External longitudinal titanium support for the repair of complex pectus excavatum in adults

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INTRODUCTION

The repair of severe, asymmetric pectus excavatum (PE) is a difficult issue and a multitude of techniques has been described. The crucial part of all procedures is the reliable chest wall stabilization, which is better achieved by substernal metal supports. Effectiveness of these devices is balanced against the possible risks, complications and disadvantages [1]. Intertrocostal bars and screws open new possibilities for the stabilization of the reshaped sternum, after sternochondroplasty, avoiding the use of retrosternal supports.

We describe an anterior stabilization after sternochondroplasty with the use of titanium struts, particularly indicated for the repair of severe, asymmetric PE, in adult patients.

SURGICAL TECHNIQUE

The patient is placed in the supine position with both arms abducted. A longitudinal median incision is made, starting from the distal margin of the sternal manubrium. All the deformed costal cartilages are exposed and removed subperichondrally including the xiphisternum. Care should be taken to preserve the intercostal bundles and the deep layer of the perichondrium. After the resection of all the deformed costal cartilages, the inner table of the sternal body is gently freed from its adhesions to the pericardium and pleura. A 7–8 mm wedge transverse anterior osteotomy is performed at the maximum curvature of the sternal body, generally located between the stumps of the third costal cartilages. The wedge osteotomy should not involve the inner table of the sternal body, which is subsequently fractured with a firm upward pressure to lift the sternal body ventrally. In this way, the shape correction will convert the wedge osteotomy into a linear fracture (Figs 1A and B and 2A). In the case of marked bone deformity, the externally concave sternal shape precludes good cosmetic results, even if the depressed sternal position has been corrected completely. The possible rotational deformity should also be adequately modified before starting the fixation procedures. In such circumstances, another transverse or oblique osteotomy is required to restore a fairly flat bone surface, tailoring the method to the individual patient's anatomic condition. This second osteotomy should linearly interrupt only the outer table of the sternum: the fracture is then completed with a downward pressure to obtain an anterior wedge-shaped loss of substance (Figs 1C and 2B). The case in point showed: Grand Canyon configuration, Haller's index: 3.38, degree of depression: 2.30, degree of asymmetry: 0.83 and sternal body rotation: 45°.

After the neosternum has been fashioned, its location is firmly fixed by two titanium struts (Synthes®, Canada Ltd), screwed to the manubrium and sternal body. The struts are modelled on the anatomic sternal shape. Before screw placement, the bone is drilled and the screw length carefully calculated to ensure anchorage to the inner sternal table, without protruding excessively towards the mediastinum. Self-tapping titanium screws are preferred for their blunt tip. Three consecutive screws should be employed in fixing each plate to the manubrium, whereas 4–7 screws are sufficient for the entire remaining sternal body. Any dead space between struts and bone should be carefully avoided. Stable fixation is guaranteed by perfect screw length and by the screwheads, firmly
locked into the threaded holes of the titanium plate (Figs 1D and E and 2).

A tension-free reapproximation of the pectoralis muscles is performed on the midline to avoid direct skin closure over the titanium plates. Finally, rectus sheaths are sutured to the inferior border of the pectoralis muscles with interrupted 0 synthetic absorbable suture. Two No. 10 Jackson-Pratt drains are placed, respectively, under the sternum and pectoralis muscle flaps.

The chest X-ray is taken at the end of the procedure; the patient is mobilized in postoperative day 1 and drains removed in day 2.

Figure 1: Severe, asymmetric deformity in an adult patient, preferred indication for the described technique (A). Two transverse osteotomies are performed: the first, wedge shaped, at the maximum curvature of the sternal body, will lift the sternum ventrally; the second is linear and corrects the possible externally concave sternal deformity (B). The shape correction will convert the proximal osteotomy into a linear fracture, and the distal fracture into an anterior wedge-shaped loss of substance (C). Once the sternum has been reshaped, it is firmly fixed by two titanium plates, screwed to the manubrium and sternal body (D and E).

Figure 2: Intraoperative view: the sternal deformity is entirely corrected, converting the second osteotomy into a full-thickness fracture (B), with a firm, downward pressure. The final result is depicted on the right.

DISCUSSION

In the repair of very severe and asymmetric PE in adult patients, open methods are still preferred over minimally invasive approaches. The use of metallic or synthetic retrosternal supports is undoubtedly the most effective solution to prevent recurrences [2], but complications and risks of such devices are not minimal and can be serious or even fatal [3, 4]. A transverse retrosternal bar limits the thoracic compliance, exposes to serious damage in the case of trauma, can be painful and generally requires a second operation for removal [5].
The introduction into the clinical practice of titanium plates, specifically built for sternal stabilization, leads us to investigate their use in complex PE repair. The anterior sternal fixation with short stainless steel plates has already been investigated after sternochondroplasty, limiting the support at the level of the wedge transverse osteotomy, for the significant thickness and weight of the material used [1]. The current availability of thin, lightweight and highly resistant titanium struts, allow for an effective support of the entire sternum, modelled by multiple fractures and maintained in the correct position by the firm anterior anchorage to the manubrium. In this way, a second surgery for the struts removal is not needed. Besides, in the case of trauma, the risk of mediastinal injury should be minimized by the solidity of the reconstructed sternum and by the lack of any retrosternal device. For the reduced thickness of the prosthesis and for their perfect fit with the sternal surface, no patient had palpable struts or screws.

In conclusion, we found this technique effective in the repair of any kind of PE but especially fitting under the severe asymmetric condition. This report introduces a novel method in the surgical scenario but further studies on large series are mandatory to definitively assess the outcomes in different clinical settings.

**Conflict of interest:** none declared.

**References**


