



Comparison of Sternum Closure Techniques with Sternal Cable and Simple Wire After Open Heart Surgery

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Rifat Özmen¹ , Ali Tekin² 

ABSTRACT

Objective: Median sternotomy is the most commonly used method for open heart surgery. Poor sternal healing after median sternotomy can cause a significant increase in morbidity and mortality and prolong hospital stay. Although several techniques are available for sternal closure, it is practically limited, and the most common technique is the simple wire technique. There is insufficient scientific study on the comparison of alternative techniques. The aim of the present study was to compare the follow-up results of the sternotomy closure techniques: sternal cable and simple wire.

Materials and Methods: Overall, 246 (141 male and 105 female) adult patients who underwent sternotomy closure with sternal cable (99) and simple wire (147) after open heart surgery were examined retrospectively. Patients' postoperative length of hospitalization, sternal dehiscence, local infection, mediastinitis, and mortality rates were evaluated. Resternotomy requirement due to sternal decomposition and surgical site infections was also evaluated. Statistical comparisons were made in terms of the parameters mentioned above.

Results: When the groups were compared in terms of age, gender, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), chronic renal failure (CRF), and smoking status, there was no statistically significant difference ($p > 0.05$). The percentage of the patients' coronary artery bypass grafting+mitral valve replacement (9.09%) was higher ($p = 0.028$) in the sternal cable group than in the simple wire group. The cross-clamp time was longer in the sternal cable group (81.24 ± 31.91) than in the simple wire group (74.08 ± 17.67) ($p = 0.044$).

Conclusion: Postoperative complications in the sternal cable group were less frequent but statistically not significant in our study. According to our results, sternal cable is effective and can be used as a good alternative to simple wire.

Keywords: Sternal dehiscence, closure technique, cardiac surgery, sternal cable, simple wire

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¹Department of
Cardiovascular Surgery,
Kayseri Training and Research
Hospital, Kayseri, Turkey
²Department of
Cardiovascular Surgery,
Health Science University,
Kayseri Health Application
and Research Center, Kayseri,
Turkey

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Correspondence
Rifat Özmen, Department
of Cardiovascular Surgery,
Kayseri Training and Research
Hospital, Kayseri, Turkey
e.mail:
rifatozmen@gmail.com

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INTRODUCTION

Nowadays as the average life span increases, cardiovascular disease rates are also on the rise. Therefore, there is an increase in minimally invasive methods for open heart surgery, and the most commonly used incision is median sternotomy (1, 2). In the early 1960s, Julian's median sternotomy was successfully performed in cardiovascular surgery (3). However, the development of sternal dehiscence after median sternotomy can be predicted in the presence of various risk factors. These risk factors include obesity, chronic renal failure (CRF), chronic obstructive pulmonary disease (COPD), smoking, internal mammary artery (IMA) grafting, long cardiopulmonary bypass (CPB) duration, excess blood transfusion, inappropriate fixation methods and osteoporosis (1).

Although the incidence of sternal complications is between 0.5% and 2.5%, the mortality rate varies between 10% and 40% in patients with complications. A good sternal fixation is essential to avoid postoperative complications of the sternotomy. Generally, if the closing technique is durable, and a good rigidity is provided, successful results can be obtained. Up to the present, many different techniques have been developed, and many different materials have been used to achieve the best stability during sternal closure (4-6). However, the studies performed to compare these methods are limited, which makes it difficult to evaluate and compare the advantages and disadvantages of these methods (7). The aim of the present study was to compare retrospectively the outcomes of the sternal simple wire closure method with the sternal cable method that has recently been proposed as an alternative method.

MATERIALS and METHODS

Patients

A total of 246 (141 male and 105 female) patients who underwent open heart surgery between February 2014 and May 2016 in the Kayseri Training and Research Hospital Cardiovascular Surgery Clinic were evaluated

retrospectively. Surgical permission forms were obtained before surgery. Ethical approval for the study was obtained from the ethics committee of Erciyes University Faculty of Medicine (E.C. no.: 2018/233, date: 09/05/2018). All patients underwent similar preoperative preparations for different cardiac procedures that were using standard median sternotomy (coronary artery bypass grafting (CABG), IMA grafting, aortic valve replacement, and mitral valve replacement (MVR)) (Table 1).



Figure 1. Sternal cable intraoperative photo.



Figure 2. Simple sternal wire intraoperative photo.

The Social Security Institution-Health Application Communique (SUT) has been taken into consideration in determining which patients will receive the sternal cable. According to the SUT criteria, patients >80 years old and with sternal fracture, COPD, bilateral IMA, CRF, and body mass index ≥ 30 were included in the sternal cable group. The sternal cable patients were selected among these patients retrospectively. Sternal simple wire patients were selected among patients whose sternal closure methods were recorded as simple wire. One of the aims of the present study was to determine whether sternal dehiscence developed in both methods during the follow-up period. It is known that osteoporosis may increase the sternal fracture. Therefore, we excluded patients who had previously undergone sternotomy and had intraoperative sternal bone osteoporosis.

After the groups were identified, patients' CRF, COPD, coronary artery disease, diabetes mellitus (DM), and smoking status were questioned. Then, patients' postoperative length of hospitalization, sternal dehiscence, local infection, mediastinitis, and mortality rates were evaluated. Resternotomy requirement due to sternal decomposition and surgical site infections was also evaluated.

Surgical Procedure

In 99 patients after median sternotomy, pioneer sternal cable system (RTI Surgical Cable®, part no. 400-890) was used (Figure 1). This sternal cable consisted of multi-strand stainless steel and titanium cables. In 147 patients, the conventional simple wire method was used for sternal closure. The monofilament 316 LVM Stainless Steel Surgical Cables (made from 100% stainless steel alloy, nickel ratio 0.5%-15.0%, and chromium ratio 12.0%-19.0%) (Figure 2) were used for conventional wiring. Multiple "figure-of-8" wire sutures were used during the sternal closure to provide optimal stabilization in both techniques. The operation durations (CPB and cross clamp time) of both methods were compared (Table 1).

Statistical Analysis

Categorical variables were expressed as number and percentage (%), and continuous variables were presented as mean \pm standard deviation. The normality test of the numerical variables was tested using the Kolmogorov-Smirnov test. Independent Samples t-test was used for independent two group comparisons. Differences between categorical variables were compared using the Pearson chi-square test.

For statistical analysis, the Jamovi (Jamovi Project 2018, version 0.9.1.7, retrieved from <https://www.jamovi.org>) (open source) program was used. A p-value<0.05 was considered as significant.

RESULTS

When the groups were compared in terms of age, gender, DM, COPD, CRF and smoking status, there was no statistically significant difference ($p>0.05$) (Table 2).

The percentage of the patients' CABG+MVR (9.09%) was higher ($p=0.028$) in the sternal cable group than in the simple wire group. The cross-clamp time was longer in the sternal cable group

(81.24±31.91) than in the simple wire group (74.08±17.67) ($p=0.044$) (Table 1). In postoperative week 6, patients with poor bony healing that was proven in the radiological and physical examinations were diagnosed as sternal dehiscence. Sternal dehiscence developed in three patients who received sternal cable. Resternotomy and revision were performed to these patients. According to the records, mediastinitis, local wound infection, or leakage was not detected in the sternal region in these patients.

According to the records, four patients in the sternal simple wire group developed sternal dehiscence, infection, and mediastinitis that required sternal re-wiring. Debridement, antibiotherapy, and sternal re-wiring were performed on these patients. The average hospitalization period of these patients was 4-6 weeks. In the sternal cable group, no infection, mediastinitis, or sternal re-wiring was recorded. In the sternal simple wire group, local wound infection developed in three patients due to wire reaction. Under local anesthesia, local wound site debridement and wire extraction were performed on these patients. The average hospitalization period of these patients was 3-5 days.

Table 1. Surgical procedures and the duration of the operations

	Sternal Cable Group	Simple Wire Group	p
IMA grafting	84 (84.85)	132 (89.8)	
CABG	87 (87.88)	138 (93.88)	
AVR	3 (3.03)	3 (2.04)	
CABG+MVR	9 (9.09)	3 (2.04)	0.028
MVR	0 (0)	3 (2.04)	
CPB time (min)	101.82±42.75	96.45±32.72	0.291
XCL time (min)	81.24±31.91	74.08±17.67	0.044

Categorical variables presented as number (%) and continuous variables presented as mean±standard deviation
 IMA: Internal mamarian artery; CABG: coronary artery bypass grafting; AVR: aortic valve replacement; MVR: mitral valve replacement; CBP: cardiopulmonary bypass; XCL: cross-clamp

Table 2. Baseline demographic characteristics of the patients

Demographic Characteristics	Sternal Cable Group	Simple Wire Group	p
Age (Year±SD)	59.02±7.97	59.8±7.25	0.430
Gender (Female/Male)	39 (39.39)/60(60.61)	66 (44.9)/81(55.1)	0.392
CRF	3 (3.03)	5 (3.4)	0.371
COPD	39 (39.39)	54 (36.73)	0.673
DM	69 (69.7)	96 (65.31)	0.472
Smoking	45 (45.45)	57 (38.78)	0.297

Categorical variables presented as number (%) and continuous variables presented as mean±standard deviation
 CRF: chronic renal failure; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; SD: standard deviation

DISCUSSION

With the increase in the average life span, there is also an increase in cardiac diseases. Though there is an increase in minimally invasive methods in open heart surgery, the most commonly used incision method is median sternotomies (1, 2). As a result of the complications that could occur in the superficial or deep sternal areas in the region and could lead to a significant cost increase, it has come across with both increased mortality and morbidity. Although the simple wire method is the most commonly used sternum closure technique today, new methods can be used for sternal reconstruction instead of conventional simple wire. In complicated cases such as multiple sternal fractures, infections, postoperative dehiscence, reoperations or osteoporosis another technique might be useful (1, 8-13). In our study, sternal dehiscence developed in both groups, and re-wiring was performed using sternal cable for all these patients. In the sternal cable group, no infection was detected in patients who developed dehiscence, but in the simple wire group, all patients had infections. Factors, such as obesity, osteoporosis, non-midline sternotomy, peripheral artery disease, smoking, and inadequate bone fixation, contribute to the development of sternal dehiscence (14). Nevertheless, when the groups were compared in terms of age, gender, DM, COPD, CRF and smoking status, there was no statistically significant difference in our study.

Tunçay et al. (1) evaluated six uninfected sternal dehiscence where sternal reconstruction was performed with sternal clips. They reported that sufficient bone healing has occurred, and early postoperative pain has decreased. Comparably in our study, re-wiring was performed using sternal cable in patients who developed sternal dehiscence in both groups, and success in treatment was achieved.

Melly et al. (3) aimed to compare the sternal cable and sternal wire techniques in terms of infection and other infectious events. They indicated that there is no statistically significant difference when comparing cable with wire in terms of sternal infection. The postoperative complications were similar in both sternal closure methods. In our study, whereas no infection or wire reaction was observed in the sternal cable group, both infection and wire reaction were observed in the simple wire group. Melly et al. (3) also suggested that the cable technique is fast, easy to use, reliable, and safe. On the contrary, cross-clamp time was longer in the sternal cable group in our study. However, this may be due to the fact that the percentage of patients who underwent CABG+MVR was higher in the sternal cable group in our study.

Grapow et al. (9) aimed to evaluate the short time results of the cable-tie-based closure system. In their study, sternal instability was not observed during postoperative day 30. They suggested that the short time results of the cable-tie-based closure system are satisfactory and can be used safely and effectively. They also stated that the cable-tie-based closure system is fast, easy to use, and can be alternative for traditional wire closure. In the present study, however, no comparison was made between simple wire and sternal cable.

Similar to our study, Oh et al. (7) and Dunne et al. (8) aimed to compare the effects of sternal cable and sternal wire techniques that were performed for sternal closure after cardiac surgery.

Oh et al. (7) compared the surgical outcomes of the multifilament cable with multifilament stainless steel wire of 1354 patients' retrospectively examined. They did not observe significant differences between the two groups in terms of mortality, major wound complications requiring reoperation, minor wound complications or mediastinitis. They indicated that the multifilament cable group has fewer sternal bleeding but it is not statistically significant (7). Dunne et al. (8) suggested that the sternal cable method seems to help early extubation after cardiac surgeries, but it does not reduce the rate of deep sternal infections. In these two studies, which are similar to ours, the superiority of the sternal cable to the simple wire was not clearly demonstrated. Similar results were obtained in our study. Although, various complications (e.g., sternal dehiscence, sternal bleeding, infections, and prolong extubation time, among others) appear to be less in the sternal cable technique according to these studies including ours, no statistical significance was shown.

However, it was stated in all studies that the sternal cable technique is as simple, reliable, and effective as the simple wire method and could be used as an alternative method.

There was no statistical difference between the groups in terms of demographic characteristics in our study. This suggests that the two groups were proper for comparison. However, our study has limitations, such as being retrospective and is not randomized.

CONCLUSION

In our study, postoperative complications in the sternal cable group were less frequent but not statistically significant. According to our results, sternal cable is effective and can be used as a good alternative to simple wire. In order to make this comparison more accurate, there is a need for randomized studies with more parameters and more patients.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Erciyes University Faculty of Medicine (Decision Date: 09/05/2018/Decision No: 2018/233).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Conceived and designed the experiments or case: RÖ, AT. Performed the experiments or case: RÖ, AT. Analyzed the data: RÖ, AT. Wrote the paper: RÖ, AT. All authors have read and approved the final manuscript.

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