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Original Article

Wire-Box Fixation: An Alternative Technique for Sternal Closure After Median Sternotomy in Cardiac Surgery

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ABSTRACT

Background: A better sternal fixation reduces the attendant risk of superficial and deep infection and enhances postoperative respiratory mechanics, thereby fast-tracking the patient's recovery and rehabilitation, as well as professional re-insertion. The aim of this study was to evaluate the safety and efficacy of Wire-Box Fixation as an alternative technique for sternal closure after median sternotomy.

Methods: This case-series study was conducted on patients undergoing routine sternal closure after median sternotomy, which was concluded with Wire-Box Fixation. The current method can be executed with a sternal wire number 5 or 7. First, a figure-of-eight (FOE) stitch is placed on the manubrium. Then, a stitch is placed above the inferior loop of the previous one in its hole. It is thereafter exited out above the former wire and turned around downstream (interlocking) to profile the second FOE stitch so as to dress the Louis angle between the manubrium and the sternal body. This procedure is repeated until a total number of 4 to 5 interlocking FOE stitches are placed in proportion to the sternal length. When placing an FOE stitch, care should be taken to stitch perpendicularly and staying trans-sternal to decrease the risk of iatrogenic bleeding.

Results: In total, 191 patients at a mean age of 56.0±14.4 years were enrolled. The mean pain score level on the first postoperative day, based on a visual analog pain scale, was reported to be 4.8±2.1, while it was reported to be 2.1±1.4 on the day of discharge. No sternum instability, dehiscence, or revision surgery was reported with the usage of Wire-Box Fixation. An incidence rate of 0.51% was reported for wound infection and 4.1% for death unrelated to wiring. No further complications were reported during a 3-month follow-up.

Conclusions: It appears that Wire-Box Fixation is an optimal technique of sternal fixation given its prominent advantages of low cost, rapid installation, and low incidence of complications. ***(Iranian Heart Journal 2018; 19(4): 13-17)***

KEYWORDS: Wiring, Wire-Box Fixation, Sternotomy, Cardiac surgery

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An adequate fixation of the sternum has always been a subject for surgical innovations. A better sternal fixation reduces the attendant risk of superficial and deep infection and enhances postoperative respiratory mechanics, thereby fast-tracking the patient's recovery and rehabilitation, as well as professional re-insertion.[1,2,3] The mainstay of sternal fixation the world over has been cerclage wiring in that it affords technical simplicity and reduced procedural times and costs. To overcome the technical shortcomings of the diverse types of sternal wiring, researchers have developed a large number of devices such as plate screws and interlocking staples, in conjunction with matrix cementation techniques, none of which has received a widespread reception.[4-8] To further the mechanical characteristics of cerclage wiring, hereby we report the surgical results of a new sternal wiring procedure termed "Wire-Box Fixation", which consists of continuous interlocking trans-sternal figure-of-eight (FOE) cerclage wiring.

METHODS

This case-series study was conducted between January 2014 and January 2016 on patients undergoing routine sternal closure via a median sternotomy concluded with the Wire-Box Fixation of the sternum. Patients with chronic obstructive pulmonary disease, obesity (body mass index=30 kg/m^2), renal failure, chronic steroid use, immunosuppression, repeat sternotomy, osteoporosis, concurrent infection, and neurologic dysfunction affecting ambulation were excluded from the study. All the patients' baseline characteristics such as age, gender, coronary risk factors, and the type of surgery were recorded before surgery. The pain score, the duration of hospital stay, and post-sternotomy complications such as dehiscence, wound infection, and related death were collected during the hospital stay and during a 3-month follow-up after surgery.

The method of Wire-Box Fixation can be executed with the use of sternal wires number 5 or 7 depending on the patient's age and sternal strength, or the surgeon's preferences. First, an FOE stitch is placed on the manubrium. Next, a stitch is placed above the inferior loop of the first stitch in its hole. Thereafter, it is exited out above the former wire and turned around downstream (interlocking) to profile the second FOE stitch so as to dress the Louis angle between the manubrium and the sternal body. This procedure is repeated until a total number of 4 to 5 interlocking FOE stitches are placed in proportion to the sternal length. During the placement of an FOE stitch, care should be taken to stitch perpendicularly (minimizing the risk of edge-cutting) and staying trans-sternal with a view to decreasing the risk of iatrogenic bleeding.

The SPSS software, version 17.0 (SPSS, Inc, Chicago, Illinois, USA), was used for the data analyses. All the categorical variables, such as gender, were expressed as numbers and percentages via charts and tables. The continuous variables, including age and the mean length of hospital stay, were expressed as mean values and standard deviations (SDs). This study was approved by The Ethics Committee of Mashhad University of Medical Sciences (grant number: 930121).

RESULTS

Baseline Characteristics

The study population was comprised of 191 patients: 84 female and 107 male patients. The mean age of the patients was 56.0±14.4 years. Isolated coronary artery bypass graft surgery was performed on 66.1% of the patients (n=127), isolated valve replacement on 11.5% (n=22), combinations of coronary artery bypass graft/valve procedures on 3.6% (n=7), and other types of cardiac surgery on 18.8% of the patients (n=35). Hypertension was the most prevalent risk factor among the patients, with a prevalence rate of 58.1% (n=111). The prevalence rate of other risk factors was 40.3%

for dyslipidemia (n=77), 35.0% for diabetes (n=67), 9.4% for smoking (n=18).

Postoperative Characteristics

No technical problem occurred during the procedure of wiring. The mean pain score level during the first postoperative day, based on a visual analog pain scale, was reported to be 4.8±2.1, whereas it was reported to be 2.1±1.4 on the day of discharge. No exaggerated pain was reported by the patients during their hospital stay. The mean length of hospital stay was 4.1±1.3 days. There was no prolonged hospital stay due to sternal closure complications. No sternum instability or dehiscence with the use of the Wire-Box Fixation method was reported. One superficial wound infection was observed in one of the patients with diabetes, which was successfully treated with oral antibiotics and there was no seroma formation. No deep wound infection was observed in our study population. The wound complication rate was reported to be 0.51% (n=1/191). No revision surgery was performed in our study participants due to our sternal closure system complications. Eight deaths occurred in our study population; they were not related to the use of wires. The causes of death were severe pneumonia (n=1), myocardial infarction (n=2), and heart failure (n=5).

Three-Month Follow-up Characteristics

No sternum instability or dehiscence, deep or superficial wound infection, revision surgery, and death with the use of the Wire-Box Fixation method were reported during the 3-month follow-up.

DISCUSSION

Our study was designed to evaluate the safety and efficacy of a new method of wiring termed "Wire-Box Fixation" for sternal closure after median sternotomy, and the results indicated the safety and efficiency of this approach to sternal closure in terms of its outcomes and complications during a 3-month follow-up period.

The fact which is highlighted with Wire-Box Fixation is that it addresses the 2 main disadvantages of the simple wiring technique, which are the constant loosening of the wire and the cut-in-through phenomenon,[9-12] because of the wire-locking mechanism of Wire-Box Fixation which acts as a brick. Moreover, we can assume some of the advantages of the FOE closure technique, because of the similar baseline characteristics of both techniques, for our fixation system. In this way, our fixation system allows an oblique and horizontal angle of shearing forces instead of direct perpendicular forces, as a result of which the wires are less likely to loosen or fracture.[13,14]

One of the other advantages of Wire-Box Fixation by comparison with the other instruments is its competitive cost, which is completely comparable to the simple wiring technique. Additionally, Wire-Box Fixation is not a complicated technique insofar as it is as easy to learn and perform as is the simple wiring technique. Moreover, it enables the surgeon to access the heart swiftly in the urgency period by cutting the wires. With respect to the significant issue of safety, post-sternal closure complications in our series were reported to have the minimum prevalence in comparison with the other studies.[15-18]

CONCLUSIONS

It appears that Wire-Box Fixation may be an optimal technique of sternal fixation on the strength of its prominent advantages of low cost, rapid installation, and low incidence of complications—all of which can be deemed a solution to the shortcomings of the simple wiring technique.

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