



## COMBINED USE OF PEDICULATED MUSCLE FLAP AND Z-PLASTY IN THE CLOSURE OF STERNAL WOUNDS IN HIGH-RISK PATIENTS

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### Abstract

**Objective:** Since deep sternal wound infections following sternotomy is a life-threatening complication, optimal management of sternal wounds still of vital importance.

This study presents our 10-year experience with the use of pediculated muscle flaps and multiple Z-plasty techniques in reconstruction and tension-free closure of deep sternal wound and skin defects.

**Material and Method:** 14 patients with deep sternal wound infection referred to our clinic between 2006 and 2016 for the closure of their defects included in our study. Following aggressive debridement, all patients underwent closure of mediastinal defect using pediculated muscle flaps, whereas primary skin repair was performed in seven patients and another seven patients required multiple Z-plasties due to high skin tension.

**Results:** The tension-free closure was performed in all patients. None of the patients developed muscle or skin flap necrosis. Of a total of three patients with postoperative complications, two of them developed seroma and one patient developed a hematoma. At a mean follow-up period of five years recovery was achieved with acceptable wound scar in patients who underwent repair with multiple Z-plasty techniques.

**Conclusion:** Aggressive therapy with muscle flap reconstruction serves to reduce morbidity and mortality caused by sternal wound infection, whereas successful use of multiple Z-plasty techniques for skin closure allows the surgeon to perform tension-free closure and reduces the risk of skin necrosis, dehiscence and infections.

**Keywords:** sternal wound infection, dehiscence, multiple Z-plasty

### Öz

**Amaç:** Sternotomiyi takiben derin sternal yara enfeksiyonu hayatı tehlike oluşturan bir komplikasyon olduğundan, sternal yaranın optimum yönetimi halen büyük önem taşımaktadır.

Bu çalışmada, derin sternaldefekt ve cilt defektinde, rekonstrüksiyon ve gergin olmayan kapama elde etmek için pediküllü kas fleplerine çoklu z-plasti tekniğinin kullanımı ile ilgili 10 yıllık deneyimlerimiz sunulmaktadır.

**Materyal ve Metot:** 2006-2016 yılları arasında derin sternal yara enfeksiyonu olan 14 hasta defekt kapatılması için kliniğimize sevk edildi. Tüm hastalarda agresif debridmansonrası mediastinaldefekti kapama pediküllü kas flepleri ile, deri kapanması ise birden fazla z-plasti kullanılarak yapıldı.

**Bulgular:** Bütün hastalarda gergin olmayan bir defekt kapatılması sağlandı. Hiçbir kas ve deri flep nekrozu oluşmadı. Toplam 3 hastanın ikisinde seroma ve 1 hastada hematom gibi postoperatif komplikasyonlar yaşadı. Ortalama 5 yıllık izlem (6 ay- 8 yıl) süresi sonunda tüm hastalarda kabul edilebilir yara izleriyle tam düzelme görüldü.

**Sonuç:** Kas flebi rekonstrüksiyonu ile agresif tedavi, sternal yara enfeksiyonunun morbidite ve mortalitesini azaltmaya yardımcı olurken, cildin kapanması için çoklu z- plasti prosedürünün başarılı bir şekilde kullanılması, cerrahın minimal bir skarlagergin olmayan bir kapama elde etmesini ve ciltte nekroz, yara ayrışması ve enfeksiyon riskini azaltmaktadır.

**Anahtar Kelimeler:** sternal yara enfeksiyonu, yara ayrışması, çoklu Z-plasti

## INTRODUCTION

Median sternotomy is the most widely preferred approach to open heart surgery because it provides wide access to the mediastinum for exploration. Various study, have reported a rate of 0.4-4% rate for wound site complications involving infections and/or dehiscence<sup>1,2</sup>. Sternal wound complications are associated with prolonged hospitalization and antibiotic requirement, need for repeat surgery as well as high morbidity and mortality<sup>2</sup>. Effective treatment of infected sternotomy wounds involves sufficient

debridement, removal of foreign bodies, use of appropriate antibiotics and promptly covering the heart and other vital organs<sup>3</sup>. Various repair techniques have been described, such as omental flap, rectus abdominis muscle flap, pectoral muscle flap and latissimus dorsi muscle flap<sup>4</sup>. After covering the vital organs using muscle flaps, high skin tension caused by the muscle flap and as a result wound dehiscence may occur<sup>5</sup>.

The aim of the present study is to compare postoperative outcomes and complications among patients who underwent primary

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closure with high skin tension, patients underwent tension-free repair with muscle flaps and multiple Z-plasties, and patients underwent repair only with muscle flaps and primary closure.

## PATIENTS AND METHODS

The records of 14 patients who underwent coronary by-pass surgery between 2006 and 2016, and who developed sternal infection and dehiscence at the operation site, were retrospectively reviewed, and the patients participated in this study after obtaining institutional ethical approval. Of these 14 patients, seven patients underwent primary skin closure following muscle flap reconstruction, and seven patients with high skin tension after end to end approximation of the skin defect using 3/0 suture material underwent multiple Z-plasties following muscle flap reconstruction. This study included Type II (purulent secretion accompanied by cellulitis and often osteomyelitis 2-4 weeks after sternotomy) and Type III (chronic, localized cellulitis, osteomyelitis and chondritis developing months-years after sternotomy) patients according to the Pairolero classification and those who do not require repair with the skin flap. Antibiotherapy based on antibiotic susceptibility testing was initiated and continued in all patients.

Localization of the defects and repair techniques were classified according to the Greig classification<sup>5</sup>. (Table 1)

**Table 1:** Greig Clasification

Wound Type	The location of sternal wound	Type of flap proposed for reconstruction
Type A	Upper half of Sternum	Pektoralis major
Type B	Lower half of Sternum	Pektoralis major and/or utilization of rektus abdominis bipedicule flap
Type C	Whole Sternum	Pektoralis major and/or utilization of rektus abdominis bipedicule flap

All patients were operated under general anesthesia. Following sufficient debridement, eight patients underwent reconstruction with rectus abdominis muscle flap, two patients underwent reconstruction with pectoralis major muscle flap, and four patients underwent reconstruction with pectoralis major and rectus abdominis muscle flaps. After repair of the sternal defect using a muscle flap, the skin was closed with multiple Z-plasties in patients with high skin tension after skin repair (Figure 1,2,3).Z-plasty flaps in the present study were therefore planned with 60 degrees angle.

**Figure 1:** Preoperative, intraoperative and postoperative images of case 1.



**Figure 2:** Preoperative, intraoperative and postoperative images of case 2.



**Figure 3:** Preoperative, intraoperative and postoperative images of case 3.



Subcutaneous tissues were sutured with 3/0, and 4/0 vicryl and skin was closed with 3/0 and 4/0 prolene stitches. Interrupted stitches were used. The negative-pressure drain was left at the operation site in all patients.

## RESULTS

The mean age of the patients was 55 years (range, 44-72) and ten patients were female, and four patients were male. The mean time

from coronary artery bypass surgery to the operation at our clinic was 1.6 months (range, 1-3). 12 patients (85.71%) had diabetes mellitus, and the mean duration of diabetes was 14.64 years (range, 9-20). According to Pairolero classification, four patients had type III and the remaining patients had type II defect. The culture was obtained from all patients before surgery and staphylococci was isolated from all samples. Methicillin-resistant *Staphylococcus aureus* was isolated from two patients, *E. coli* was isolated in addition to *Staphylococcus* in one patient, and *Enterococcus* was isolated from one patient.

According to Greig classification, two patients had type A, eight patients had type B, and four patients had type C wounds.

Patients were monitored in the intensive care unit at least for one day after surgery with a mean follow-up duration of 11 days (range, 6-22 days) at the clinic. One patient with primary skin closure died of respiratory failure at day 2 after surgery. The mean time to drain removal was 6.2 days (range, 3-10 days). Skin sutures were removed on days 10-12; one patient who underwent repair without multiple Z-plasties suffered from dehiscence of the closure of skin and subcutaneous tissues and one patient developed the postoperative hypertrophic scar. The complication rate was determined as 25%. Seven patients who underwent repair with Z-plasties did not develop any complications in the postoperative period. Patients who attended regular follow-up and showed no complications in the long term (follow-up period six months to eight years).

## DISCUSSION

Complications, such as presternal skin infections, wound dehiscence, sternal osteomyelitis and mediastinitis, may occur in patients who undergo coronary artery bypass graft surgery<sup>1,2,5</sup>. These complications may be fatal although they have a prevalence rate ranging from 0.4% to 4%<sup>1,2,5</sup>. Sternal infections that occur after coronary artery bypass graft surgery often manifest with purulent discharge, chronic sinuses with discharge, specific findings, such as sternal instability, and fever, cellulitis, and leukocytosis. The symptoms may become apparent in the early period after surgery or in the late period weeks after discharge from hospital.<sup>5,6</sup> The patients must be closely monitored for the signs and symptoms of sternal infections because delays in diagnosis and treatment will increase morbidity and mortality<sup>6</sup>. *S. aureus* is the most isolated microorganism in culture samples obtained from the sternal wounds, and it is recovered from 75% of the cultures<sup>7</sup>. Other commonly isolated microorganisms are *Enterobacter* spp., *E. coli*, *Klebsiella* spp., *Serratia* spp., and *Pseudomonas* spp.<sup>7,8</sup>. Discovery of methicillin-resistant *Staphylococcus aureus* (MRSA) in the cultured samples complicates treatment. No bacterial growth can be observed in 23% of the cultured samples. Thus, all patients, including those with negative cultures, should be placed on therapy with broad-spectrum antibiotics before surgery<sup>8</sup>. *Staphylococci* were isolated from the cultures of all patients in the study. Methicillin-resistant *Staphylococcus aureus* was isolated from two patients, *E. coli* was isolated in addition to *Staphylococcus* in one patient, and *Enterococcus* was isolated from one patient.

Risk factors associated with sternal infections have been divided into groups as preoperative, perioperative and postoperative risk factors. Preoperative risk factors include male gender, smoking, and comorbidities, such as obesity, diabetes, and chronic obstruction pulmonary disease. Perioperative risk factors include operation time, use of left internal mammary artery (IMA) and use of bilateral IMA. Postoperative risk factors include low cardiac output syndrome, prolonged ventilation and postoperative hemorrhage, and repeat sternotomy due to wound dehiscence or delayed primary closure<sup>1,5,9</sup>. Sternal infections easily develop due to impaired cellular and humoral immunity in diabetic patients. Furthermore, use of bilateral IMA may impair presternal blood supply and therefore increase the risk of developing infections<sup>9,10</sup>. In the present study, 12 out of 14 patients had a history of diabetes mellitus. In terms of preoperative risk factors, four patients were male and seven patients were obese. Bilateral IMA was not used in any of the patients. No postoperative complications were encountered.

The initial approach to the repair of infected sternal defects involves extensive debridement of the infected site, wound edges, bone and cartilage. Superficial infections could be treated by abscess drainage if present, wound care and administration of antibiotics, whereas the treatment of deep infections should involve exploration, extensive debridement, removal of foreign bodies and repair of defects with flaps with good vascular supply. Early debridement increases the chance of success in all infections<sup>3,10,11</sup>. The use of various muscle flaps is recommended following debridement and infection control. Skin flaps are of no use

in the treatment. Major pectoral muscle flap (unilateral or bilateral), rectus abdominis muscle or muscle-skin flap, omentum flap, latissimus dorsi muscle flap (unilateral or bilateral) and less often serratus anterior muscle flap could be used<sup>12</sup>. Furthermore, negative-pressure wound therapy products have been recently introduced as an adjunct to usual therapy<sup>13</sup>. Planning of flap reconstruction takes into account the localization and size of the defect. Planned flap is transferred after appropriate and sufficient debridement. The use of more than one flaps is sometimes required<sup>13</sup>. Poor blood supply due to the closure of the wound with high skin tension is one of the reasons for sternal infection and dehiscence<sup>11,13</sup>. Skin tension is not a concern after primary closure; however, if there is a factor causing elevation or tension after closure, such as the use of muscle flap just below the suture line, there is need to relieve tension. In addition, the presence of a defect on a former suture line may complicate primary approximation and suturation. Dehiscence and infections could be observed even suturation has been performed<sup>14</sup>. This requires the use of tension-relieving procedures. Body site is also an important factor for wound closure. Skin tension is remarkable at body sites, such as the sternum known as the midsection of the body, and high-tension areas, such as vertex. Skin defects of 2-3 cm in width in other sites of the body can be closed with primary closure as the skin could elongate physically. This is, however, almost impossible on the sternum.<sup>15</sup>. Various types of flaps can, therefore, be used to relieve the tension, and the present study postulated that Z-plasty technique could relieve the tension in patients who do not have a large tissue defect in whom primary closure would

otherwise produce high skin tension. Flap angle of Z-plasty is important. Theoretically, the advantage that could be obtained with this procedure is predictable. However, in practice, flaps with approximately 60 degrees angle are the most appropriate flaps<sup>16</sup>.

Apart from these, repairs on the anterior chest wall pose the highest risk for the development hypertrophic scars and cheloids. Z-plasty technique both allows good closure by relieving the tension and reduces the risk of developing hypertrophic and cheloid scars<sup>16</sup>. The chance of developing hypertrophic scar on the sternum following coronary artery bypass graft surgery ranges from 10% to 20% in previous studies<sup>17</sup>; however, in the present study, hypertrophic scar was not observed in patients who underwent Z-plasty, whereas one patient who underwent primary repair developed hypertrophic scar and another patient suffered from dehiscence of closure of skin and subcutaneous tissues.

## CONCLUSION

In high-risk patients with sternal infections and dehiscence following coronary artery bypass graft surgery, skin repair with multiple Z-plasties can reduce the rate of complications following muscle flap reconstruction in patients that would develop high skin tension with primary closure.

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