Pectus Bar Removal After Minimal Invasive Repair of Pectus Excavatum: Advantages of Bar Stabilizer Anvil Tool

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Purpose. Dislocation of pectus bars after minimal invasive repair of pectus excavatum has been reduced by use of bar stabilizers. However, during bar removal, intense bone formation around the pectus bar and bar stabilizer makes it difficult to detach them from one another. A tool was designed to facilitate the detachment of the bar stabilizer from the pectus bar.

Description. The Bar Stabilizer Anvil (Walter Lorenz Surgical Inc, Jacksonville, FL) is a stainless steel tool placed directly on the bar stabilizer during surgery. Using a simple tapping action with a hammer on the tool, the bar stabilizer slides and detaches from the pectus bar.

Evaluation. The first developed prototype was used in 5 patients during bar removal, but had to be redesigned with slight modifications. The second redesigned prototype of the bar stabilizer tool could be optimally inserted at the surgical site and enabled the detachments of the bar stabilizer with ease when employed in the second series of 5 patients.

Conclusions. The Bar Stabilizer Anvil is a useful tool for the detachment of the stabilizer plate from the pectus bar after minimal invasive repair of pectus excavatum.

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Technology

Since the initial report of minimal invasive repair of pectus excavatum (MIRPE) in 1998, the technique has rapidly gained acceptance and is gaining popularity for the repair of pectus excavatum in children and adults [1]. This technique has been shown to be safe with good aesthetic outcomes, as well as shorter operating times and less blood loss than the traditional Ravitch repair [2]. This minimal access technique utilizes two symmetric incisions in the lateral thoracic wall through which a convex bar (pectus bar) is placed into the substernal position to leverage the deformity into a more anatomically correct position. To prevent the pectus bar from migration during chest wall healing, a stabilizer plate (bar stabilizer) is notched to grip the serrated edge of the pectus bar end. A nonresorbable suture or wire is finally placed around the rib, the pectus bar, and the bar stabilizer to secure them as a single unit [3]. The pectus bar is left in place for 24 to 36 months, after which it is removed by reopening the lateral incision. Significant bone formation differences have been identified around the pectus bar at the time of their removal [4]. Bone formation around the pectus bar and the bar stabilizer can pose technical challenges in the separation of the bar stabilizer from the pectus bar. To aid in the detachment of the bar stabilizer from the pectus bar, a special tool was developed. Consent was obtained from the Ethics Committee along with waiver of patient consent for this retrospective study.

Technique

Material and Methods

During pectus bar removal, the scar from the MIRPE procedure is excised and the pectus bar is reached after careful dissection through the subcutaneous tissue and muscles until the bar stabilizer is reached. Because only one bar stabilizer is used at our center (on the right side) during bar removal, the incision is made only on this side. The reaction of the tissue to the implanted pectus bar varies from simple scar tissue pocket to significant bone formation. The anchor point (ie, nonresorbable suture or metal wire) used to secure the bar stabilizer, is identified and removed. If minimal scar tissue or bone formation is present, the bar stabilizer can be slid off with ease over the edge of the pectus bar. In cases of severe scar or bone formation, the scar is resected or the bone formation is carefully chiseled off to free the sliding path of the bar stabilizer. The ends of the pectus bar, which
have serrated edges that allow better grip of the bar stabilizer, can also pose further problems during its removal. Because it is not possible to remove the tissue between the serrated edges of the pectus bar, tissues (ie, scar and bone formation) trapped in and around the serrated edges prevent the detachment of the bar stabilizer.

To address this technical point, a Bar Stabilizer Anvil tool (Walter Lorenz Surgical Inc) was designed. According to the design specifications provided, a prototype was made by the manufacturer. The Bar Stabilizer Anvil is a rod-shaped tool that is designed to fit over the medial segment of the exposed pectus bar (without gripping the pectus bar) with a slightly splayed tip to contact the flanges of the bar stabilizer (Fig 1). Once the suture (or wire) around the bar stabilizer has been removed, the anvil tool is placed on the bar stabilizer. The anvil tool is tapped to enable the transmission of force onto the flanges of the bar stabilizer. This facilitates the bar stabilizer to slide over the pectus bar resulting in its detachment. The detached bar stabilizer is then recovered from the wound. The freed pectus bar is now bent and slightly elevated from the chest wall using a steel spanner. A hooked retractor that latches onto the hole (present on the end of the pectus bar) is finally used to pull the pectus bar out of the thoracic cavity.

**Clinical Experience**

During pectus bar removal, because a single bar stabilizer was used on the right side, incisions were made only on the right side of the chest wall in all 10 patients. No patient required an incision on the left side. The first prototype of the anvil tool was used in 5 patients (age range, 15 to 20 years) in which significant scarring and bone growth around the stabilizer plate was evident, and easy detachment of the stabilizer plate was not possible. Application of the anvil tool was successful in all of the patients. The bar stabilizer was detached within a maximum time of 2 to 3 minutes. However, due to the bulky tip of the first prototype, and the large disproportion in size between the anvil tool and the bar stabilizer flanges, slipping of the anvil tool was frequently observed. Furthermore the wide tip of the anvil tool edge caused frequent rotation of the tool and prevented optimal placement on the bar stabilizer flanges in 2 patients.

Taking into account these technical problems during use of the anvil tool in surgery, the tool was redesigned and a second prototype of the Bar Stabilizer Anvil tool was also manufactured by Walter Lorenz Surgical Inc (Fig 2). The modifications involved a tapering of the tip to permit easier insertion into the wound. This also improved the contact proportion of the anvil tool tip to the flanges of the bar stabilizer, and it allowed optimum...
technology applied with the hammer. The second prototype was used in 5 patients (age range, 16 to 24 years). The second prototype could be placed in the wound with ease in all of the patients. The problems associated with the slipping and rotations of the contact edge were overcome. The time for placement of the anvil tool and bar stabilizer removal was a maximum of 1 minute in all the patients with the second prototype.

Results

Pectus bar dislocation is one of the most common complications reported in the repair of MIRPE [5]. Various methods (such as application of wires to bar stabilizer) have been used to counter this problem. At our center, the pectus bar is placed on the rib cage and secured to the underlying rib using a standard technique that involves the use of a single bar stabilizer and polydioxanone cords on the right side. The ease of removing the bar stabilizer (36 months after the procedure) depended on the amount of scar tissue and bone formation around the pectus bar. Despite development and advances in the design of the pectus bar and the introducer to provide better instruments for MIRPE, no tool was developed for removal of the bar stabilizer.

In patients with less scar tissue or bone formation around the pectus bar, the bar stabilizer could be slid off from the pectus bar end with minimal effort. However, in moderate or severe forms this could be challenging. Under these circumstances the use of improper instruments to manipulate the bar stabilizer could be associated with risk of injury, especially if the makeshift instrument slipped. Furthermore, improper instruments are associated with unnecessary manipulation and increased trauma to the surrounding tissue. Using improper instruments increases the time required for the procedure and can lead to unnecessary damage of the makeshift instruments that are used. The Bar Stabilizer Anvil tool (Walter Lorenz Surgical Inc) has been found to be an ideal instrument for patients with moderate to severe bone or scar formation around the pectus bar and bar stabilizer.

Comment

The first prototype of the Bar Stabilizer Anvil (Walter Lorenz Surgical Inc) was found to be a valuable tool in the removal of the bar stabilizer. After our initial experience in its application on 5 patients, we evaluated the anvil tool in regard to its implementation and ease of use in surgery. The first prototype was found to be bulky at the point of contact with the bar stabilizer, and disproportion in the contact area was the reason for minor technical hurdles, such as slipping and rotation. The second prototype of the Bar Stabilizer Anvil (Walter Lorenz Surgical Inc) was designed, and the specifications were provided to the manufacturer. The modifications involved a tapering of the tip to permit easier insertion into smaller sized wounds and to improve the contact area proportion to the flanges of the bar stabilizer. These modifications also permitted optimum transmission of force applied with the hammer. The second prototype overcame the shortcomings of the first one and could be handled more efficiently during the procedure. The Bar Stabilizer Anvil has been found to be a useful tool in the removal of bar stabilizers used in the MIRPE.

Disclosures and Freedom of Investigation

The author discloses that the Bar Stabilizer Anvil tool was manufactured and donated to the study by Biomet Austria GmbH and Walter Lorenz Surgical, Inc. The author had full control of the design of the study, methods used, outcome measurements, analysis of data, and production of the written report.

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References


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