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Comparison of the sternal wires and sternal cable in closure of the sternum during cardiac surgery

Yücel Özen, Sabit Sarıkaya, Murat Bülent Rabuş, Deniz Günay, Eray Aksoy, Mehmet Dedemoğlu, Kaan Kırali

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Objectives: This study aims to compare the effectiveness of the sternal cable system (Cable group) with the standard monofilament system (Wire group) in the sternal closure of cardiac surgery patients.

Patients and methods: Between January 2014 and September 2014, a total of 56 patients were included. The patients were divided into two groups according to the closure modality. The Cable group in whom the sternal cables were used consisted 24 patients, whereas the Wire group included 32 patients. Risk factors such as obesity, chronic obstructive pulmonary disease, diabetes mellitus, reoperation and closure with figure-of-8 were considered in the selection of these patients. The length of intensive care unit and hospital stay, blood drainage, infection and sternal complications were compared between the groups.

Results: Preoperative and perioperative variables between two groups were similar. There was no postoperative sternal complications for the Cable group, however, sternal dehiscence and superficial wound infections were observed in two patients in the Wire group. An inflammatory reaction to the wire developed within one month in a patient.

Conclusion: We recommend using sternal cable system instead of wires in the patients having risk factors for sternal instability.

Keywords: Cable; obesity; sternal dehiscence.

Median sternotomy is the standard approach in open heart surgery. It is also necessary to perform sternal closure properly. Although this procedure is relatively simple, sternal complications such as dehiscence, sternal nonunion or infection may occur about 0.25-5%.[1,2] The mortality rate is observed up to 25% in patients with a deep sternal wound infection.[3,4] Furthermore, higher costs for hospitalization are present due to prolonged hospital stay.

The predisposing factors which may cause such complications, namely chronic obstructive pulmonary disease (COPD), high body mass index, diabetes mellitus, older age and smoking are defined in several studies.[4] We assume that sternal dehiscence and infection ratios can be reduced by using a reliable closure technique. In this study, we compare the patients in whom we used a sternal cable and sternal wire in aspects of postoperative complications.

PATIENTS AND METHODS

The sternal cable system (Pioneer Surgical Technology, Inc., Marquette, Michigan, USA) was inserted in 24 patients during a six-month period. The patients in whom we performed open heart surgery by median sternotomy were divided into two groups. We also included the patients whose body mass index was over 30 and sternum was closed by figure-of-8 in both groups. The patients with a sternal wire closure were selected retrospectively. We compared postoperative drainage, the length of intensive care unit (ICU) and hospitalization stay, admission time, sternal infection and sternal dehiscence ratio between two groups.

Surgical technique

The cables were in the same diameter with the standard wires. They were inserted by using multiple figure-of-8 suturing constructs, each were tightened with a gauged instrument and were fixed in place with a reproducible crimp type device (Figure 1). We provided the 8 figure by passing the wire through the intercostal space and secured it with special clips (Figure 2). Three cables were used for each patient which resulted a tighter and more

Department of Cardiovascular Surgery, Kartal Koşuyolu Yüksek İhtisas Training and Research Hospital, İstanbul, Turkey

Corresponding author: Yücel Özen, M.D. Kartal Koşuyolu Yüksek İhtisas Eğitim ve Araştırma Hastanesi Kalp ve Damar Cerrahisi Kliniği, 34844 Cevizli, Kartal, İstanbul, Turkey.
Tel: +90 505 - 872 76 56 e-mail: yucelozen74@yahoo.com

Figure 1. Closure device.

evenly distributed force than the use of wires. It also eliminated the human variable of determining how tight each wire actually was and the potential for wire fatigue and breakage due to over tightening.

Statistical analysis

Statistical analysis was performed using SPSS version 15.0 software (SPSS Inc., Chicago, IL, USA). Compliance with the normal distribution of variables were analyzed by visual (histograms and probability graphics) and analytical (Kolmogorov-Simirnov/ Shapiro-Wilk tests) methods. Descriptive analyses were done for categorical variables. Descriptive statistics for categorical data was presented in the mean and the standard deviation of the bionormally distributed samples. Median and interquartile values were used for samples with non-normal distributions. The significance between the Cable group and Wire group for abnormally distributed parameters was assessed with the Mann-Whitney U test. Categorical parameters between the Cable group and Wire group were compared with the chi-square and Fisher's exact test. A p value of <0.05 was considered statistically significant.

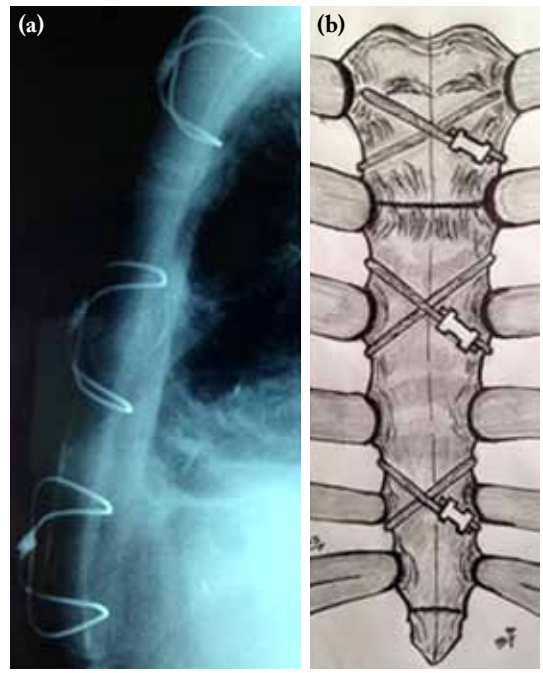

Figure 2. Figure-of-8 suturing **(a)** X-ray image. **(b)** Figure-of-8 which made by crossing intercostal spaces.

RESULTS

Demographic data of two groups are shown in Table 1. There were no statistically significant differences between preoperative variables. Surgical interventions of the patient groups are shown in Table 2.

Table 1
Demographic data of the patients

Parameter	Cable group (n=24)			Wire group (n=32)			
	n	%	Mean±SD	n	%	Mean±SD	p
Age			66.2±8.9			64.0±9.0	0.4
Sex							
Male	15	62.5		23	71.9		0.80
Body mass index (kg/m^2)			34.4±3.1			34.2±2.7	0.92
Smoking	11	45.8		8	25		0.02
Diabetes mellitus	6	25		5	15.6		0.29
Chronic obstructive pulmonary disease	4	16.6		5	15,6		0.68
Renal failure	1	4.1		2	6,3		0.85
Operative time (min)			156±45			176±64	0.71
Ejection fraction			52±13			49±24	0.58
Logistic EuroSCORE			16±13			19±17	0.44

Table 2
Surgical procedures

Variables	Cable group (n=24)	Wire group (n=32)
CABG	15	18
AVR	2	3
MVR	3	1
CABG + AVR	1	2
AVR + MVR	0	1
CABG + MVR	1	3
AASGI + CABG	1	2
REDO CABG	1	2

CABG: Coronary artery bypass graft; AVR: Aortic valve replacement; MVR: Mitral valve replacement; AASGI: Ascending aortic separated graft interposition.

Three cables were used to maintain 8 figures. Hemi-sternums were converged with the use of equal pressure by closure device. Postoperative data of the Wire group and Cable group are presented in Table 3. The drainage amount of the Wire group was less than the Cable group (p=0.001). The hospitalization time was significantly shorter in the Cable group (p=0.004). Sternal dehiscence in three patients and sternal revision in five patients were observed in the Wire group, however, there was no statistically difference among two groups. The closure via cable was longer than the closure time with a wire. The right internal mammary artery was injured by the cable put through the intercostal space in one patient. In the Cable group, one patient in whom cardiovascular resuscitation was performed about 15 minutes had a ventricular fibrillation attack at early postoperative period. This patient was discharged without sternal dehiscence.

DISCUSSION

Median sternotomy was first described by Minton[5] in 1887 and still remains the most common surgical approach in cardiac surgery. The incidence of sternal dehiscence was reported to be 0.5% to 8% depending on the presence of a mechanical defect, and type and degree of the infection.[6] In addition, several techniques have been described for the sternal closure. This study was conducted to investigate whether a sternal cable could be an alternative to the sternal wire. In this study, we compared the patients with sternal closure via a cable by a single surgeon and those via a wire by several surgeons. The selection of the patients were utilized by the body mass index >30 and the use of figure-of-8 in the sternal closure in both groups. Urgent cases were excluded from the study.

Although many materials have been used for the sternal closure so far, a sternal wire has been widely adopted currently. Grapow et al.[7] used a new material namely ZipFix, which had successful results. Permut et al.[8] performed the cable system in pediatric patients and reported that the ratio of postoperative pain and restlessness were relatively low in this patient population. The postoperative pain and painkiller use were relatively low in patients in the Cable group. Corset was not used in any patient. Superficial wound infection was observed in one patient, while dehiscence was not found in any patient. The length of hospital stay was significantly shorter in the Cable group.

In conclusion, although there were no statistically significant difference between two groups, we conclude that sternal cable system can be used safely instead of standard sternal wire in patients whose body mass index are >30 and those with comorbidities. However, further large-scale studies are required to establish a conclusion.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Table 3
Postoperative variables

Parameter	Cable group (n=24)			Wire group (n=32)			
	n	%	Mean±SD	n	%	Mean±SD	*p*
Drainage (mL)			499.0±218.3			741.9±243.3	0.001
Intensive care unit stay (day)			2.4±0.8			4.3±4.5	0.14
Hospitalization time (day)			7.2±2.0			13.6±15.1	0.004
Bleeding revision	1	4.16		3	9.4		1
Dehiscence	0	0		3	9.4		0.27
Superficial wound infection	1	4.16		5	15.6		0.38

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