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THE EFFECTS OF STERNUM CLOSURE METHODS ON DEHISCENE

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ABSTRACT

Objective: In patients undergoing median sternotomy, we compared the the effects of high-cost titanium cables and low-cost steel wire-monoflament absorbable polyglycan suture combination used to close the sternum.

Patient and Method: Between October 2018 and October 2019, we examined 98 patients who underwent median sternotomy. The patients were randomly divided into 2 separate groups with similar risk factors. Titanium cables were used in the first group of patients. In patients in the second group, steel wires were supplied with monoflament absorbable polyglycan sutures. Patients who needed postoperative chemotherapy or radiotherapy due to malignancy were excluded from the study.

Results: No dehiscence or mediastinitis was detected in either patient group. Superficial wound infection was seen in 5 of the patients in the first group, and 4 of the patients in the second group; and were successfully treated with antibiotic therapy. There was no significant difference between the two groups regarding the intensive care stay, the duration of hospitalization, the amount of bleeding and reexploration ($p > 0.05$).

Conclusion: In high-risk patients; We believe that the use of steel wire combined with absorbable monoflament polyglyconate sutures instead of titanium cables with similar soft tissue infection rates is a simple, safe, inexpensive and effective technique.

KEYWORDS: *Titanium cables, monoflament polyglyconate sutures, dehiscence.*

INTRODUCTION

Despite surgical techniques and technological advances, cost-effective and low-wound casuing steel wires are still first choice in patients undergoing median sternotomy.[1,2] Sternal dehiscence is the cause of morbidity and mortality.[3] Although the incidence of dehiscence in the absence of additional risk factors is 2.5%; this rate rises to 6% in patients have additional risk factors such as obesity, advanced age, diabetes, chronic obstructive pulmonary disease (COPD), prolonged operation and cardiopulmonary bypass time.[4] Risks of dehiscence after median sterntomy have led to the development of new but expensive techniques such as titanium plates, titanium hooks, thermoreactive nitinol clips, flat wire sternal closure systems, plastic material systems and titanium cables in addition to hard-to-implement techniques such as Robicsek (double wire wrap).[5,6,7] These new methods are known to reduce the risk of complications but increasing costs and extending the duration of surgery. Because of that reasons the use of these techniques still discussing. In many centers, steel wires are still using primarily. The use of steel wires in patient groups with high risk of dehiscence is controversial despite its ease of use, short time applicability and low cost.[8]

In this article, we compared the high-cost titanium cables and low-cost steel wire-monoflament absorbable polyglycan suture combination used to close the sternum in patients undergoing median sternotomy and their risk of dehiscence.

Figure 1: Titanium cables.

PATIENTS AND METHODS

Ethical Approval

Informed consent was obtained from the relatives of each patient before the procedures after explaining the interventions, risks and benefits as a policy of the health system in the country.

MATERIAL AND METHODS

Between October 2018 and October 2019, we examined 98 patients who underwent median sternotomy. The patients were randomly divided into 2 separate groups with similar risk factors. Titanium cables were used in the first group of patients. In patients in the second group, steel wires were supplied with monoflament absorbable polyglycan sutures. Patients who needed postoperative chemotherapy or radiotherapy due to malignancy were excluded from the study.

Statistical analysis

Statistical analysis was performed with the SPSS version 24.0 program (SPSS Inc. Chicago IL, USA). The normal distribution of the variables was examined by histogram graphs and the Kolmogorov-Smirnov test. Mean ± standard deviation values were used to present descriptive analyzes. Pearson Chi-Square and Fishers Exact Tests were compared with 2x2 tables. While normally distributed (parametric) variables were evaluated among the groups, Student T-test was used. Mann Whitney U Test was used to evaluate nonparametric variables. Logistic regression tests were performed to find odds ratio. P-values below 0.05 were evaluated as statistically significant results.

RESULTS

The patients were divided into two groups. The patients' sternums in the first group were closed using titanium cables (Pioner surgical technology Inc). The mean age of the patients was 67.6 ± 8.5 (min 61-max 74.1). 24 of the patients (55.8%) were women. Diabetes mellitus was present in 19 (44.2%), hypertension in 11 (25.6%) and COPD in 8 (18.6%) (with FEV^1<80% and FEV^1/FVC<70% with spirometry) patients. 22 (51.2%) patients were smoker (more than 10 years/pack), 12 (27.9%) patients were obese (BMI>30 kg/m^2). 29 (67.4%) patients had multiple comorbidity.

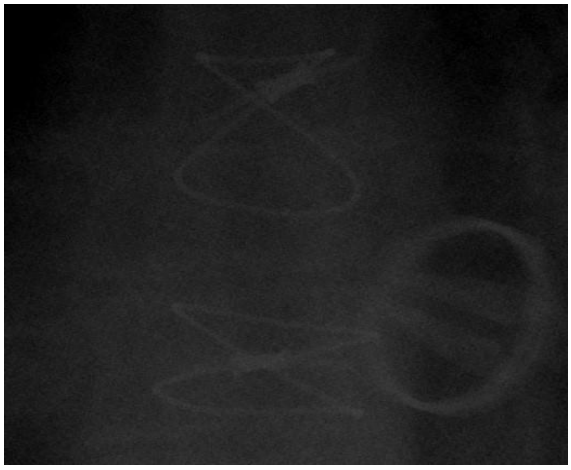

Figure 2: Post-operative direct radiography of which sternotomies are closed with sternal titanium cables.

The patients' sternums in the second group were closed using monoflament absorbable polyglycanic sutures and steel wires. The average age was recorded as 64.3 ± 9.3 (min 57-max 76.6). 27 (49.1%) of the patients were women. Diabetes mellitus was present in 13 (23.6%), hypertension in 10 (18.2%), COPD in 12 (21.8%) (FEV^1<80% and FEV^1/FVC<70% with spirometry) patients. 18 (32.7%) patients were smoker (more than 10 years/pack), 9 (16.4%) patients were obese (BMI>30 kg/m^2). 40 (72.7%) patients had multiple comorbidity.

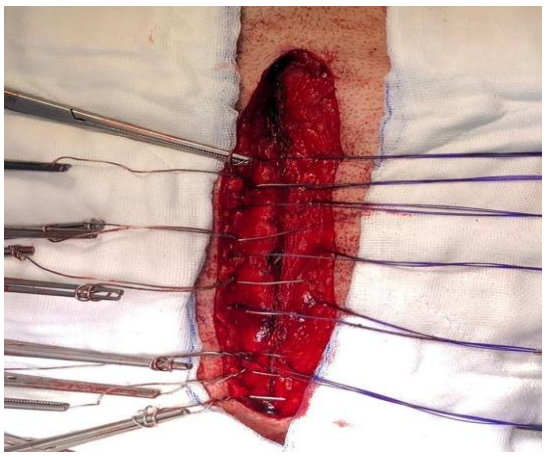

Figure 3: Closed sternum using by monoflament absorbable polyglycanic sutures and steel wires.

Table 1: Preoperative patients characteristics.

	Cable N=43	PDS N=55	P
Age	67.6±8.5	64.3±9.3	0.069
Female (%)	24 (%55.8)	27 (%49.1)	0.509
DM (%)	19(% 44.2)	13(%23.6)	0.034
HT (%)	11(% 25.6)	10(%18.2)	0.378
COPD (%)	8(%18.6)	12(%21.8)	0.879
Smoker (%)	22(% 51.2)	18(% 32.7)	0.067
Obesity (BMI>30kg/m^2)	12(%27.9)	9(%16.4)	0.171
Multiple comorbities (%)	29(% 67.4)	40(%72.7)	0.570
Cardiac operations (%)	39(%90.7)	43(%78.2)	0.105
Non-cardiac operations (%)	4(%9.3)	12(%21.8)	0.105

All patients underwent standard median sternotomy and operations were performed under cardiopulmonary bypass (CPB) with aortic cross-clamp. Cephalosporin was used in all patients for surgical prophylaxis. While sternotomies were closed; the skin, subcutaneous tissue and sternum were wiped with povidone iodine in all patients. 4-6 (average five) polyglyconate sutures (Maxon ™ Polyglyconate, Monofi Lament Synthetic Absorbable Sutures-Covidien) were placed after steel wires in the second group of patients. First the wires, then the polyglyconate sutures were tied very tightly. Subcutaneous tissues were closed individually with 2/0 vicryl, skin with 2/0 sharp prolene.

All patients used a sternal corset during post-operative follow-up for 6-week. None of the 98 patients had dehiscence. Both groups were evaluated postoperatively. Postoperative drainage was 472±198 (345-720) cc in the first group and 515±188 (420-790) cc in the second group. There was no significant difference between the postoperative bleeding amount between the groups (p>0.05, P=0.271). Postoperative mechanic ventilation requirement of the patients was seen as 7.1±2.5 (4.3-10.3) hours for the first group and 6.9±2.2 (43.9-9.4) hours for the second group. There was no significant difference between the two groups (p>0.05, P=0.680). Prolonged inotrope was needed in 12 (27.2%) patients in the first group and in 11 (20%) patients in the second group. No significant difference was found between the two groups (p>0.05, P=0.361).

Postoperative intensive care hospitalization time was 27.6±13.3 (21.4-48.5) hours for the first group and 31.8±16 (24.8-53.3) hours for the second group. No significant difference was found between the two groups (p>0.05, P=0.178).

The average length of hospital stay was 5.7±1.9 (5.1-8.3) days for the first group and 5.9±1.4 (4.7-7.9) days for the second group. There was no significant difference between the two groups (p>0.05, P=0.811).

None of the patients in the first group required reexploration, while one in the second group (1.8%) needed reexploration. There was no significant difference between the two groups (p>0.05, P=0.596). Superficial tissue infection appeared in 5 (11.3%) patients in the first group and in 4 (7.2%) patients in the second group. There was no significant difference between the two groups (p>0.05, P=0.463). Staphylococcus aureus was considered as the cause of superficial tissue infections. Empirical antibiotic therapy was applied and wounds were treated. None active microorganism was grown in the control swab cultures.

Sternal dehiscence and mediastinitis were not observed in both groups.

Aseptic dehiscence or allergic reaction did not develop against the materials used in both groups.

Table 2: Postoperative follow-up.

	Cable N=43	PDS N=55	P
Postoperative bleeding (ml)	472±198	515±188	0.271
Reexploration	0	1(%1.8)	0.596
Ventilation (hour)	7.1±2.5	6.9±2.2	0.680
Prolonged inotrope	12(%27.2)	11(%20)	0.361
ICU stay (hour)	27.6±13.3	31.8±16	0.178
Hospital stay (day)	5.7±1.9	5.9±1.4	0.811
Sternal dehiscence	0	0	0.904
Superficial wound infection	5(%11.3)	4(%7.2)	0.463
Mediastinitis	0	0	0.904
Rewire	0	0	0.904
Mortality	0	0	0.904

DISCUSSION

The rate of dehiscence is 2.5% on average when there is no underlying risk factor in median sternotomy operations. This rate is gradually increasing due to the increase of risk factors and prolonged human life.[4] Increasing average age, changing world conditions; increasing incidence of obesity, chronic obstructive pulmonary diseases and malignancies were effective in developing additional techniques to avoid dehiscence. There are additional complications such as breaking the sternal bone tissue in osteroporosis patients or bleeding that the wires can cause when passing through intercostal spaces in the Robicsek method which traditional steel wires are used.[9] As a result of all these needs, highly durable systems have been developed such as titanium plates, titanium hooks, thermoreactive nitinol clips, flat wire sternal closure systems, kryptonite bone glue, plastic material systems, and titanium cables.[10] However, these systems are less preferred due to their high cost despite their technical ease of use.[11]

Sudden cough crises due to smoking and chronic obstructive pulmonary disease cause increased intrathoracic pressure. This pressure causes sternum fracture or damages to the bone structure by metal materials.[12] Studies have shown that dehiscence affects female patients with obese and osteroporotic bone structure more.[13]

Another reason for strenal dehiscence is the development of hypersensitivity and allergic reaction regardless of any pathogen.[14] It has been shown that an allergic reaction to classical sternal wires is very rare.[15] However, the probability of developing an allergic reaction to the nickel element which forms the metallic structure of the new generation closure types is up to 20% in western societies.[16] In the study made on the development of dehisens again after re-application of steel wire in a patient who was reoperated for sternal dehiscence, it was shown a hypersensitivity reaction to steel wires.[17]

Traditional steel wire and steel wire supplied with monoflement absorbable sutures were compared and no significant difference was found in a study.[18] High-risk patients were closed only using monoflament absorbable sutures and this sutures were preserved for up to 42-92 days in another study.[19] There are studies showing that monofilament sutures are superior to steel wire in terms of aseptic decomposition.[20] No dehiscence was observed in patients using a combination of steel wire and monoflament absorbable sutures in the high-risk patient group in our study. There was no significant difference in terms of hospital stay and infection.

LIMITATION

Further randomised-control studies will be needed before routinely use of this technique.

CONCLUSION

The combination of steel wire with absorbable monoflament polyglyconate suture protects against dehiscence, but does not have a protective against soft tissue infections in high-risk patients.

Nevertheless, we believe that the use of steel wire combined with absorbable monoflament polyglyconate sutures instead of titanium cables is a simple, safe, inexpensive and effective technique in high-risk patients.

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