Sternal Steel Wire Combined with Sternal Closure Systems for The First Sternotomy Closures in Patients with High Risk for Sternal Complications; Thermoractive Nitinol Clips or Titanium Sternal Closure Plate?

Sternal Komplikasyon Riski Yüksek Hastalarda İlk Sternotomi Kapamalarında Çelik Tel İle Sternal Kapatma Sistemlerinin Kombinasyonu: Termoreaktif Nitinol Klips Mi? Titanyum Sternal Kapatma Plağı Mı?

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Öz

Bu çalışmada ilk sternotomilerin kapatılmasında kullanılan geleneksel çelik tel yöntemi, bu yöntem ile yüksek riskli hastalarda kombine edilen termoreaktif nitinol klips (TNK) veya titanyum sternal kapatma plağı (TSKP) kullanımı sonrası gelişebilecek sternal komplikasyon oranları gruplar arasında karşılaştırıldı. Mayıs 2018 – Ekim 2020 tarihleri arasında median sternotomi ile açık kalp cerrahisi uygulanan toplam 210 hasta (153 erkek, 57 kadın; ortalama yaş 62.87±10.21; dağılım 21-86 yıl) geriye dönük olarak incelendi. Hastalar sade çelik tel uygulanan (n=179), çelik tel ile TNK uygulanan (n=17) ve çelik tel ile TSKP uygulanan (n=14) olmak üzere üç gruba ayrıldı. Gruplar arasında demografik, klinik özelliklere ve postoperatif sternal komplikasyon oranları karşılaştırıldı. Sadece geleneksel çelik tel yöntemi ile sternotomisi kapatılan toplam 2 hastada (%1.1) sternal dehisens, toplam 2 hastada (%1.1) yüzeyel cilt enfeksiyonu gelişti. Çelik tel ile TSCP'nin kombine edildiği grupta ise 1 hastada (%7.1) yüzeyel cilt enfeksiyonu saptandı. TNK ve TSCP kullanılan gruplarda sternal dehisens izlenmedi. Her üç grup arasında sternal komplikasyonlar açısından istatistiksel bir fark saptanmadı. TNK ve TSKP kullanılan gruplarda diyabet oranı yüksek saptandı (p=0.002). Hastalar vücut kitle indekslerine (VKİ) göre dört gruba ayrıldı. Sadece geleneksel çelik tellemeye kıyasla TNK ve TSKP kullanılan hastalarda 35-39.9 ve >40 kg/m^2 VKİ oranları anlamlı saptandı (p<0.001). TNK ve TSKP kullanımı üzerinde forward stepwise multinominal lojistik regresyon modeli oluşturularak kendi aralarında değerlendirildi. TNK için DM (OR=8.26), 30-34.9 kg/m^2 VKİ (OR=14.28) anlamlı etkiye sahip bulundu. TSKP kullanımı üzerinde 30-34.9 (OR=41.66) ve 35-39.9 kg/m^2 VKİ (OR=10.75) varlığı anlamlı etkiye sahip bulundu. TNK veya TSKP'nın özellikle sternal dehisens riski yüksek hastalarda ilk sternotomiyi kapatmakta geleneksel çelik tel ile kombine edilmesinin gelişebilecek sternal komplikasyonları azaltabileceği ve güvenle kullanılabileceği kanaatindeyizdir.

Anahtar Kelimeler: Nitinol Klips, Sternal Dehisens, Titanyum Plak

Abstract

In this study, we aimed to compare the sternal complication rates of traditional steel wire closure, steel wire combined with thermoreactive nitinol clips (TRC) or steel wire combined with titanium sternal closure plate (TSCP) methods used in first sternotomy closures in high risk patients. 210 patients (153 males, 57 females, mean age 62.87±10.21, distribution 21-86 years) that underwent open heart surgery via median sternotomy between May 2018-October 2020 were studied retrospectively. The patients were divided into three groups according to the methods used for sternal closure as; steel wire only (n=179), steel wire combined with TRC (n=17) and steel wire combined with TSCP (n=14). The groups were compared in terms of demographic changes, clinical specifications, and sternal complication rates. Sternal dehiscence was evaluated in 2 patients (1.1%) whose sternums were closed with only steel wire, and among all the patients included in the study, superficial wound infection was seen in these 2 patients (1.1%). Superficial wound infection was seen in 1 patient (7.1%) in the group where TSCP combined steel wire was used. No sternal dehiscence was seen in patient groups in which TSCP and TRC were used. There was no statistical significance observed regarding sternal complications among three group. DM ratio was higher among the TRC and TSCP groups (p=0.002). The patients were divided into four groups according to their body mass indexes (BMI). The BMI rates of 35-39.9 and> 40 kg/m^2 were found to be significant in the patients for whom TRC and TSCP used (p <0.001) in comparison with the BMI rates of the patients to whom conventional steel wiring was applied. A forward stepwise multinomial logistic regression model was created to evaluate the use of TRC and TSCP. DM (OR=8.26) and 30-34.9 kg/m^2 BMI (OR=14.28) were found significantly effective for TRC. 30-34.9 kg/m^2 and 35-39.9 kg/m^2 BMI (OR=10.75) were found significantly effective for TSCP. We believe that using reinforced stell wire with TSCP and TRC for closure of first sternotomies was safe and could prevent further possible sternal complications among the patients that have high risks of sternal dehiscence.

Keywords: Nitinol Clips, Sternal Dehiscence, Titanium Plaque

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Introduction

Although minimally invasive procedures become more popular in cardiac surgery, today median sternotomy is still the most frequently used choice of surgical approach to heart in open heart surgeries (1,2). Sternal dehiscence, sternal wound infection, mediastinitis and osteomyelitis are major complications of median sternotomy approach that are seen approximately 0.5-2.5% and mortality rates

for these complications are about 10-40% (3). Older age, chronic obstructive pulmonary disease (COPD), New York Heart Association (NYHA) class IV status, low ejection fraction (EF), osteoporosis, bilateral internal mammary artery (IMA) harvesting, peripheral vascular disease (PVD), surgical reexploration, intra-aortic balloon counterpulsation (IABP), extracorporeal membrane oxygenation (ECMO) support, prolonged ventilation and sepsis are among the risk factors for the development of complications following sternotomy (4,5).

To prevent the complications of sternotomy, proper and safe sternal stabilization is needed. Generally, technique of a well reinforced sternal closure should be applied for preventing sternal dehiscence (6,7). Sternal closure technique using stainless steel wires is the most frequent method for sternotomy closure worldwide (8). However, many closure techniques that are using different materials are applied for sternal closure. But there are still some controversies about the best method for sternal closure (6-9). In our study, we aimed to compare the standard sternal closure technique using steel wires with the closure techniques using steel wires reinforced with thermoreactive nitinol clips (TRC) and steel wires reinforced with titanium sternal closure plate (TSCP).

Material and Method

The present case–control study was conducted in accordance with the principles of the Helsinki Declaration and approved by the Isparta Suleyman Demirel University Clinical Research Ethics Committee (22/10/2020-334). The written consent form was obtained from all the patients that were included in the study. The data of two hundred and ten patients that underwent open heart surgery in cardiovascular department between May 2018-October 2020 were collected and studied retrospectively. All operations were performed in the same institution by the same 3 adult cardiac surgeons. Patients were divided into three groups based on the technique applied to them as; group 1: classic sternotomy closure technique using steel wire, group 2: closure technique using steel wire reinforced with TRC, group 3: closure technique using steel wire reinforced with TSCP. BMI>30, age>80, COPD (FEV1 <%80, FEV1/FVC <%70), chronic kidney failure and neoadjuvant chemotherapy were determined as the criteria for use of TRC or TSCP. TRC and TSCP were never used together on any patient. Patients that died in the first month following surgical procedure and patients that needed reexploration via redo median sternotomy were excluded.

Detailed medical history, physical examination and routine blood tests, echocardiogram, electrocardiogram, chest radiogram and respiratory function tests, and body mass index (BMI) were performed to all the patients that were planned to have an open heart surgery. Patients that continued smoking on the date of coronary angiography were considered as a smoker. Endocrinology consultation was requested from the patients who had a previous diagnosis of DM, and the patients who did not have a diagnosis of DM but had fasting blood glucose >126 mg/dl and the diagnosis of DM was confirmed. Patients who had previously received antihypertensive treatment and those who had >130/85 mm/Hg blood pressure during clinical follow-up were considered hypertensive (HT) patients. All patients that had COPD were evaluated by a chest physician with pulmonary function tests, and those who could not perform pulmonary function tests were evaluated with arterial blood gas analysis and physical examination. Patient data were evaluated for cardiopulmonary bypass (CPB) time, cross clamp (x-clamp) time, amount of blood and blood products used on post-operative period, intensive care unit (ICU) stay period, deep and superficial wound infections, and sternal dehiscence. Sternal dehiscence was defined as palpable sternal click on physical examination and/or radiographic evidence of nonunion or wire fracture. Deep sternal wound infection was defined as dehiscence of the sternal wound involving the sternum or pectoral myofascial layer, visible sternum or periosteum and any wound infection requiring intravenous antibiotics over 48 hours. Non-infectious sternal wound complications were defined as either complaint of discomfort due to hardware or persistent tissue reactive inflammation requiring operative intervention. Sternal complication outcomes were compared between patients undergoing traditional wire cerclage closure and patients undergoing sternal plate reinforcement.

Sternal Closure Technique

No.5 monofilament stainless steel wire (Monowire; Boz, Ankara, Turkey) was used for sternal closure. For the patients that were applied TRC and TSCP, two or three intercostal holes drilled adjacent to corpus sterni to both opposing sides by using electrocautery. Classic sternal closure technique with steel wires was completed as in traditional way. For the patients that were applied TRC (Flexigrip; Praesidia, Bologna, Italy), after sternal closure with steel wires, clips were implanted next to the parasternal line. Distances were measured to ascertain the correct clip size. The appropriate clips were cooled in iced water (<10°C) and mounted onto an applicator that separate the legs of the clips into an open position. The clips were then applied to the holes that weredrilled on the sternum. Clips were rewarmed (35°C), returned to their original shape and strength, and held the sternal edges together (Figure 1). For the patients that were applied TSCP (Fixter; Yayla-Med, Ankara, Turkey), plaques were implanted next to the parasternal line.

Distances were measured to ascertain the correct plate size (Figure 2). Titanium plates were mounted on an application apparatus and positioned parallel to sternum and placed in the holes that were drilled before. The plates were approximated by using a closure device and its screw was turned to the closed position and sternal stabilisation was completed (Figure 3).

Figure 1. Clips were rewarmed (35°C), returned to their original shape and strength, and held the sternal edges together

Figure 2. Distances were measured to ascertain the correct plate size

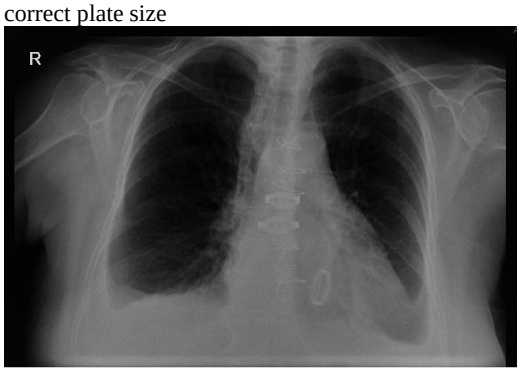

Figure 3. The plates were approximated by using a closure device and its screw was turned to the closed position and sternal stabilisation was completed

The statistical analyses of the study were performed by SPSS 20.0 (IBM Inc, Chicago, IL, USA). The descriptive statistics were presented as mean±SD (Standard Deviation) or (median, min, max where necessary) for numerical and frequency (percentage) for categorical variables. The normality of the continuous variables was checked by Kolmogorov-Smirnov test, and it was observed that none of the variables were distributed normally except for the age of the patients. The comparison between the study groups were performed by the related pairwise comparison of the Kruskal-Wallis test. Monte Carlo exact chi-square test was used to determine the relations between the categorical variables. A multinomial logistic regression model was established to determine the factors affecting the klemp usage methods. In all the analyses, $p<0.05$ value was considered as statistically significant result for 5% Type-I error.

Results

Mean age was 62.87±10.21, median age was 63.5 and age distribution was 21-86 years among 210 patients (153 males, 57 females) that were included in the study. Ages of the patients did not differ significantly between the groups ($p=0.114$). Baseline demographic and clinical characteristics of the patients are listed in Table 1. Population of the patients that were applied classic steel wire, wire reinforced with TRC and wire reinforced with TSCP were 179, 17 and 14 respectively. Sternal dehiscence was observed in 2 female patients (1.1%) to whom traditional steel wire closure was applied. In one of these patients DM, COPD, and>35 BMI and in another patient DM and >40 BMI was present as comorbidity. There was no sternal dehiscence observed in the other two groups of patients. In one patient (7.1%) that were applied wire reinforced with TRCP group, superficial wound infection was detected. There was no statistical significance detected among the groups regarding sternal dehiscence and superficial wound infection. No deep sternal wound infection was detected either.

Male predominance was evaluated only in the group that were applied conventional closure with wire, and female ratio was found significantly higher in the group that were applied reinforced TRC ($p<0.001$) (Table 2). Most of the patients underwent CABG operation (88.6%). DM was the most common comorbidity with the rate of 51% among all the patients.

Preoperative, operative, and postoperative specifications were compared between the three groups (Table 3). Among the variables, statistical significance was found between the BMI ratios. No statistical difference was observed among the other variables. Mean BMI ratios of all patients in the groups that were applied conventional sterna wire technique were low ($p<0.001$) whereas there was no significant difference determined for the rest. And also, no significant difference was determined although the usage of TRC was higher than TSCP. The clinical and demographic specifications of the

patients were evaluated for preoperative risk factors. Forward stepwise multinomial logistic regression model was created by taking only the patients that were applied the steel wire method as the reference category and the factors affecting the use of TRC and TSCP as independent variables. DM (OR=8.26), 30-34.9 kg/m^2 BMI (OR=14.28) and advanced age (OR=1.16) were found effective on TRC usage. 30-34.9 (OR=41.66) and 35-39.9 kg/m^2 BMI (OR=10.75) were found effective on TSCP usage. Goodness of fit values of the model were found to be high (-2LL=70.06 and R^2=0.465) (Table 4).

Table 1. Demographical and clinical characteristics of the patients

	Categories	**n**	**%**
Groups	Stell wire	179	85.2
	Steel wire and TRC	17	8.1
	Steel wire and TSCP	14	6.7
Sex	Male	153	72.9
	Female	57	27.1
Operation type	CABG	19	88.6
	AVR	6	2.9
	AVR+CABG	3	1.5
	CABG+mitral repair	3	1.5
	MVR	7	3.4
	MVR+ tricuspit annuloplasty	2	1.0
	Right atrialvegetation	1	0.5
	ASD	1	0.5
	CABG+free wall rupture	1	0.5
DM	No	103	49.0
	Yes	107	51.0
HT	No	106	50.5
	Yes	104	49.5
COPD	No	133	63.3
	Yes	77	36.7
CAS	No	184	87.6
	Yes	26	12.4
Tobacco usage	No	170	81.0
	Yes	40	19.0
Morbidty	No	187	89.0
	PostoperativeSVO	9	4.2
	Prolonged intubation	2	1.0
	Sternaldehiscence	2	1.0
	Bleeding revision	4	1.9
	Pneumothorax	3	1.4
	Late postoperative tamponade	1	0.5
	Re-intubation	2	1.0
Sternal Complication	Dehiscence	2	1.0
	Sternal wound complications	3	1.4

TRC: thermoreactive nitinol clips, TSCP: titanium sternal closure plate, CABG: coronary artery bypass grafting, AVR: aortic valve replacement, MVR: mitral valve replacement, ASD: atrial septal defect, COPD: chronic obstructive pulmonary disease, CAS: carotid artery stenosis

Discussion

Although median sternotomy complications were reported as 0.3-5%, there were reported complication ratios about 10% in some series of studies (3,4,10). We observed sternal dehiscence in 2 patients (1%) and superficial wound infection in 3 patients (1.4%) in line with data on literature. Complications of median sternotomy were associated with increased length of stay, hospitalization costs, morbidity, and mortality (11). Many different methods using materials to ensure good sternal stability and to avoid sternal complications include materials such as conventional steel wire, sternal cable titanium plate, talon system, TRC, cryptonet bone cement and polydioxanone sutures, and these materials and methods have been compared to each other in many studies (6-9). Classic sternal closure with stainless steel wire is the most frequent technique used for sternal closure (3,9). We also used this classic technique in our study with 179 patients (85.2%), which was correlated with the results in literature.

Presence of the risk factors including older age, obesity, COPD, NYHA class IV status, surgical priority, low EF, chronic steroid use, DM, osteoporosis, renal failure, PVD, bilateral mammary artery harvesting, surgical reexploration, long CPB time, asymmetrical sternotomy, IABP, extracorporeal membrane oxygenation support, prolonged ventilation, sepsis, and respiratory failure could raise the complication rates due to sternotomy (4,5).

Table 2. Categorical characteristics of the patients

		Steel wire	Stell wire with sternal closure systems	
Characteristics	**Categories**	**n (%)**	**n (%)**	**p**
Sex	Male	140 (78.2)‡	13 (41.9)	<0.001*
	Female	39 (21.8)‡	18 (58.1)	
Operation	CABG	162 (90.5)	28 (90.3)	0.995
	AVR	8 (4.5)	1 (3.2)	
	MVR	6 (3.0)	2 (6.5)	
	Mitral repair	3 (1.7)	0 (0.0)	
Diabetes mellitus	No	97 (54.2)‡	6 (19.4)	<0.001*
	Yes	82 (45.8)‡	25 (80.62)	
Hypertension	No	93 (52.8)	13 (41.9)	0.304
	Yes	86 (48.0)	18 (58.1)	
COPD	No	113 (63.1)	20 (64.5)	0.883
	Yes	66 (36.9)	11 (35.5)	
Tobacco usage	No	141 (78.8)	29 (93.5)	0.054
	Yes	38 (21.2)	2 (6.5)	
Groups of BMI	<30	130 (72.6)‡	8 (25.8)	<0.001*
	30-34,9	41 (22.9)	9 (29.0)	
	35-39,9	6 (3.4)‡	10 (32.3)	
	>40	2 (1.1) ‡	4 (12.9)	
EF	<35	9 (5.0)	1 (3.2)	0.664
	>35	170 (95.0)	30 (96.8)	

*: significant at 0.05 level according to Chi-square test‡: Significantly different with respect to other categories, CABG: coronary artery bypass grafting, AVR: aortic valve replacement, MVR: mitral valve replacement, COPD: chronic obstructive pulmonary disease, BMI: body mass index, EF: ejection fraction

Table 3. Clinical characteristics of the patients according to clips/plaque usage

	Steel wire (n=179)	**Steel wire with TRC (n=17)**	**Steel wire with TSCP (n=14)**	
Variables	**Unit**	**Mean±SS (Median; min-max)**		**p**
Age	62.64±10.37 (63; 21-86)	67.59±8.31 (68; 53-85)	60±8.96 (64; 44-69)	0.114
EF	59.19±9.29 (55; 30-65)	56.18±9.11 (60; 35-65)	55±8.55 (55; 40-65)	0.677
GFR	84.33±17.51 (86; 12-130)	85.35±12.55 (90; 61-100)	75.93±24.81 (76.50; 18-111)	0.422
ICU time	3.38±2.76 (3; 1-22)	3.12±1.50 (2; 1-6)	3.15±1.68 (3; 2-8)	0.972
Hospitalization day	8.76±6.31 (7; 0-62)	8.59±2.94 (8; 6-16)	9±8.96 (8; 0-36)	0.684
X-klemp	69.17±27.47 (66; 0-159)	65.71±18.21 (66; 30-94)	82.29±41.25 (67; 45-203)	0.622
CPB time	114.82±39.77 (117; 0-274)	112.88±32.67 (105; 55-171)	126.36±43.42 (115; 75-239)	0.799
ES	1.24±1.09 (1; 0-5)	1.18±0.64 (1; 0-3)	2.07±1.44 (2; 0-4)	0.069
FFP	1.32±0.84 (1; 0-5)	0.88±0.70 (1; 0-2)	1.79±0.97‡ (1.5; 1-4)	0.024*
BMI	28.14±4.5‡ (27.8; 17.3-44.8)	34.11±4.92 (34.8; 23.8-41.6)	32.42±6.45 (33.8; 20.3-41.3)	<0.001*
Number of Clips or plate	N/A‡	2.35±0.79 (2; 1-4)	1.79±0.43 (2; 1-2)	<0.001*

*: significant at 0.05 level according to Kruskal-Wallis test‡: Significantly different with respect to other categories, TRC: thermoreactive nitinol clips, TSCP: titanium sternal closure plate, EF: ejection fraction, GFR: glomerular filtration rate, ICU: intensive care unit, CPB: cardiopulmonary bypass, ES: erythrocyte suspension, FFP: fresh frozen plasma, BMI: body mass index

In a study by Molina et al., sternal dehiscence ratio among 1253 patients having>30 BMI was found 6.46% whereas the ratio of patients having %, <30 BMI was found 1.6% among 1905 patients (12). Kiessling et al. found obesity as a major risk factor for sternal dehiscence in a study that included 100 patients having>32 BMI (13). Dell'Amore et al. found DM ratio as 43% among 237 patients that were applied reconstruction for sternal dehiscence and mediastinitis (14). Two patients that developed

sternal dehiscence in our study, advanced age, DM and >35 BMI were determined as risk factors.

Obesity is most commonly seen in females (15). Male predominance was evaluated with in the conventional steel wire closure group in our study (p<0.001). We conclude that this difference was caused by the accumulation of female patients with risk factors of DM and obesity on TRC/TSCP applied groups and for the reason of male patient count was higher in group that used traditional steel wire closure technique.

Methods used for sternal stability after sternal dehiscence became to be used for the first closure of the patients by itself or with combinations of each other (16-23). As in our clinic, titanium and nitinol plate systems reinforced with steel wires were the most preferred methods for sternal closure (16,17,20,22).

The risk factor that was frequently considered by the surgeon when using nitinol clips / titanium plates reinforced with the traditional steel wire method and / or alone in the first closure of the sternotomy is the BMI ratio (18,21,23). We evaluated statistically significant relation between TRC/TSCP usage and BMI ratios with Chi-Square analyses (p<0.001). Also, <30 BMI is a low-risk group for sternal dehiscence, and traditional steel wire usage was found higher only in this group (p<0.001).

Table 4. Preoperative risk factor profile

	TRC		TSCP	
	p	**OR (95% CI)**	**p**	**OR (95% CI)**
DM	0.018*	8.26 (1.43-47.61)	0.547	
Hypertension	0.261		0.125	
COPD	0.519		0.370	
Tobacco usage	0.451		0.702	
BMI 30-34,9	0.030*	14.28 (1.29-166.66)	0.001*	41.66 (4.27-500.1)
BMI 35-39,9	0.230		0.038*	10.75 (1.13-100.1)
BMI >40	0.213		0.544	
Age	0.002*	1.161 (1.055-1.277)	0.785	
Reference category: No klemp			-2LL=70.06	R^2=0.465 (Nagelkerke)

*: significant at 0.05 level according to Multinomial Logistic Regression, TRC: thermoreactive nitinol clips, TSCP: titanium sternal closure plate, DM: diabetes mellitus, COPD: chronic obstructive pulmonary disease, BMI: body mass index

In the studies that compared rigid sternal fixation method with combined titanium plate and traditional steel wire closure, ICU and hospital stay periods were found similar in both groups (17). Liao et al. found no differences between hospital stay periods of morbid obese patients that were applied only sternal wire and sternal wire combined with titanium plate (21). Bejko et al. found no differences between the ICU stay periods of the patients that were closed with nitinol clips alone and the patients that were closed with steel wire (24). Although Tulugan et al. found no differences in sternal complications in their study including 564 patients where they compare nitinol clips combined steel wire closure and steel wire closure alone, they found shorter hospital stay periods in nitinol clips group (25). We found no differences between three groups regarding ICU stay (p=0.972) and hospital stay periods (p=0.684) as similar to other studies. We also determined no difference between three groups related to X-clamp (p=0.622) and CPB times (p=0.799) as similar to other studies in literature (21,24).

Allen et al. found that the risk of sternal dehiscence and sternal wound infection were decreased by using the rigid sternal plate fixation in their randomized controlled study (26). Many studies reported that, using rigid sternal plate or nitinol clips for closure of the sternum prevents the development of sternal dehiscence and wound complications (7,17,18,24,25). In our study, we evaluated one superficial wound infection in TSCP group, but there was no sternal dehiscence among the groups that were closed with TRC/TSCP combined steel wire. Although there is no statistically significant difference, we think that this is due to the low number of patients in the TRC and TSCP groups. On the other hand, there is no detailed and sufficient study that compares the effectivity of titanium plates and nitinol clips using for sternal closure in literature. In our study, we observe similar results between the use of TRC and TSCP in the closure of the first sternotomies in terms of efficacy and prevention of sternal complications, especially in patients with high risk of developing sternal complications.

It should be kept in mind that an extra apparatus is required to remove titanium plates in secondary sternotomy applications in patients that were applied TSCP. We believe that this situation may cause a serious problem in emergency situations, especially in clinics that do not use TSCP.

A major limitation of this study is its retrospective design with relatively small size of the TRC/TSCP groups. The patients reflect a single centre experience. Further high-powered and multi-institutional studies are needed to better identify a

group of patients that are best served by primary sternal reinforcement.

In conclusion, we think that reinforcing traditional steel wire with TRC or TSCP to close the first sternotomy, especially in patients with high risk of sternal dehiscence, can reduce sternal complications. However, these results must be supported with randomized controlled and multicenter studies.

Ethics Committee Approval: Isparta Suleyman Demirel University Clinical Research Ethics Committee Permission was obtained with the letter dated 22/10/2020 and numbered 334.

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