

# Surgical Approach to Cases with Sternal Dehiscence After Sternotomy

## Sternotomi Sonrası Sternal Dehisens Gelişen Olgulara Cerrahi Yaklaşım Yöntemlerimiz

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### ABSTRACT

**Background:** Sternotomy is the most commonly used method of cardiovascular surgery. Sternal instability and infection in the region that develops after sternotomy are serious complications. Reoperation is often required to ensure sternal stability. In this study, we aim to present the surgical methods used in cases of sternal dehiscence.

**Materials and Methods:** Between December 2020 and July 2023, 632 patients who underwent sternotomy due to coronary artery disease and/or valve replacement were retrospectively analyzed at Tekirdağ Dr. İsmail Fehmi Cumaloğlu City Hospital.

**Results:** Surgical intervention was performed in 23 (3.6%) cases with sternal dehiscence. The mean age was 62±8.7 years (range: 40-77) and the majority were male (n=18, 78.3%). The operation types were steel wire removal, steel wire reuse, the Robicsek technique, sternal plate use, and sternal clip use. Two patients who underwent surgery due to sternal dehiscence underwent revision surgery due to recurrent sternal instability. No morbidity or mortality was observed in any patient who underwent surgery due to dehiscence.

**Conclusion:** Sternal dehiscence is a complication that can cause serious morbidity and mortality, and its intervention is important. We prefer the application of sternal clips as the most appropriate and physical support material for ensuring stability.

**Keywords:** Sternotomy, sternal dehiscence, sternal clip

### ÖZ

**Amaç:** Kalp ve damar cerrahisinde sternotomi en sık kullanılan yöntemdir. Sternotomi sonrası gelişen sternal instabilite ve bölgenin enfeksiyonu ciddi bir komplikasyondur. Sternal stabiliteyi sağlamak için sıklıkla reoperasyon gerekmektedir. Bu çalışmada, sternal dehisens gelişen olgulara uyguladığımız cerrahi yöntemleri sunmayı hedefledik.

**Gereç ve Yöntemler:** Tekirdağ Dr. İsmail Fehmi Cumaloğlu Şehir Hastanesi'nde, Aralık 2020 ile Temmuz 2023 tarihleri arasında koroner arter hastalığı ve/veya kapak replasmanı nedeniyle sternotomi uygulanan 632 hasta retrospektif olarak analiz edildi.

**Bulgular:** Sternal dehisens gelişen 23 (%3,6) olguya cerrahi müdahale yapıldı. Yaş ortalaması 62±8,7 yıl (aralık: 40-77) iken büyük çoğunluğu erkek idi (n=18, %78,3). Operasyon tipleri; çelik tel çıkartılması, tekrar çelik tel kullanımı, Robicsek tekniği, sternal plak kullanımı ve sternal klips kullanımı idi. Sternal dehisens nedeniyle operasyon gerçekleştirdiğimiz hastalardan iki tanesi tekrarlayan sternal instabilite nedeniyle revizyon operasyona alınmıştır. Dehisens nedeni ile cerrahi yapılan hiçbir olguda morbidite ve mortalite izlenmedi.

**Sonuç:** Sternal dehisens ciddi morbidite ve mortalite yaratabilecek bir komplikasyondur ve müdahalesi önem arz etmektedir. Stabilite sağlanması açısından en uygun ve fiziksel destekleyici materyal olarak sternal klips uygulamasını tercih etmekteyiz.

**Anahtar Kelimeler:** Sternotomi, sternal dehisens, sternal klips



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## Introduction

Sternotomy is the primary approach in cardiovascular surgery. Despite a median wound infection incidence of 1% among patients undergoing median sternotomy, the associated morbidity and mortality rates remain notably elevated, ranging from 14% to 47%, as reported in the literature (1). There is currently no universally agreed-upon surgical method for managing complex cases of median sternotomy. Essential procedural steps include wound debridement and foreign material removal.

In cases of type I mediastinitis, closed mediastinal irrigation may yield successful outcomes, whereas patients with type II-V mediastinitis likely benefit most from major reconstructive surgery. Advances in diagnostic tools and ongoing evaluation of primary sternal fixation's advantages suggest its potential use alongside reconstructive procedures in type I-III mediastinitis, aiming to enhance outcomes in these high-mortality complications (1).

The patient-related risk factors were obesity, smoking history, hypertension, diabetes, septicemia after sternotomy, use of the bilateral internal mammary artery for coronary bypass, chronic obstructive pulmonary disease, and prolonged use of mechanical ventilation in the postoperative period. In cases of acute infection, treatment includes early debridement, antibiotic therapy, and, in some patients, the use of a pectoralis or omentum flap to improve vascularization. However, in some of these patients, the condition is characterized by stitch opening and chronic wounds. Some separations can only be corrected by debridement and approximation of the edges until the tissues involved are in better condition. Although there are various sternal closure methods, the use of flaps is a standardized method in some modalities. The selection of flap is based on the wound type, and the most important indicator is the amount of tissue loss (2,3).

In this study, we aimed to present the methods and results of sternal dehiscence cases.

## Material and Methods

We retrospectively examined patients who underwent surgery due to sternal dehiscence during the follow-up period and who underwent 632 sternotomies for 518 coronary artery diseases, 71 mitral valve replacements, and 43 aortic valve replacements between December 2020 and July 2023 at Tekirdağ Dr. İsmail Fehmi Cumalıoğlu City Hospital. During the postoperative outpatient clinic follow-up, the development of sternal dehiscence was diagnosed by clinical examination at different time points. Thorax computed tomography was performed for mediastinal area

examination and evaluation of existing steel wires. The acute-phase reactant values were controlled by laboratory investigations.

Close outpatient follow-up of the cases in our clinic and accessibility of the patients to their primary surgeons at all times can facilitate early diagnosis and acceleration of the treatment plan. Due to early diagnosis, no serious infections were observed in this series. After diagnosis, the patients were hospitalized, and intravenous antibiotherapy was started after consultation with the Department of infectious diseases. Perioperative images were discussed with the Department of Infectious Diseases, and antibiotherapy treatment was extended if necessary during the postoperative period.

The fact that the materials used for sternal stabilization are of foreign origin has created access difficulties during the COVID-19 pandemic. In addition, working in a peripheral hospital creates transport difficulties. For this reason, in the first cases, the dislocated steel wires were removed to prevent infection if the risk of recurrence due to a lack of equipment was taken into consideration or if partial field stabilization was relied upon.

During surgery, the infected tissues were debrided, and the dislocated steel wires were removed. Sternal tissue was debrided if necessary. Culture was collected from the infected area, and postoperative antibiotherapy was extended as necessary. Because the risk of sternal dehiscence is high in patients with osteoporotic bone structure, the Robicsek technique was used based on a perioperative decision. The Robicsek technique consists of placing bilateral peristernal double rows of wire sutures and then reconnecting the separated sternal parts with transverse sutures supported by two double axial suture lines (4). The use of sternal clips among locally produced sternal stabilization equipment has increased in our clinic due to the increased accessibility of sternal clips. The surgical methods are presented as radiological imaging and perioperative images in Figure 1.

IBM SPSS Statistics Version 26 software was used. The descriptive results of this study are presented as frequencies with corresponding percentages for nominal or ordinal variables. Continuous variables are presented as mean and standard deviation. Permission for the study was obtained from Tekirdağ Dr. İsmail Fehmi Cumalıoğlu City Hospital Clinical Research Ethics Committee (approval number: 14/2022, date: 16.12.2022). Informed consent forms were obtained.

## Results

A total of 632 median sternotomies were performed, and 23 (3.6%) of them underwent surgical intervention due to the development of sternal dehiscence. The mean age

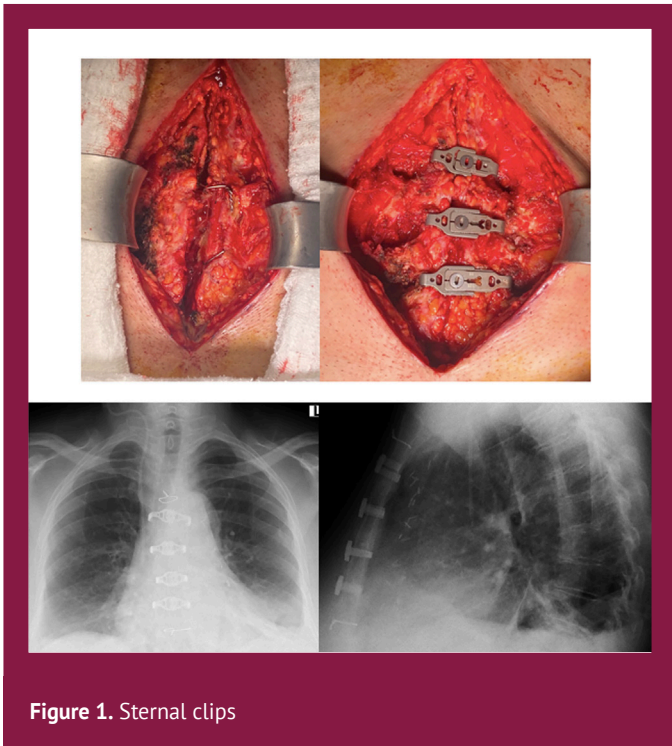


Figure 1. Sternal clips

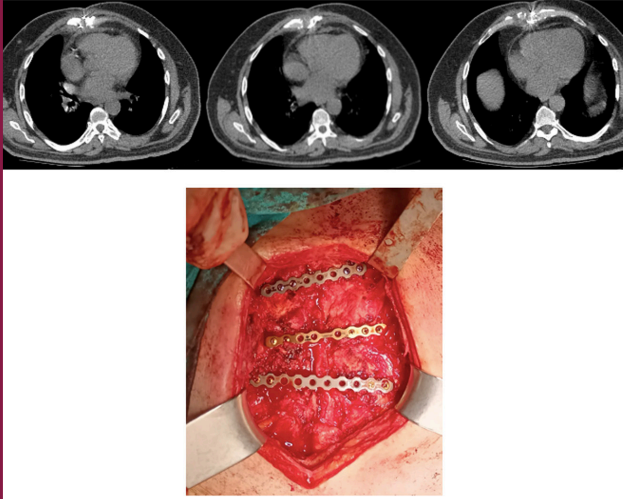
was  $62 \pm 8.7$  years (range: 40-77). There were 18 (78.3%) males and 5 (21.7%) females. Comorbidity was detected in 15 (65.2%) patients. Hypertension was found in 6 (26.1%) patients, chronic obstructive pulmonary disease in 3 (13%), diabetes mellitus in 2 (8.7%), congestive heart failure in 2 (8.7%), asthma in 1 (4.3%), and chronic renal failure in 1 (4.3%). The demographic features of the cases are shown in Table 1.

Local infection was observed in 2 cases (8.7%) and systemic infection in 4 cases (17.4%). Patients with elevated acute-phase reactants were operated after intravenous antibiotic therapy and regression of infection parameters. The types of operation were 4 (17.4%) steel wire removal, 5 (21.7%) steel wire reuse, 4 (17.4%) Robicsek technique, 2 (8.7%) sternal plate use, and 8 (34.8%) sternal clip use. In two patients who underwent surgery again using steel wires due to sternal dehiscence, recurrent sternal instability was observed during the second week of follow-up after discharge. Osteomyelitis due to infection in the sternal tissue caused the steel wires to dislodge again. Intravenous antibiotic treatment and surgery were planned. While a sternal plate was used in one case, a steel wire was used

Table 1. Demographic characteristics of the patients

Patients	Gender	Age	Comorbidities	Infection	Surgical types
1	Male	77	Hypertension	Local	Wire removal
2	Male	59	Asthma	Local	Wire removal
3	Male	66	Heart failure	Systemics	Wire removal
4	Male	50	None	None	Wire removal
5	Male	68	Hypertension	None	Reuse of wire*
6	Male	62	Hypertension	None	Reuse of wire*
7	Male	51	None	None	Reuse of wire
8	Male	58	None	Systemics	Reuse of wire
9	Male	67	Diabetes mellitus	Systemics	Reuse of wire
10	Male	62	Renal failure	None	Robicsek technique
11	Female	73	Hypertension	None	Robicsek technique
12	Male	75	None	None	Robicsek technique
13	Female	56	Heart failure	None	Robicsek technique
14	Male	40	None	None	Plaque technique
15	Male	62	None	Systemics	Plaque technique
16	Male	58	Hypertension	None	Sternal clip
17	Male	53	None	None	Sternal clip
18	Male	65	None	None	Sternal clip
19	Male	66	None	None	Sternal clip
20	Female	61	Hypertension	None	Sternal clip
21	Female	61	None	None	Sternal clip
22	Female	60	Diabetes mellitus	None	Sternal clip
23	Male	74	Chronic obstructive pulmonary disease	None	Sternal clip

\*Reoperations are the reuse of the wire and plaque technique



**Figure 2.** Sternal plate



**Figure 3.** Robicsek technique

again in the other case due to difficulty in accessing the material. No recurrence of sternal instability was detected during follow-up after discharge.

No complications related to the procedure were observed after surgery. During follow-up of the cases, no

recurrent sternal instability, hemorrhage, wound infection, or mediastinitis was observed. The patients were followed up in the postoperative ward, and the patients whose antibiotherapy treatment was completed were discharged. No mortality or morbidity events were observed.

## Discussion

Sternal dehiscence and mediastinitis after sternotomy, which is preferred for cardiovascular and thoracic surgery, is a complication that negatively affects quality of life and may cause serious morbidity and mortality. Among the complications, the development of mediastinitis is particularly an indicator of poor prognosis. For reference, the classification of mediastinitis is presented in Table 2(1).

In the study by Gucu et al. (5), nitinol thermo-reactive clips were used in patients with sternal dehiscence. This method was found to be safe, easy, and effective for non-infective secondary sternal closure. No recurrent dehiscence or instability was observed in the postoperative period. It has been reported that the advanced shape memory and flexibility of nitinol clips facilitate their use (5).

In the study by Ergene et al. (6), cases of sternal fractures who were admitted to the emergency department because of trauma were analyzed. In 66% of the cases with additional system pathologies, the operation was usually performed on the second post-traumatic day after stabilization was achieved. The radius plate used in radius fractures was reshaped to fit the sternal region perioperatively, and stabilization was provided. The technique using a locked volar distal radius plate was found to be safe and effective. It has been reported that large vessel injuries are avoided with the use of a sternal stabilization system that does not require the mediastinum (6).

Lafci et al. (7) modified the Robicsek technique in their study. The Robicsek technique is based on the principle of strengthening the side by passing a steel wire through intercostal spaces to strengthen the unstable sternal region. In this study, the method was modified. In the bilateral intercostal region, the Robicsek technique was applied, and the sternum strength was doubled using a figure of 8-sutures in the sutures to be applied horizontally. It has been reported that it does not require the use of a plate or clip and therefore does not incur additional costs (7).

In a study by Şahin et al. (8) in 2022, 13 cases were included, and vacuum-assisted closure treatment was applied before secondary closure. The application was performed as 1-10 (Median: 4), and surgical closure was decided if the culture result was negative. In 10 patients, the omentum was removed transdiaphragmatically and placed in the sternal cavity. During follow-up, seroma and local infection recurrence were observed in two patients,

**Table 2. Classification of mediastinitis among patients undergoing cardiovascular surgery**

Class	Description
Type I	Mediastinitis occurring within 2 weeks after surgery without the presence of additional risk factors
Type II	Mediastinitis appearing between 2 and 6 weeks after surgery without additional risk factors
Type IIIA	Type I mediastinitis with one or more risk factors
Type IIIB	Type II mediastinitis with one or more risk factors
Type IVA	Mediastinitis Types I, II, or III after unsuccessful initial treatment
Type IVB	Mediastinitis Type I, II, or III persisting after more than one unsuccessful treatment attempt
Type V	Mediastinitis more than 6 weeks after surgery, presenting for the first time

and incisional hernia was found in one patient. Thoracic stabilization was achieved in all patients (8).

In a study by Arazi et al. (9) in 2022, modified stenoplasty was used in deep mediastinitis and sternal dehiscence. After freeing the area to the level of the middle clavicular line, the sternum is approximated with horizontal steel wires after the use of sagittal steel wires between the costae. The bilateral pectoral muscle flap is pulled to the area, and closure is performed. Femoral-femoral cardiopulmonary bypass can be performed to release adhesions and to be safe during the sternal re-entry phase. Although an increase in postoperative complications and length of hospitalization was observed, this method was reported to be safer (9).

Sternal dehiscence is a complication that can cause serious morbidity and mortality, and its intervention is important. We prefer the application of sternal clips as the most appropriate and physical support material for ensuring stability. The use of sternal clips among locally produced sternal stabilization equipment has increased in our clinic due to the increased accessibility of sternal clips. Supporting the sternal area from the bilateral lateral area is the best stabilization technique. The reciprocity of bone ends supports osteogenesis and has the advantage of not affecting blood flow in the region. The only disadvantage of this approach is that it slightly increases the access time to the cardiac area in cases requiring urgent re-sternotomy. Sternal stabilization were achieved with the use of sternal plate and Robicsek technique, and we prefer to use the sternal clip technique in our clinic.

## Ethics

**Ethics Committee Approval:** Permission for the study was obtained from Tekirdağ Dr. İsmail Fehmi Cümaliöğlü City Hospital Clinical Research Ethics Committee (approval number: 14/2022, date: 16.12.2022).

**Informed Consent:** Informed consent forms were obtained.

## Footnotes

### Authorship Contributions

Surgical and Medical Practices: M.Ü., H.A., Concept: M.Ü., Design: M.Ü., Data Collection or Processing: M.Ü., Analysis or Interpretation: M.Ü., Literature Search: H.A., Writing: M.Ü.

**Conflict of Interest:** No conflict of interest was declared by the authors.

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