In a prospective study, 150 consecutive obese patients (body mass index ≥ 30) with cardiac surgery performed via median sternotomy were analyzed. In the negative pressure wound dressing treatment group (n = 75), a foam dressing (Prevena, KCI, Wiesbaden, Germany) was placed immediately after skin suturing, and negative pressure of –125 mm Hg was applied for 6 to 7 days. In the control group (n = 75), conventional wound dressings were used. The primary end point was wound infection within 90 days. Mann–Whitney *U* test and Fisher exact test were used. Freedom from infection was estimated by Kaplan–Meier analysis.

Results: Three of 75 patients (4%) with continuous negative pressure wound dressing treatment had wound infections compared with 12 of 75 patients (16%) with conventional sterile wound dressing ($P = .0266$; odds ratio, 4.57; 95% confidence interval, 1.23-16.94). Wound infections with Gram-positive skin flora were found in only 1 patient in the negative pressure wound dressing treatment group compared with 10 patients in the control group ($P = .0090$; odds ratio, 11.39; 95% confidence interval, 1.42-91.36).

Conclusions: Negative pressure wound dressing treatment over clean, closed incisions for the first 6 to 7 postoperative days significantly reduces the incidence of wound infection after median sternotomy in a high-risk group of obese patients. (J Thorac Cardiovasc Surg 2013;145:1387-92)

Wound-healing impairment and wound infection after median sternotomy are important problems associated with increased morbidity and mortality.[1,2] Excess costs arise primarily because of prolonged hospital stays and the need for repeated surgical procedures in these patients.[3] Chronic obstructive pulmonary disease (COPD), smoking, diabetes, bilateral harvest of the internal thoracic artery, and, in particular, obesity have been identified as major risk factors.[1,2,4,5]

The breakdown of skin sutures with subsequent seepage of bacteria into the deeper layers has emerged as the key event in the development of the majority of wound infections after sternotomy, and Gram-positive bacteria are the most commonly isolated organisms in up to 80% of cases.[1,6,7] This pathogenesis may explain why the risk of wound infections is especially elevated in obesity, because shear and traction forces on skin sutures are high and colonization of skin folds with skin flora is ample. To prevent this kind of wound infection, diverse suture techniques and topical adhesives have been investigated in cardiac surgery.[8-11]

Placing a negative pressure wound dressing on clean skin immediately after suturing represents a new concept to reduce the likelihood of wound complications. The purpose of this study was to compare a new commercially available negative pressure wound therapy (NPWT) system (Prevena Incision Management System; KCI, San Antonio, Tex) and conventional sterile dry wound dressing in a high-risk group (ie, obese patients), with special regard to wound complications and infections. We hypothesized that NPWT for 6 to 7 days applied immediately after skin closure reduces the numbers of wound infections.

MATERIALS AND METHODS

In the period between April 1, 2010, and October 31, 2011, 163 patients with a body mass index of 30 kg/m^2 or more underwent operation at Deutsches Herzzentrum Berlin. Of these patients, 159 met the inclusion criteria, which were defined as follows: body mass index of 30 kg/m^2 or greater, age 18 years or more, legal competence, and absence of preoperative signs of inflammation. Exclusion criteria were defined as follows: immunologic disease, immunosuppressive therapy, (thoracic) skin disease, participation in another clinical study, and refusal of informed consent. A total of 156 patients were enrolled and allocated to 2 study groups, alternating according to the time of operation. Patients with additional diabetes

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Abbreviations and Acronyms
COPD = chronic obstructive pulmonary disease
CI = confidence interval
NPWT = negative pressure wound therapy
OR = odds ratio

were allocated half and half to both groups, with priority. The primary end point of the study was the occurrence of wound infection within the 90-day follow-up period after surgery. The secondary end point was the occurrence of sterile wound complications, that is, dehiscence of skin or sternum. Informed consent to participate was obtained from each patient.

Incision and Skin-Closure Techniques

The skin of all patients was disinfected with 1% iodine in 50% alcohol (Braunoderm; Braun, Melsungen, Germany), and incision drapes were used. Antibiotic prophylaxis consisted of a preoperative injection of cefazolin, followed by a repeat dose after 8 and 16 hours. Skin and presternal soft tissue were incised by scalpel, and electrocautery was used cautiously. For sternum osteosynthesis, 7 to 8 single cerclages or 4 to 6 figures of 8 cerclages were used, and skin closure was performed with a monofilament absorbable suture (Biosyn 4-0; Syneture, Mansfield, Mass) by a meticulous intracutaneous running technique or with a monofilament nonabsorbable suture (Prolene 3-0; Ethicon, San Angelo, Tex) by the Donati technique depending on the surgeon's preference. Postoperatively, all patients wore an elastic thoracic bandage (Samco Clinhand, Mainburg, Germany). To minimize the risk of postoperative wound infections, postoperative hyperglycemia had been kept at less than 200 mg/dL by intensive perioperative glucose monitoring in all patients.

Study Groups

In the NPWT group (n = 75), the wound was covered with the foam dressing (Prevena Incision Management System) immediately after skin suturing and under sterile conditions. The suction pump was connected, and negative pressure of –125 mm Hg was applied. The foam dressing was removed after 6 to 7 days. In the controls (control group; n = 75), conventional wound dressings were changed for the first time on the first or second postoperative day. In both groups, wounds were inspected every 1 to 2 days thereafter.

Definition of Risk Factors

Diabetes, COPD, use of internal thoracic arteries, age, and gender were documented as additional risk factors. COPD was regarded as present if forced expiratory volume in 1 second was less than 80%, and diabetes was documented if it was insulin-dependent or if diabetic-induced organ damage had already occurred.

Wound Infections

After removal of the primary wound dressing on day 6 or 7 in the NPWT group and after dressing removal on day 1 or 2 in the control group, all patients were examined daily up to the time of discharge for wound healing and signs of infection. Preoperatively, on postoperative days 1, 2, 4, and 7, and on the day before discharge, the leukocyte count and C-reactive protein were determined. If infection was suspected, these parameters also were measured on an ad hoc basis. To document infections after discharge, patients were contacted by phone 3 months postoperatively.

Superficial wound infections were defined on the basis of the criteria of the US Centers for Disease Control and Prevention: if there was microbiological evidence of microbes in the cutaneous or subcutaneous tissue at the site of the incision, if the incision was purposely reopened, or if at least one of the following secondary diagnoses was made: purulent secretion from the superficial incision with or without laboratory confirmation, positive bacterial culture from a fluid or tissue sample taken from the superficial incision under aseptic conditions, and at least 1 sign/symptom of infection: redness, heat, pain, or swelling.[12,13] Deep wound infections were deemed present if there was a positive bacterial culture from mediastinal tissue or fluid, and a clinical picture of infection in the presence of one of the following: fever greater than 38°C, purulent secretion from the wound, chest pain, sternal instability, or positive bacterial culture from the blood or mediastinal drainage fluid. In accordance with the criteria published by El Oakley and Wright,[1] involvement of the sternum or cerclage wires was regarded as a criterion for deep wound infections.

Statistical Analysis

Qualitative data are presented as number (n) and percent. For quantitative data, median and quartiles were calculated. To compare study groups, the Mann–Whitney *U* test and the Fisher exact test were used for dichotomous data. The odds ratio (OR) with a 95% confidence interval (CI) was calculated. Freedom from infection was estimated by Kaplan–Meier analysis, and patient groups were compared by log-rank test. The data were processed and analyzed while preserving the patients' anonymity.

RESULTS

Six of 156 patients had to be excluded because of early rethoracotomy due to bleeding (n = 3) and death unrelated to wound complications (n = 3). A total of 150 of 159 (94%) of the screened patients were included in the study analysis after the end of the follow-up period. In each group, all 75 patients could be followed for at least 90 days. NPWT was well tolerated in all patients. In 2 patients, the foam dressing had to be readjusted because of air leakage after 3 and 4 days, respectively. Preoperative patient characteristics, comorbidities, and procedure-related variables were comparable between the NPWT group and control group (Table 1).

Wound Infections and Sterile Complications

Three of 75 patients (4%) with NPWT (NPWT group) and 12 of 75 patients (16%) with conventional dressing (control group) had wound infections ($P = .0266$; OR, 4.57; 95% CI, 1.23-16.94) (Table 2). Gram-positive skin flora was found in only 1 wound swab in the NPWT group but in 10 wound swaps in the control group ($P = .0090$; OR, 11.39; 95% CI, 1.42-91.36), whereas 2 of 3 wound infections in the NPWT group and 2 wound infections in the control group were deep infections caused by contamination with Gram-negative bacteria (Table 2). Superficial wound infections had to be treated by debridement and secondary wound closure in 5 cases (including the case in the NPWT group) and by repeated revisions, including vacuum-assisted closure therapy, in the remaining 4 cases.

Sternum dehiscence was found in 1 patient in the NPWT group and in 3 patients in the control group ($P = .6199$). However, all 3 patients in the control group had additional sternum osteomyelitis caused by skin flora requiring therapy for weeks, whereas the single patient in the NPWT group had a sterile sternum with completely healed skin

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