Simplified closure of ministernotomy using thermoreactive sternal clips

Martin TR Grapow, Florian Rüter, Ludovic Melly, Bernhard Winkler, Friedrich S Eckstein and Peter Matt



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Abstract

An increasing number of aortic valve replacements are performed through a ministernotomy. Due to the small incision and partial fixation of the caudal sternum, the traditional wire closure can be complicated and even harmful to the surrounding tissue. In such cases, we recommend the use of nitinol clips for sternal closure. This technique, which we have used in 48 patients, is simple, safe, and fast, and results in excellent outcomes.

Keywords

cardiac surgical procedures, nitinol [supplementary concept], sternum

Introduction

An increasing number of aortic valve replacements are now performed through a ministernotomy.¹ This less invasive procedure offers several advantages compared to conventional sternotomy, including improved cosmetic results, less bleeding, reduced ventilation time, and a shorter hospital stay.¹ The most common approach is via an upper partial sternotomy. Due to the small incision and partial fixation of the caudal sternum, the traditional wire closure can be challenging and even harmful to the surrounding tissue. The use of nitinol Flexigrip clips (Praesidia SRL, Bologna, Italy) is a novel, simplified, and improved technique, especially suitable for ministernotomy closure.

Technique

As a first step, a single stainless steel wire is placed at the manubrium for sternal re-approximation. Electrocautery is used to create small incisions in the intercostal grooves on either side of the sternum. Both parts of the sternum are approximated with a Flexigrip device, and the appropriate size of Flexigrip clips is determined. The correct size of implanted Flexigrip clip is crucial for a stable and enduring osteosynthesis. Clips that are too large will lead to sternal instability, and clips that are too small will reduce the flexibility of the sternum. Once the correct clips have been selected, they are immersed in cold water (<10°C), allowing the semicircular arms to bend (Figure 1), and then placed in the appropriate intercostal spaces at either side of the sternum. Contact with the tissue and application of warm water (>25°C) results in re-bending of the clip arms, fixing both sternal parts. We use one stainless steel wire and 2 Flexigrip clips for ministernotomy closure in most patients (Figures 2 and 3). Alternatively, only Flexigrip clips can be applied to re-approximate the manubrium and sternum. Clips in the manubrium position are placed with the " Ω " towards the cranium; the other clips are placed with the " Ω " towards the caudal sternum. The decision on whether to use a single clip or steel wire on the manubrium is based on the surgeon's preference.

Discussion

From January 2009 to May 2011, Flexigrip clips were used for sternal closure in 48 patients after an upper

Department of Cardiac Surgery, University Hospital Basel, Basel, Switzerland.

Corresponding author:

Martin TR Grapow, MD, Department of Cardiac Surgery, University Hospital Basel, Spitalstrasse 21, CH-4031 Basel, Switzerland Email: mgrapow@uhbs.ch

Figure 1. A Flexigrip clip prior to placement on the sternum. (A) The Flexigrip clip in its original form. (B) The clip is immersed in cold water ($<10^{\circ}$ C), allowing the semicircular arms to bend using a needle holder.

Figure 2. Intraoperative view after ministernotomy closure with one stainless steel wire at the manubrium and 2 Flexigrip clips (arrows) re-approximating the sternum. CR = cranial.

partial V-shaped sternotomy for isolated aortic valve replacement. Of these 48 patients (mean age 69 ± 11 years; 31 males) for whom ministernotomy closure was achieved using Flexigrip clips, 45 (94%) had a completely uneventful postoperative course. Two (4.4%) patients had to be re-operated on due to bleeding problems a few hours after the initial operation. In both cases, a dysfunction of coagulation unrelated to the Flexigrip clips was found. The same Flexigrips were easily reused. One (2%) patient developed a sternal infection requiring surgical debridement and vacuum therapy. We have not observed any post-

discharge sternal complications in patients treated

with Flexigrips so far. The application of Flexigrip clips for sternal closure provides an alternative to the traditional wires made of stainless steel or titanium. An important advantage of nitinol, a nickel-titanium alloy, is its elasticity that allows a 10% to 15% deformation in width in case of a sudden increase in tension forces (e.g. when coughing).^{2,3} This characteristic is enhanced by the middle " Ω " shape of the Flexigrip clips. The elasticity further reduces bone ischemia, which is important for uncomplicated wound healing. Other potential advantages of Flexigrip clips are their lighter weight, larger contact surface with the sternum, and absence of bone or fibrous tissue incorporation, which is important in redo situations years later; Flexigrips can be removed easily (information provided by company), and are compatible with computed tomography and magnetic resonance imaging.²⁻⁴ Most important from a surgical standpoint is probably the thermoreactivity of Flexigrip clips, which facilitates rapid implantation without trauma to the bone or surrounding tissue. This is especially helpful in a minimally invasive setting. The successful use of Flexigrip clips for full midline sternotomy closure has been described in large cohorts of patients.²⁻⁴ These clips proved to be effective even in high-risk patients and those with sternal dehiscence who had previously undergone sternal closure with steel wires.² Flexigrip clips can be used after cardiac surgery for fixing late sternal instability without the need to re-enter the mediastinum.^{5,6}

Figure 3. Radiograph at discharge showing the intact and correctly positioned steel wire and 2 Flexigrip clips (arrows).





We found that this technique was highly effective: it simplified and hastened sternal closure without the risk of injury to the surroundings, especially retrosternal tissue. The cost of a Flexigrip clip (approximately 100–120 Euros) is higher than that of a steel wire; however, the improved ministernotomy closure technique may justify its use. Clips are currently available in Europe, the United States, Middle East, and Australia. In Japan, Korea, and Taiwan, they will be available after completion of the registration process by end of 2011 (company information). Further studies are clearly needed to validate our data and investigate whether Flexigrip clips may be associated with additional benefits such as reduced postoperative pain, improved physical capacity and/or quality of life.

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Conflict of interest statement

The authors have no financial or commercial conflict of interest.

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