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ORIGINAL ARTICLE

Is the Abramson technique effective in pectus carinatum repair?

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Summary *Background:* The minimally invasive pectus carinatum (PC) surgery described by Abramson has been performed in many centers. We have been using this technique since 2011. This article describes our experience with PC correction.
Methods: Between 2011 and 2016, 32 patients at our institution underwent minimally invasive repair of a PC deformity. All patients presented with cosmetic complaints. The deformity involved the lower sternum (all had chondrogladiolar type PC), and three patients had asymmetrical deformities. All operations followed the principles defined by Abramson.
Results: Satisfactory esthetic results were achieved in our patients. The hospital stay averaged 5.3 days (range 4–7 days). The most common early complication was pneumothorax, and the most common late complication was wire suture breakage.
Conclusion: The Abramson technique is an effective, minimally invasive procedure for PC with shorter operating and hospitalization times and low morbidity rates.

1. Introduction

Pectus carinatum (PC) is a deformity characterized by protrusion of the anterior chest wall caused by overgrowth of the costal cartilage.[1–4] There are two different types of PC: the chondrogladiolar type, in which the gladiolus and inferior costal cartilage protrude along the most prominent aspect of the sternum; and the chondromanubrial type, in which the manubrium and superior costal cartilage protrude.[5,6] Open surgery has been the treatment of choice for PC for the past 50 years. Most existing techniques are modifications of the Ravitch procedure, which features resection of the deformed costal cartilages along with sternal osteotomy. The optimal surgical and orthopedic treatments of PC deformities remain unclear.[7] Open surgical techniques were favored until Abramson described a

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minimally invasive technique in 2005.[8,9] The Abramson method is a modification of the Nuss procedure, featuring the use of a presternally placed metal bar to compress the sternum; the bar is fixed to both sides of the chest wall using metal plates.[10] As this minimally invasive technique is very successful, it has become preferred in many centers, including our clinic.

Here, we retrospectively review the outcomes of 32 patients treated by us via the Abramson technique between 2011 and 2016. We evaluate the operative technique *per se*, duration of operation, complications, patient satisfaction, and recurrence. We then explore the overall effectiveness of the technique.

2. Patients and methods

2.1. Patients

This study was approved by the Ethics Committee of Cumhuriyet University, Sivas, Turkey (by letter with the descriptor 2016-04/17). From June 2011 to January 2016, 32 patients were operated on at our institution for minimally invasive repair of PC deformities. Written informed consent was obtained from all patients or from their parents if the patients were younger than 18 years. The median patient age was 16.4 years (range: 12—20 years), and the majority of the patients were male (25 males, 7 females). All patients presented with cosmetic complaints. Surgery was performed on PC patients with moderate-to-severe defects, the chondromanubrial type of PC (symmetric or asymmetric), or flexible chests (i.e., patients with compressible chest walls). Compression tests were performed to check chest wall flexibility; we compressed the sternum while the patient was leaning against a wall. Posteroanterior and lateral chest X-rays were taken. Cardiac and pulmonary function evaluations were routinely performed preoperatively; no abnormal findings were noted. All operations were performed as suggested by Abramson et al.[10]

2.2. Surgical method

Patients underwent single-lumen tube intubation under general anesthesia, with the arms bent at the elbow while in the supine position, and both arms abducted to $<90^{\circ}$. The arms were not subjected to hyperextension to avoid stretching of the brachial plexus. After covering and regional disinfection, we pressed the highest region of the chest to achieve the desired shape. Meanwhile, a soft template was fitted to determine bar length and shape. The soft template was pulled down when the anterior chest became flat. The border of the template was marked using a sterile pen (Figure 1). Two transverse incisions, approximately 3 cm in length, were made at the midaxillary line, and the muscles were dissected. We identified two ribs (1 upper, 1 lower) in this region. Helical double-wire sutures were passed under the ribs in the region of the periosteum and loosely sutured to fixed stabilizers on either side. A trocar with a chest tube was pushed toward the opposite side under the muscular layer and then removed from the tube. The bar was placed in the required position via compression over the sternum, and the ends were placed into the stabilizers. The loose wire sutures were now thoroughly tensioned, imparting a normal shape to the chest. Each operation required two steel stabilizers and one steel bar. Bars were placed through a tunnel passing under the skin in the first four operations. In subsequent cases, the bars were passed along the chest wall after dissection of the muscles.

Figure 1 Preoperative marking of the pectus carinatum margins.

3. Results

Satisfying esthetic results were achieved by all patients. Initially, all were satisfied. The bars placed ranged from 22.9 cm to 40.6 cm in length, and stabilizers were placed on either end. The median operative duration was 80 minutes (range: 60—120 minutes); we noted no significant blood loss. Systemic analgesic agents were all that were required, except by three patients who required epidural analgesia. The duration of hospital stay ranged from 4 days to 7 days (average = 5.3 days). Patients were told to perform gentle exercise, and they returned to normal activities within 2—3 weeks.

The early complications [4 patients (12.5%)] were pneumothorax of a size that did not require chest tube drainage, and two (6.25%) instances of wound discharge (Table 1). The late complications in five (15.6%) patients were wire suture breakage caused by growth and activity (Table 2); these were patients for whom bar removal was planned. Therefore, no treatment was required. No fracture developed in any patient. In two patients (6.25%), the skin over the bars became eroded and the bars moved, caused by excessive weakening, in Months 24 and 30. We removed the bars because the deformities were corrected and, at the 8-month follow-up, noted no further problems. In one patient, the bar was removed prior to the planned

Table 1 Early complications.

Pneumothorax	4 (12.5%)
Wound complications	2 (6.25%)
Metal allergy	0 (0%)

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