Sternal dehiscence in patients with moderate and severe chronic obstructive pulmonary disease undergoing cardiac surgery: The value of supportive thorax vests

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Objective: Sternal dehiscence after open surgery is a major cause of morbidity and mortality, and chronic obstructive pulmonary disease is a significant risk factor. Therefore, we aimed to determine whether moderate and severe chronic obstructive pulmonary disease had an effect on the development of sternal dehiscence and whether the use of the Robicsek technique for sternal closure along with sternal support vest postoperatively would reduce the incidence of sternal dehiscence in patients with moderate/severe chronic obstructive pulmonary disease undergoing cardiac surgery.

Methods: Two studies were performed. In study 1, 842 patients undergoing cardiac surgery and figure-of-8 wire closure were retrospectively evaluated in 2 groups: group 1a (328 patients with chronic obstructive pulmonary disease) and group 1b (514 patients without chronic obstructive pulmonary disease). In study 2, 221 patients with moderate and severe COPD who were scheduled for open surgery were prospectively enrolled. The Robicsek technique was used for sternal closure. The postoperative thorax support vest was used in 100 patients (group 2a), and no additional procedure was applied in 121 patients (group 2b).

Results: In study 1, the dehiscence rate was significantly higher in group 1a (7.9%) than in group 1b (1.2%; $P < .001$), and mortality rates in patients with dehiscence were 53.8% and 33.3%, respectively. In study 2, the dehiscence rate was significantly lower in group 2a (1%) than in group 2b (11.5%; $P = .002$). None of the patients with dehiscence in group 2a died, and 35.7% of patients died in group 2b.

Conclusions: The Robicsek technique for sternal closure and the use of a thorax support vest postoperatively are highly effective in preventing sternal dehiscence after cardiac surgery in patients with moderate and severe chronic obstructive pulmonary disease. (J Thorac Cardiovasc Surg 2011;141:1398-402)

Sternal dehiscence after median sternotomy is a serious complication and may lead to prolonged hospitalization, increased cost of care, and significant mortality.[1-4] Chronic obstructive pulmonary disease (COPD) is one of the major risk factors for sternal dehiscence in patients undergoing cardiac surgery.[5-7] The benefits of reinforced sternal closure techniques are controversial. Previous studies have shown that reinforced closure of the sternum may decrease sternal dehiscence rate in high-risk patients.[8-10] In addition, the use of a thorax support vest after the operation has been shown to reduce sternal wound complications.[11] We evaluated the influence of COPD on the development of sternal dehiscence in patients undergoing cardiac surgery in the first study. In the second study, we evaluated whether the use of a postoperative thorax support vest along with the Robicsek sternal closure technique would reduce the rate of sternal dehiscence after cardiac surgery in patients with moderate and severe COPD.

MATERIALS AND METHODS

Selection and Description of Participants

Two studies were performed. In the first study, we retrospectively evaluated the incidence and mortality of sternal dehiscence after cardiac surgery in patients with and without COPD. In the second study, we prospectively enrolled patients with COPD who were scheduled for open surgery. The studies were performed in the Medicana Hospitals Group in Istanbul, Turkey, and were approved by the Clinical Research Ethics Committee of the hospitals. Written informed consent was obtained from all patients enrolled in the prospective study.

Patients with chronic infectious diseases (eg, brucellosis and hepatitis), emergency sternotomy, repeat sternotomy, prior radio/chemotherapy, off-pump surgery, or previous thoracic trauma were excluded in both studies.

COPD was classified according to American Thoracic Society guidelines.[12] Moderate COPD was defined as less than 50% forced expiratory volume in 1 second (FEV_1) less than 80% of the predicted value, and severe COPD was defined as less than 30% FEV_1 less than 50% of the predicted value. Diagnosis of sternal dehiscence was made on the basis of clinical criteria and lateral and posterior-anterior chest radiographs, and multislice computed tomography if required. Isolated sternal dehiscence was defined as ''partial or complete dehiscence of skin, soft tissue, and sternum without infection (mechanical, pain, and clicking).'' The descriptions proposed by El Oakley and Wright[13] were used: superficial sternal wound infection as ''a redness, swelling, bogginess or frank discharge (blood

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Abbreviations and Acronyms
COPD = chronic obstructive pulmonary disease
FEV_1 = forced expiratory volume in 1 second

stained or purulent from skin and subcutaneous tissue)'' and deep sternal infection as ''complete separation of the sternum, mediastinitis, and frank pus discharge from an open wound.''

In the interpretation of chest radiographs, sternal dehiscence was defined as a mid-sternal stripe of lucency, sternal wire displacement (2 cm of displacement seen in ≥ 2 wires), and sternal wire breaks.[14] In computed tomography evaluations, mediastinitis was defined as small air bubbles or an air-fluid level in the mediastinum.

In study 1, 842 patients with and without COPD, who had undergone elective cardiac surgery via midline sternotomy between July 2004 and September 2007, were retrospectively evaluated. The peristernal figure-of-8 wire closure technique had been used in sternal closure in all patients. The patients were analyzed in 2 groups: group 1a (patients with COPD) and group 1b (patients without COPD). Furthermore, to evaluate the relation between respiratory functions and sternal dehiscence in patients with COPD, group 1a was divided into 5 subgroups according to predicted FEV_1 values.

In study 2, 221 patients with moderate and severe COPD undergoing open surgery between December 2007 and September 2009 were prospectively analyzed. The study was planned for 244 patients, 122 patients for each group. Patients were randomly assigned to 2 groups 1 to 2 weeks before surgery: vest and non-vest. A computer-generated randomization list was used, and individual allocations were placed in sealed envelopes. An external investigator blinded to the allocation sequence picked consecutive allocation envelops for consecutive participants.

The Robicsek closure technique was used in the sternal closure of all patients. The patients were randomly allocated into 2 groups; sternal support vests were used postoperatively in group 2a, and no additional procedure was performed in group 2b. The patients were followed up for 6 months.

All patients evaluated in the 2 studies received preoperative physiotherapy for 7 days. Other risk factors associated with sternal dehiscence, including diabetes mellitus, obesity (body mass index > 30 kg/m^2), osteoporosis, reexploration for bleeding, and use of bilateral internal thoracic artery grafts, were also analyzed.

Statistics

Continuous and normally distributed data are expressed as mean $\pm$ standard deviation. Categoric data are shown as percentages. Univariate analysis of categoric data was carried out using the Pearson chi-square and Fisher exact tests for categoric variables, and the unpaired t test for continuous variables. In the prospective study (study 2), analysis was performed in patients who completed the trial. Sternal dehiscence rate was calculated according to COPD severity.

RESULTS

There were 328 patients with COPD (group 1a) and 514 patients without COPD (group 1b) in study 1. Patient characteristics, comorbidities, procedure-related variables, and duration of hospitalization are shown in Table 1. No significant difference was found between the 2 groups with regard to age, gender, presence of risk factors (eg, osteoporosis, peripheral arterial disease, diabetes, and chronic renal failure), and procedure-related variables ($P > .05$).

In group 1a (COPD group) and group 1b (non-COPD group), 26 of 328 patients (7.9%) and 6 of 514 patients (1.1%) had a sternal dehiscence diagnosis. The dehiscence rate was significantly higher in the COPD group than in the non-COPD group ($P < .001$). Although the rates of isolated dehiscence and superficial wound infections were similar between the 2 groups, the rate of deep sternal wound infections was higher in the COPD group than in the non-COPD group ($P < .001$). Furthermore, COPD severity also had a significant effect ($P = .002$) on the development of sternal dehiscence. In patients with COPD, sternal dehiscence incidence was 3.5% (3/85) among patients with an FEV_1 value of 60% to 70% and 45.4% (10/22) among patients with an FEV_1 value of 30% to 40% (Figure 1).

Debridement and Robicsek closure were performed in all 26 patients with dehiscence in group 1a. Of these 26 patients, 12 (46.2%) improved and 14 (53.8%) died of mediastinitis and sepsis despite all efforts of rewiring and debridement.

In group 1b (non-COPD group), 6 (1.1%) of 514 patients with a sternal dehiscence diagnosis were treated using the same method; 2 of these 6 patients (33.3%) died of respiratory insufficiency and sepsis, and 4 of 6 patients (66.6%) recovered after the reoperation.

The mortality rate of the COPD group with sternal dehiscence (53.8%; 14/26) was significantly higher than the mortality rate of the non-COPD group with sternal dehiscence (33.3%, 2/6; $P < .001$).

Study 2

The study was planned for 244 patients, 122 patients for each group. However, only 221 patients were eligible for analysis, because 23 patients withdrew their consents in different phases of the study (1 from the non-vest arm and 22 from the vest arm). Twenty-one who withdrew their consents in the vest arm were obese female patients, and 1 was an elderly male patient who found it difficult to wear the vest. The patient who withdrew his consent in the non-vest arm wanted to wear a vest for his chest pain. The power of the study was calculated backward, and it was determined that group sample sizes of 100 and 121 were adequate to achieve 86% power to detect a difference of 11% in deep sternal wound complications between the 2 groups.

No significant difference with regard to age, gender, presence of risk factors (eg, osteoporosis, peripheral arterial disease, diabetes, and chronic renal failure), and procedure-related variables was observed between the 2 groups evaluated in the second study ($P > .05$) (Table 1). The use of a support vest was associated with a significantly shorter duration of hospitalization (13.7 ± 6.7 days vs 17.8 ± 15.4 days, $P = .03$).

With the experimental event ratio as $0/100 = 0$ and the control event ratio as 8/121, the decrease in the relative risk was calculated as 0.066. Therefore, we estimated that 15 patients would need to be treated to prevent 1 sternal wound complication.