Surgical Technique

FlatWire Sternal Closure System technique for median sternotomy closure

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Abstract: Sternal closure after median sternotomy traditionally uses a stainless steel wire cerclage. Sternal wires are placed through or around the sternum, and the wire ends are twisted together to bring the sternum back together. Complications of this technique include sternal instability, dehiscence, non-union, and increased pain. Compared to traditional wire cerclage, the Figure 8 FlatWire Sternal Closure System has been demonstrated to be stronger and significantly reduce sternal cut-through and postoperative pain. There was no significant difference in hospital length of stay or mean hospitalization cost. Operative time was slightly longer in the FlatWire group, but this difference has been attributed to the learning curve of mastering the FlatWire technique. This article and supplemental video will demonstrate the technique of FlatWire Sternal Closure System. Briefly, the FlatWire is placed around the sternum, and the FlatWire end is fed through the security box. Once all of the wires are placed, the Figure 8 tensioning device is used to tighten each wire through the security box to the appropriate tensile force. Next, the FlatWires are rotated 90 degrees to hold the sternal position temporarily. Once sternal approximation is achieved, each FlatWire is twisted 120 degrees, and any excess length of the FlatWire is clipped.

Keywords: Sternal closure; sternal wire; sternotomy

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Introduction

Median sternotomies became a common surgical technique in the 1950s for surgical procedures requiring open access to the mediastinum (1). Sternal closure following a procedure with a median sternotomy most often utilizes a stainless steel wire cerclage. Sternal wires are placed through or around the sternum, the wire ends are twisted together to bring the sternum back together. This technique requires a decent amount of upper body strength, and twisting a wire too many times or too forcefully can lead to breaking the wire (2). While this remains a popular, cost-effective approach, the complications of this technique include sternal instability, dehiscence, non-union, cut-through, and increased pain, with a mortality rate as high as 10–40% (3,4). These complications are becoming more and more common, as cardiac surgery patients today are older and often have multiple comorbidities (including lung disease, renal insufficiency, diabetes, obesity, osteoporosis, and poor nutritional status) (4). Many variations of the classic steel

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wire approach have been trialed over the years to reduce these events, such as rigid plate fixation, clips, flat wires, and titanium cables. The Figure 8 FlatWire Sternal Closure System was developed as an alternative to the traditional sternal wire cerclage (4). Prior studies have demonstrated that FlatWire is 70% stronger than standard wire cerclage when placed in transverse configuration, and 40% stronger when used in the crossed ("X") pattern. FlatWire also demonstrated significantly reduced cut-through and improved lateral and longitudinal cyclical testing when compared to traditional wire cerclage (4,5). The pilot study utilizing FlatWire for sternal closure showed excellent sternal stability and a significant reduction in postoperative pain on day of discharge, and similar pain at 30 and 60 days. Time from off pump to end of surgery was significantly increased by 15.9 minutes, but the authors credited this to the learning curve of mastering the FlatWire technique. The FlatWire group also had slightly reduced hospital length of stay and reduced mean hospitalization cost (approximately $4,000 less), although both of these were not statistically significant (4). This article will describe the sternal closure technique utilizing the FlatWire Sternal Closure System. We present this article in accordance with the SUPER reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-110/rc).

Highlight box

Key findings

- The FlatWire is placed around the sternum, and the FlatWire end is fed through the security box. Once all of the wires are placed, the Figure 8 tensioning device is used to tighten each wire through the security box to the appropriate tensile force. Next, the FlatWires are rotated 90 degrees to hold the sternal position temporarily. Once sternal approximation is achieved, each FlatWire is twisted 120 degrees, and any excess length of the FlatWire is clipped.

What is known and what is new?

- Similar to conventional sternal wires, the FlatWire is placed around the sternum during chest closure.
- After the FlatWire is placed around the sternum, the FlatWire end is fed through the security box, and the Figure 8 tensioning device is used to tighten each wire through the security box. The FlatWires are twisted 120 degrees to lock the sternal reapproximation in place.

What is the implication, and what should change now?

- Compared to conventional sternal wires, the Figure 8 FlatWire Sternal Closure System has been demonstrated to be stronger and significantly reduce sternal cut-through and postoperative pain. Surgeons can consider using the FlatWire sternal wires for future procedures.

Preoperative preparations and requirements

The Figure 8 FlatWire Sternal Closure System is packaged as a kit with eight FlatWires and a reusable aluminum Figure 8 tensioning device. Each FlatWire has two ends: the proximal end has a stainless steel needle, and the distal end has a rotating central hub and laser-welded security box, which can withstand >1,400 N of force (4). Once the surgical procedure is complete, hemostasis is achieved, and the chest is ready for closure, the surgeon can proceed with using the FlatWire Sternal Closure System as described below.

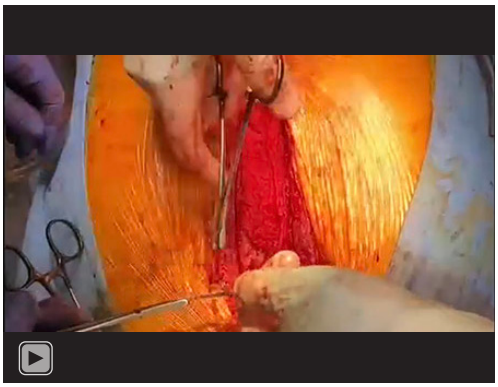
Step-by-step description

Similar to conventional sternal wires, the FlatWire is placed around the sternum using a standard needle driver. The needle is removed with standard wire cutters, and the FlatWire end is fed through the security box. This wire temporarily remains in this position while the remaining wires are placed. Once all of the wires have been placed along the sternum, the Figure 8 tensioning device is used to tighten each wire through the security box to the appropriate tensile force. Of note, the Figure 8 tensioning instrument has a custom built-in break away mechanism which prevents applied forces from exceeding 300 N. The FlatWire is then rotated 90 degrees to temporarily hold the sternum in place. At this point, the closure remains reversible simply by untwisting and straightening the FlatWire. Once the surgeon is satisfied with the degree of sternal reapproximation, the FlatWires are twisted 120 degrees without tension and any excess length of the FlatWire is clipped (4). Please see the supplemental video for a demonstration (*Video 1*).

Postoperative considerations and tasks

There are no differences in the postoperative management of patients with conventional sternal wire or FlatWire sternal wire closure. In cases of redo sternotomy, standard wire cutters can be utilized.

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of this article and accompanying images. A copy of the written consent is



Video 1 This supplemental video is a demonstration of the sternal closure technique utilizing the FlatWire Sternal Closure System.

available for review by the editorial office of this journal.

Tips and pearls

After the Figure 8 tensioning device is used to tighten each FlatWire through the security box, the FlatWire is rotated 90 degrees to temporarily hold the sternal position. To reverse the closure at this point, the user can easily untwist and straighten the FlatWire. Once the surgeon is satisfied with the degree of sternal reapproximation, the FlatWires can be twisted 120 degrees to lock everything in place.

Discussion

Numerous variations in sternal closure systems have been introduced; however, none provide all of the requirements listed: mechanically assisted apposition, compression, separation prevention on all axis, similar technique to conventional wire cerclage, and similar cost to conventional wire cerclage (4). This article describes the technique of utilizing the FlatWire Sternal Closure System, which in our experience provides all the desired requirements of sternal closure. A flat sternal wire increases the bone contact area compared to the traditional standard method. Dispensing the load over a larger surface area redistributes the force and allows for a greater closure tension, which is an important factor when considering the possible mechanical complications (6,7). Studies have shown significantly reduced postoperative pain after sternotomy in patients using the FlatWire system compared to the traditional approach (4). Similar findings were demonstrated in a study comparing poly-ether-ether-ketone based sternal ZipFix implant to conventional wires: patients with ZipFix had lower mean pain severity scores at 1, 3, 6, and 12 months after discharge and also lower incidence of sternal dehiscence (8). In the authors' experience, there have not been any post-procedural issues or any increase in sternal dehiscence in the FlatWire patient cohort. In order to evaluate this, it would require a long-term study that involved performing computed tomography imaging as follow-up for these patients.

In a pilot study, there was no significant difference in hospital length of stay or mean hospitalization cost between the FlatWire group and the traditional wire cerclage group. Finances and costs are determined by the manufacturing company: the FlatWire system is more expensive than conventional sternal wires but less expensive than sternal plates. A limitation of this technique is the learning curve required with any new system and new technique. In the authors' experience, once surgeons were comfortable with the technique, there was no difference in operative time between using the FlatWire system or conventional wires.

Conclusions

This article and the supplemental video will allow surgical teams to learn this new sternal closure technique easily. Further studies are necessary to investigate long-term outcomes, such as sternal wound complications, for the FlatWire system.

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Footnote

Reporting Checklist: The authors have completed the SUPER reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-110/rc

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-110/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patients for publication of this article and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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