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# Pushing the boundaries of minimally invasive repair of pectus excavatum: first experience with a 4-bar technique

Mustafa Yüksel<sup>a</sup> and Hasan Ersöz<sup>id b,\*</sup>

<sup>a</sup> Department of Thoracic Surgery, Demiroğlu Bilim University Faculty of Medicine, İstanbul, Turkey

<sup>b</sup> Department of Thoracic Surgery, İzmir Katip Çelebi University Faculty of Medicine, İzmir, Turkey

\* Corresponding author. Department of Thoracic Surgery, İzmir Katip Çelebi University Faculty of Medicine, Atatürk Eğitim ve Arastırma Hastanesi, Gogus Cerrahisi Klinigi, Karabağlar, 35150 İzmir, Turkey. Tel: +90-2322434343; e-mail: hasan.ersoz@ikcu.edu.tr (H. Ersöz).

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## Abstract

Several modifications to minimally invasive repair of pectus excavatum have been reported to date. Of these, the use of multiple bars was a major development. At present, there are 2 established techniques: cross-bar and parallel bar placement. We used a combination of both parallel and cross-bar techniques in a 25-year-old male patient with deep, Grand-Canyon type pectus excavatum, placing a total of 4 bars and 4 stabilizers. The patient had no complications during the 7 months of postoperative follow-up. We share this case report as the first experience using this modified technique in the literature.

**Keywords:** Minimally invasive repair of pectus excavatum • Nuss • Cross-bar • Parallel bar

## INTRODUCTION

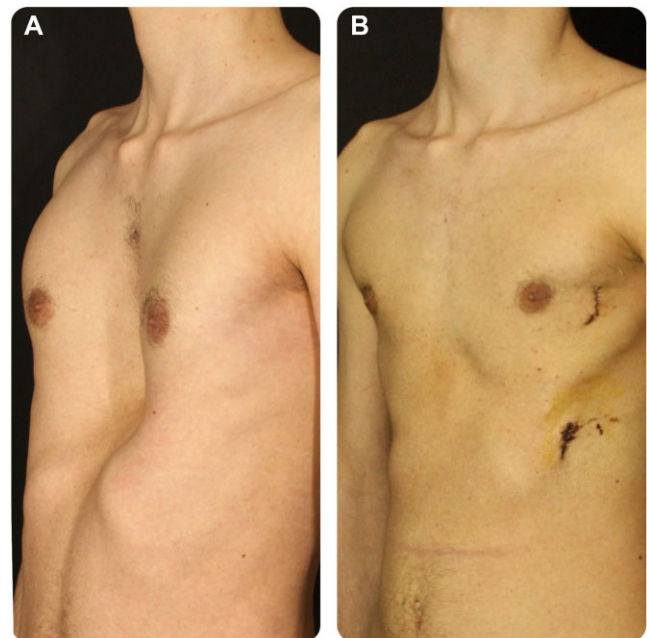
The Nuss technique [1] and all of its variations are collectively referred to as minimally invasive repair of pectus excavatum (MIRPE).

Here, we describe a correction performed with 4 bars and 4 stabilizers in the first case report in the literature using this new variation of MIRPE.

## PATIENTS AND METHODS

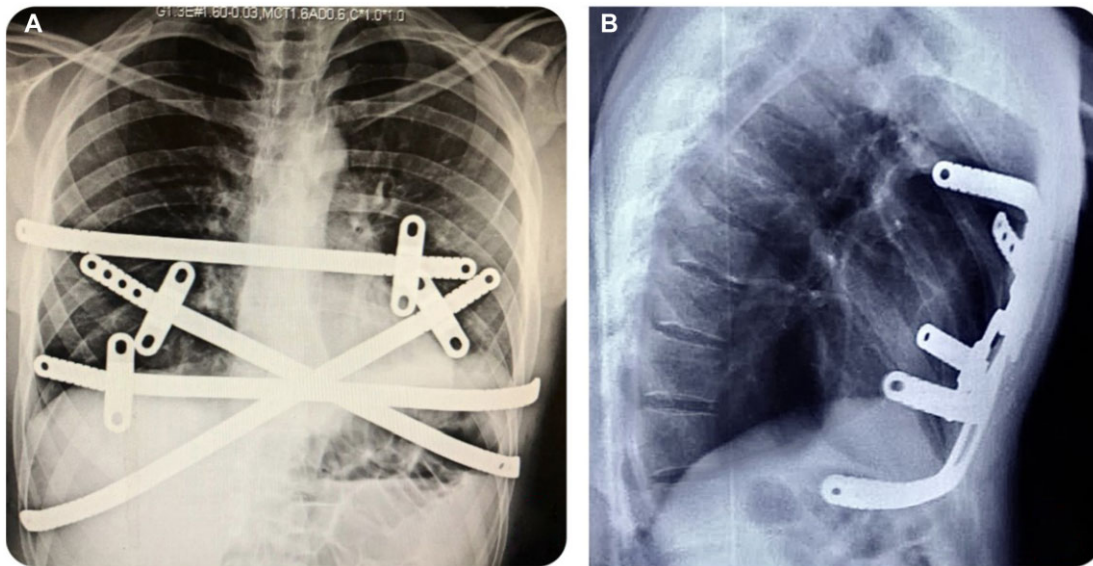
A 25-year-old man presented with deep Grand-Canyon type pectus excavatum deformity (Fig. 1A). The deformity depth was 7 cm. Haller index was 5.25.

It was decided to perform MIRPE. While anaesthesia single-lumen ventilation plus CO<sub>2</sub> insufflation used. During the procedure, an upper transverse bar was first placed to partially elevate the sternum and correct the manubrial depression. The deep depression in the lower sternum was then corrected using the cross-bar technique. However, we were concerned that the 2 cross-bars were overloaded and that the transverse costal depression would not be fully corrected. Therefore, we placed an additional transverse bar passing over the centre of the lower depression. In order to provide a smooth appearance of the pectoral muscle, the bar ends reaching the pectoral muscle level were placed under the muscle by the dissection plan provided under the muscle from the incision made on the side of the pectoral muscle to the point where the bar enters or exits the thorax. Each bar was fixed with a stabilizer. Since we think that placing the stabilizers on the upper ends of the cross-bars provides better stabilization, we placed them upper ends of the bars. In



**Figure 1:** (A) Preoperative appearance of the patient's chest. (B) Postoperative appearance of the patient's chest.

parallel bars, by placing the stabilizer on the side where the rib cage is more protruding at the bar level, we aim for the stabilizers to suppress the protrusion better. Therefore, we placed a left stabilizer on the upper bar and a right stabilizer on the lower bar in our case (Fig. 2). The deformity was satisfactorily corrected (Fig. 1B). For pain



**Figure 2:** Postoperative chest radiographs showing the placement of the bars and stabilizers. **(A)** Posteroanterior X-ray. **(B)** Lateral X-ray.

control, intercostal nerve blockade was applied to the intercostal spaces where the bars entered or exited the thorax during the operation. In addition, acetaminophen was administered at a dose of 4 g/day and diclofenac at a dose of 150 mg/day for 1 month in the postoperative period. In addition to these, intravenous patient-controlled analgesia containing tramadol was applied in the postoperative period until the patient's discharge. The dose of patient-controlled analgesia was adjusted according to the patient's pain sensation. The Haller Index value decreased to 2.25. The patient was discharged on postoperative day 5. No complications were observed during 7 months of outpatient follow-up.

## DISCUSSION

The most common complication of MIRPE is bar dislocation [2]. There are many publications indicating that the use of double bars prevents migration. The sole purpose is to reduce the load on the bar.

In deep pectus excavatum deformities like the present case, we do not start the dissection at the most depressed part of the sternum. Instead, we dissect the safer, more elevated upper mediastinum and place a transverse bar across the upper sternum to achieve partial sternal elevation. We can then more safely dissect the area of deepest sternal depression and place the other bars.

Pain control is another benefit of multiple bars. The bars receive the force necessary to elevate the sternum from the intercostal region where they enter and exit the thorax. This pressure on the intercostal region is transmitted directly to the intercostal nerves, resulting in neuropathic pain. The more bars are used, the load is distributed to more intercostal regions. This reduces the severity and duration of neuropathic pain.

Recurrence of the deformity is one of the main issues to consider after MIRPE [3]. The use of multiple bars prevents recurrence, with the likelihood decreasing even further as the number of bars used increases.

Based on our experience, we have observed that patients who undergo cross-bar repair may present with depression of the xiphoid tip in long-term follow-up. We believe that the fourth bar applied to the lower end of the sternum may also reduce this risk.

There are 2 established surgical techniques for the use of multiple bars: parallel and cross-bar placement [4, 5]. In this first case in the literature, we placed a total of 4 bars, using both the parallel and cross-bar techniques in combination. With this technique, we achieved better cosmetic correction, safer dissection, as well as pain control (we observed that pain control was achieved thanks to the feedback we received from the patient). We both minimized the possibility of bar dislocation and recurrence. As a result, the patient was very comfortable postoperatively and was discharged early. Cosmetically, the technique both provided better chest elevation and also corrected the transverse rib depression while eliminating the rib-flaring deformity.

The limitation of this case report is the lack of lung function testing and thus the inability to report the functional outcome.

## CONCLUSION

We believe that our combined parallel and cross-bar technique using a total of 4 bars is beneficial for selected patients.

**Conflict of interest:** none declared.

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