

Therapeutic Outcomes of Pectoralis Major Muscle Turnover Flap in Mediastinitis

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Background: This study aimed to evaluate the therapeutic results and safety of pectoralis major muscle turnover flaps in the treatment of mediastinitis after coronary artery bypass grafting (CABG) procedures. **Methods:** Data regarding 33 patients with post-CABG deep sternal wound infections (DSWIs) who underwent pectoralis major muscle turnover flap procedures in the Emam Reza and Ghaem Hospitals of Mashhad, Iran were reviewed in this study. For each patient, age, sex, hospital stay duration, remission, recurrence, and associated morbidity and mortality were evaluated. **Results:** Of the 2,447 CABG procedures that were carried out during the time period encompassed by our study, DSWIs occurred in 61 patients (2.5%). Of these 61 patients, 33 patients (nine females [27.3%] and 24 males [72.7%]) with an average age of 63±4.54 years underwent pectoralis major muscle turnover flap placement. Symptoms of infection mainly occurred within the first 10 days after surgery (mean, 10.24±13.62 days). The most common risk factor for DSWIs was obesity (n=16, 48.4%) followed by diabetes mellitus (n=13, 39.4%). Bilateral and unilateral pectoralis major muscle turnover flaps were performed in 20 patients (60.6%) and 13 patients (39.4%), respectively. Complete remission was achieved in 25 patients (75.7%), with no recurrence in the follow-up period. Four patients (12.1%) needed reoperation. The mean hospitalization time was 11.69±6.516 days. Four patients (12.1%) died during the course of the study: three due to the postoperative complication of respiratory failure and one due to pulmonary thromboembolism. **Conclusion:** Pectoralis major muscle turnover flaps are an optimal technique in the treatment of post-CABG mediastinitis. In addition to leading to favorable therapeutic results, this flap is associated with minimal morbidity and mortality, as well as a short hospitalization time.

Key words: 1. Mediastinitis
2. Coronary artery bypass
3. Deep sternal wound infection
4. Pectoralis muscle turnover flap
5. Morbidity

INTRODUCTION

Median sternotomy, first suggested by Shumacker and

Lurie [1] in the 1950s, is the most commonly used incision for cardiac operations, including valvular procedures and coronary artery bypass grafting (CABG). However, median ster-

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notomy is associated with a variety of complications, of which the most life-threatening condition is mediastinitis [2]. Mediastinitis, or deep sternal wound infection (DSWI), has been reported to occur in 0.4%–8.4% of patients after median sternotomy, although the most frequently reported incidence is 1%–3% [3,4]. DSWI is a potentially fatal condition due to subsequent septicemia and sepsis, with a reported mortality rate of 5%–50%, and is also associated with higher morbidity, leading to longer hospitalization and placing a heavy economic burden on the healthcare system [5-7]. The etiology is complex, but *Staphylococcus* bacteria (*Staphylococcus aureus* and coagulase-negative *Staphylococcus* species) are considered the most common pathogens that cause DSWI, mostly during surgery or through an endogenous pathway [8,9]. Various risk factors are associated with DSWI, including obesity, diabetes mellitus, smoking, chronic obstructive pulmonary disease, corticosteroid use, re-exploration to control bleeding, a prolonged operation, harvesting of the internal mammary artery (especially when performed bilaterally or in a pedicled fashion), renal failure, malnutrition, peripheral vascular disease, sternal rewiring, a longer interval between admission and operation, and emergency surgery [2,4,6,9-11]. Patients undergoing median sternotomy are now older, and risk factors such as diabetes mellitus (DM) and renal insufficiency are more prevalent, putting patients at a higher risk level that requires proper management [2,4]. The recommended approach for DSWI is early resection of the necrotic and infected tissues, including soft tissue and the sternum, chest stabilization (sternum fixation), and incision closure using various flaps. These include omental, rectus abdominis, latissimus dorsi, breast, and pectoralis major muscle (turnover and advancement) flaps. The latter type of flap is considered the primary reconstruction method, since it has shown no adverse effect on pulmonary function and even improves spirometric parameters, cosmetic outcomes, and stabilization of the chest [5,6,9,12].

This study aimed to evaluate the therapeutic outcomes and safety of pectoralis major muscle turnover flaps in the treatment of mediastinitis after CABG procedures.

METHODS

1) Patients and methods

The files of 33 patients who underwent bilateral or unilateral pectoralis major muscle turnover flap procedures after debridement due to post-CABG DSWIs in Emam Reza and Ghaem Hospitals of Mashhad, Iran between March 2008 and April 2014 were reviewed in this retrospective descriptive study. Data regarding the age, sex, length of hospital stay, remission, recurrence, and associated morbidity and mortality were extracted from the files and evaluated for these patients, who underwent follow-up at 1, 3, 6, and 12 months after surgery.

2) Surgical procedure

DSWI was diagnosed when a patient fulfilled at least one of the criteria defined by the Centers for Disease Control and Prevention (CDC) for mediastinitis. First, intravenous antibiotic therapy covering Gram-positive and anaerobic bacteria was started, and the incision was opened and the infected tissues, including bone and cartilage, were debrided under local anesthesia. If laboratory, radiological, and clinical findings did not improve and the patient failed to respond to treatment, the wires were removed under general anesthesia and rewiring was performed in cases of sternal instability. Irrigation with normal saline and intravenous antibiotic therapy were continued in all patients. If the patient still did not respond to treatment, further debridement was performed. If restabilization of the sternum was impossible, an omental or pectoral flap was performed after complete open drainage of the wound and omission of any loculated area of infection. The connections of the pectoral muscle to the ribs, skin, and subcutaneous tissues were released. The inferior and lateral borders were then cut, closely approaching the connections to the humerus bone. Subsequently, the free pectoral muscle was rotated to the midline (i.e., to the sternum defect) and fixed in place. Pectoral muscle turnover flaps were performed unilaterally or bilaterally based on the extent of the defect.

RESULTS

Among all patients who underwent CABG during the study period, 2,447 patients had available files with the data re-

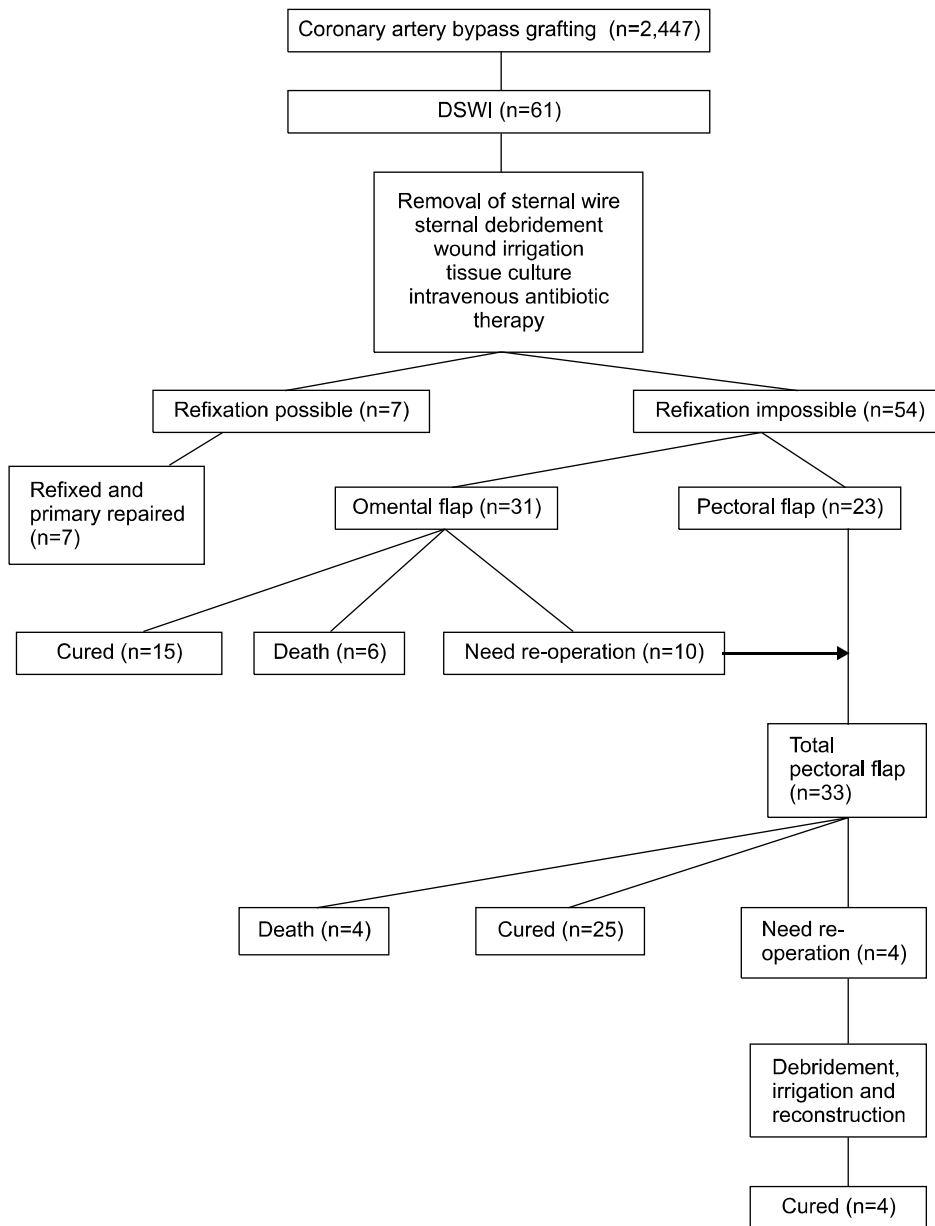


Fig. 1. Treatment algorithm for DSWI. DSWI, deep sternal wound infection.

quired for this study. Among these patients, 61 (2.5%) experienced DSWI. Seven patients in whom a small area of tissue was infected underwent debridement and irrigation alone. In these patients, restabilization of the sternum was possible. Complete remission was achieved in all of these patients. In 31 patients who underwent debridement, irrigation, and placement of an omental flap, complete remission was achieved in 15 (48.3%), death occurred in six (19.3%), and re-operation was required in 10 (32.2%). A pectoralis major muscle turnover flap was performed in these 10 patients, who were add-

ed to the 23 patients in whom a pectoralis major muscle turnover flap was initially placed, resulting in a total of 33 patients. The treatment algorithm is presented in Fig. 1.

Pectoralis major muscle turnover flaps were placed in a total of 33 patients, including nine females (27.3%) and 24 males (72.7%), with an average age of 63 ± 4.54 years (range, 54–74 years). Most patients showed symptoms within the first 10 days after surgery, with an average interval of 10.24 ± 13.62 days (Fig. 2). The most common risk factor for DMWI was obesity ($n=16$, 48.4%), followed by DM ($n=13$, 39.4%),

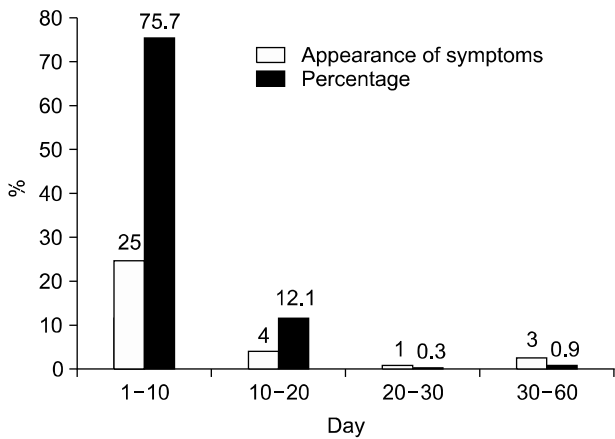


Fig. 2. Interval between open heart surgery and the appearance of deep sternal wound infection symptoms.

and the need for re-operation (n=10, 30.3%). Other risk factors are presented in Table 1. Bilateral pectoralis major muscle turnover flaps were performed in 20 patients (60.6%), and unilateral flaps were performed in 13 patients (39.4%).

Complete remission was achieved in 25 patients (75.7%), with no recurrence of symptoms in the follow-up period. However, four patients (12.1%) required reoperation, in which debridement, irrigation, and reconstruction of the wound were performed again. These four patients were all treated successfully and required no additional treatment.

The mean hospitalization time was 11.69±6.516 days (range, 4-27 days) (Fig. 3). Unfortunately, four patients (12.1%) passed away during the study: three due to the post-operative complication of respiratory failure and one due to pulmonary thromboembolism during hospitalization.

DISCUSSION

DSWI is diagnosed when at least one of the three criteria defined by the CDC for DSWI in 1988 is present: (1) an organism cultured from mediastinal tissue or fluid; (2) evidence of mediastinitis seen during the operation or by histopathologic examination; or (3) presence of chest pain, sternal instability, or fever (>38°C), in combination with either purulent drainage from the mediastinum or an organism isolated from blood culture or culture of the mediastinal area [13]. Mediastinitis can lead to a high incidence of morbidity and mortality among post-CABG patients if not treated quickly.

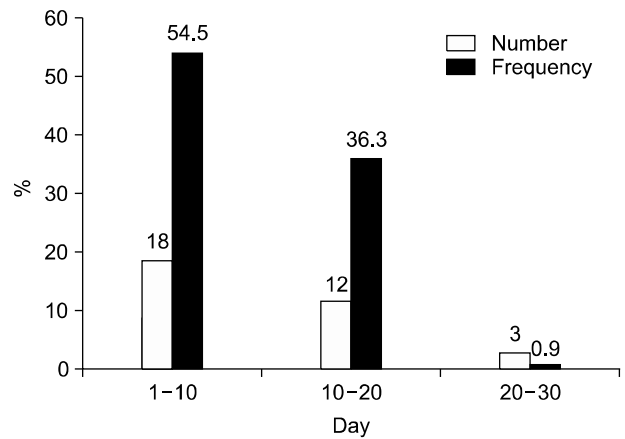


Fig. 3. Hospitalization times of patients in whom a pectoralis major muscle turnover flap was performed as part of deep sternal wound infection treatment.

Table 1. Risk factors present in patients with post-coronary artery bypass grafting deep sternal wound infection

Risk factor	Frequency
Obesity	16 (48.4)
Diabetes mellitus	13 (39.4)
Need for re-operation	10 (30.3)
Hypotension	9 (27.3)
Hypertension	5 (15.1)
Bilateral internal mammary artery harvesting	5 (15.1)
Renal failure	1 (3.0)

Values are presented as number (%).

Although uncommon, this condition is of high clinical importance, requiring a prompt diagnosis and appropriate therapeutic intervention by the surgeon to prevent complications to the greatest extent possible [14,15]. The first step is total resection of the necrotic tissues, followed by various reconstruction procedures, including muscle or omental flaps [15,16]. When using flaps, it is important to ensure good perfusion, which provides adequate nutrition to the tissues and ensures that the immune system can help fight the infection [17]. The greater omentum can be used as a flap for defect reconstruction, but doing so is problematic, because a complex procedure in the presence of other risk factors can result in more complications and even increase the mortality rate. It is important to note that using the greater omentum does not improve sternal stability and mostly involves skin transfer [6,18]. Muscle flaps decrease the mortality rate, improve therapeutic

outcomes, and reduce hospitalization time [19,20]. Jones et al. [12] reported a 0% mortality rate, a 13% morbidity rate, and a shortened hospital stay in comparison to patients who were managed conservatively (22 days vs. 82 days), as well as good stability of the sternum in their patients in whom pectoralis major muscle advancement flaps were placed. Similar improvements were seen in our study, which evaluated the use of pectoralis major muscle turnover flaps. Optimal therapeutic outcomes, consisting of sternal fixation, complete alleviation, and no recurrence of DSWI during the follow-up period, were achieved in 75.7% of our patients. The mean hospitalization time was even shorter (11.69 ± 6.516 days) than the figure of 22 days reported by Jones et al. [12] or the figure of 25 days reported by Floros et al. [7]. The mortality rate was 12.1% in our study over one year of follow-up after surgery. Three patients died due to the postoperative complication of respiratory failure and one patient died from pulmonary thromboembolism during hospitalization.

Ghazi et al. [18] performed omental flaps in 52 DSWI patients, either for primary reconstruction (n=35) or after a failed muscle flap (n=17). The 60-day mortality rate was 24% in the patients who underwent a salvage procedure. The overall mortality rates in the patients who needed an omental flap transfer and 52 muscle-flap controls were 42% and 18% at three years, respectively.

Among muscle flaps, pectoralis major muscle flaps based on the pedicle of the thoracoacromial or internal mammary arteries are now considered to be the primary approach to treating DSWIs, due to better stability of the sternum, non-impaired pulmonary function, favorable cosmetic outcomes, and good coverage of the wound [5,6,21]. Other muscle flaps, including the rectus abdominis and latissimus dorsi, are also effective, but a range of problems are encountered, such as a deficit in perfusion to the grafted tissues in a large proportion of patients, weakening of the structures that protect the abdominal wall, not providing enough tissue, and extensive exposure of subcutaneous tissue, which make them a less preferable approach for reconstruction [6,17]. Nahai et al. [22] found that unilateral turnover flaps were not capable of completely filling the mediastinal dead space, so a rectus abdominis flap was turned over to obliterate the remaining space. If bilateral turnover flaps are performed and a large area is not

covered, a rectus abdominis flap is needed; otherwise, one of the pectoralis major muscle flaps must be split to cover the remaining part.

The most common risk factor in our study was obesity, which was present in 48.4% of our patients. Several studies have found that obese patients show an incidence of mediastinitis three times greater than that observed in non-obese patients. This may be due to lower than desired penetration of antibiotics into the fat tissue, in addition to the technical difficulties faced during the surgery [9,23,24]. The second most common risk factor was DM, which was present in 39.4% of our patients. DM is capable of weakening immunity, as well as leading to delayed wound healing due to ischemia [25]. However, a lower rate of wound complications can be achieved in diabetic patients with tight perioperative control of glucose by intravenous insulin [14,23]. We attempted to minimize the risk of DSWI in CABG patients by using broad-spectrum antibiotics, ensuring tight glucose control in diabetic patients, avoiding bilateral internal mammary artery harvesting, avoiding drugs that lead to impaired wound healing, careful modification of the patient's nutritional status, and careful hemostasis in order to prevent re-exploration. Three patients of this study showed symptoms of DSWI after 30 days (one of them on the 58th day after surgery), which indicates the possibility that this condition may appear in a delayed manner, which is a possibility that both physicians and patients should be aware of. It is extremely important to emphasize the role of prevention, which includes controlling related risk factors, reducing the chance of infection as much as possible at every step, and so on [26,27]. The results of a study by Song et al. [28] on 45 high-risk patients are interesting in this regard. In their study, high risk referred to the presence of at least three risk factors. They performed a rigid plate fixation of the sternum for better bone healing. Despite being at high risk, no postoperative DSWIs occurred in the patients in their study.

In conclusion, the pectoralis major muscle turnover flap is the primary surgical technique used in the treatment of mediastinitis. In addition to leading to favorable therapeutic results, this flap is associated with minimal morbidity, mortality, and a short hospitalization time.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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