

## A Case of Successful Surgical Repair for Pectus Arcuatum Using Chondrosternoplasty

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Pectus arcuatum is a rare complex chest wall deformity. A 31-year-old female presented with a severely protruding upper sternum combined with a concave lower sternum. We planned a modified Ravitch-type operation. Through vertical mid-sternal incision, chondrectomies were performed from the second to fifth costal cartilages, saving the perichondrium. Horizontal osteotomy was performed in a wedge shape on the most protruding point, and followed by an additional partial osteotomy at the most concaved point. The harvested wedge-shape bone fragments were minced and re-implanted to the latter osteotomy site. The osteotomized sternum was fixed with multiple wirings. With chondrosternoplasty, a complex chest wall deformity can be corrected successfully.

Key words: 1. Pectus carinatum  
2. Funnel chest  
3. Thoracic wall  
4. Sternum  
5. Bone transplantation

### CASE REPORT

A 31-year-old female presented with a severely protruding upper sternum combined with depressed lower sternum (Fig. 1A, Fig. 2A). She did not complain of any cardio-respiratory symptoms, such as dyspnea, palpitation, chest discomfort, or exercise intolerance. Her father also had a chest wall deformity with the same features, which had never been treated. On preoperative chest computed tomography scan, the right ventricle was compressed by the sternum and the pulmonary artery was two times as large as the aorta in diameter. However, there was no cardiac anomaly on echocardiography.

We planned a modified Ravitch-type operation, instead of a

minimally invasive repair using a pectus bar, due to the protruding upper sternum. A vertical mid-sternal skin incision was made. After dissecting under the bilateral pectoralis major muscles, chondrectomies were performed from the second to fifth costal cartilages, saving the perichondrium. We performed the first horizontal osteotomy in a wedge shape on the most protruding point, the angle of Louis. In order to unbend the anteriorly concaved lower sternum, we made an additional partial osteotomy at the most depressed point. The bone segments, harvested from the wedge-shape osteotomy, were minced into small pieces and implanted into the unbent lower osteotomy site. After unbending, the remnant protruding part was ground with a bur grinder. The osteotomized

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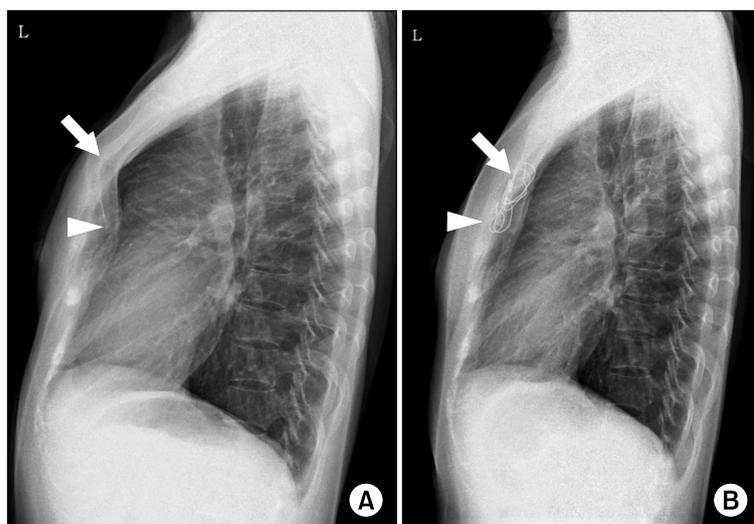
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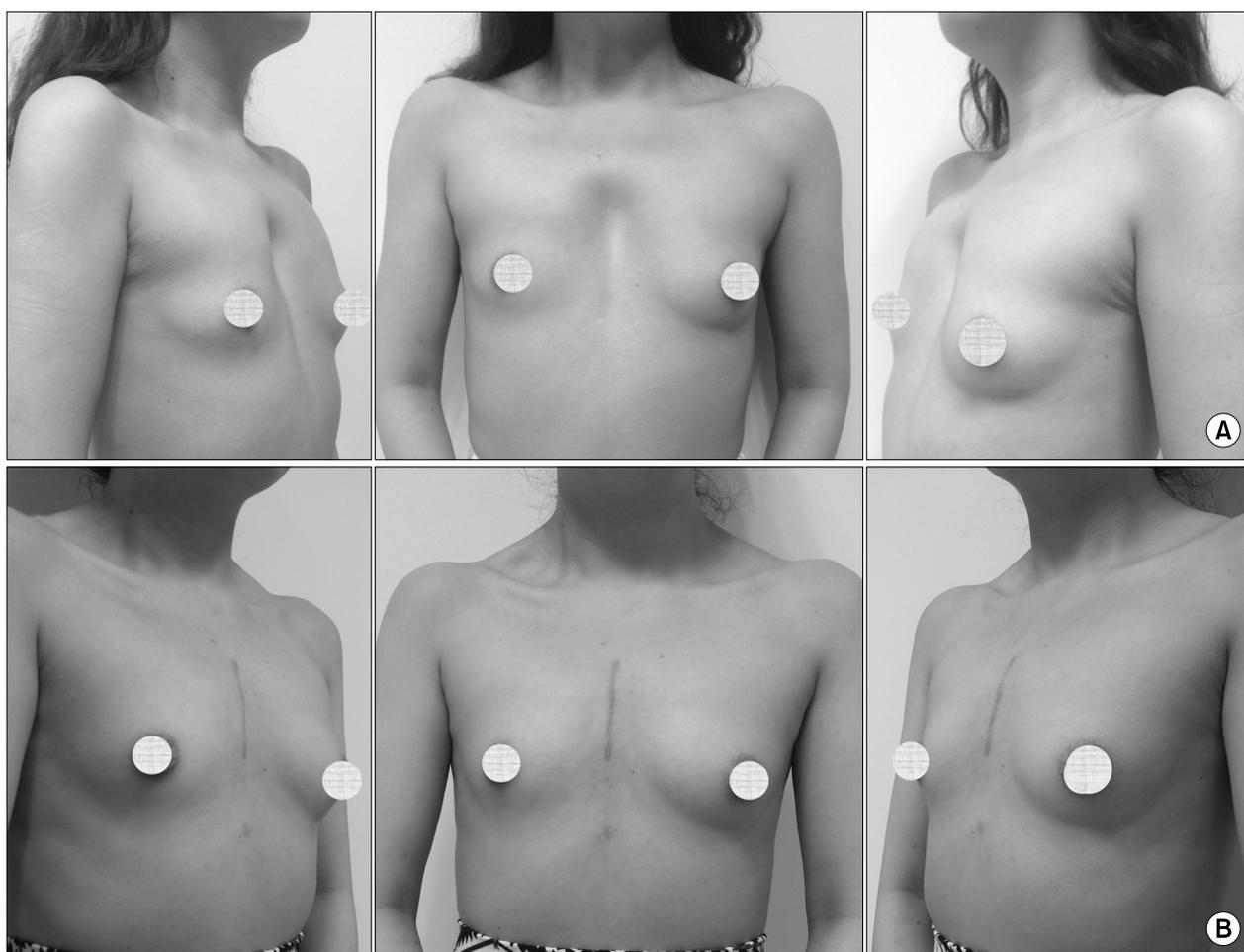
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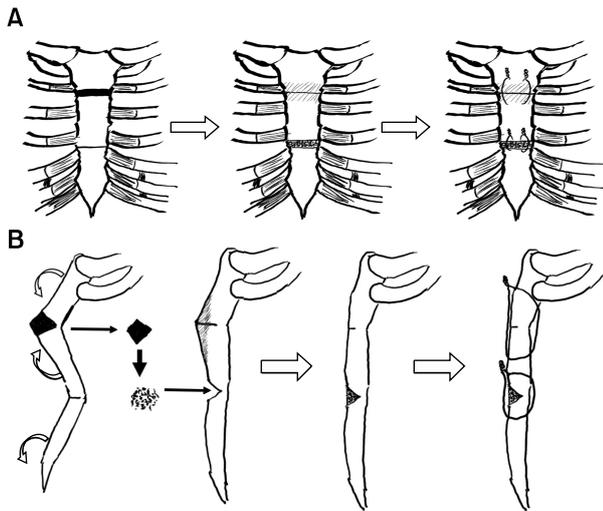
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**Fig. 1.** (A) Preoperative left lateral chest X-ray. Arrow: most convex point. Arrowhead: most concaved point. (B) Six-month postoperative left lateral chest X-ray. Arrow: wedge-osteotomy site was stabilized with vertical wiring. Arrowhead: partial osteotomy with bone segment implantation site was stabilized with vertical wiring.



**Fig. 2.** (A) preoperative medical photograph (B) Six-month postoperative medical photograph.



**Fig. 3.** (A) Sequential illustration of sternoplasty in frontal view. (B) Sequential illustration of sternoplasty in sagittal view.

sternum was fixed with multiple vertical wires to prevent horizontal displacement (Fig. 3).

The patient was discharged without complication on the sixth postoperative day. No auxiliary external compression devices or braces were used. External morphology of the chest wall has been stabilized and more satisfactory after a 6-month remodeling period (Fig. 1B, Fig. 2B).

## DISCUSSION

Pectus arcuatum, which is also called ‘pouter pigeon breast,’ is a rare complex chest wall deformity. It involves a wave-like deformity, a mixed form of excavatum and carinatum features, either along a longitudinal or along a transverse axis [1]. This very rare form of chest wall deformity is not frequently dealt with in the literature, particularly not in Korea. We demonstrate a case of the successful surgical correction of pectus arcuatum with chondrosternoplasty.

Utilization of the Ravitch operation has decreased, while the treatment of pectus excavatum has been substituted with minimally invasive repair using the Nuss technique. However, the Ravitch operation still has a critical role in the correction of chest wall deformity in cases of pectus carinatum or in asymmetric pectus excavatum. Pectus arcuatum is a rare mixed form of chest wall deformity combining pectus car-

inatum and excavatum [1]. Surgical repair of this rare deformity also requires a modified Ravitch technique.

The basic steps in the surgical correction described by Ravitch are as follows: bilateral parasternal and subperichondrial resection of the deformed costal cartilages, detachment of the xiphoid process, transverse wedge osteotomy at the upper edge of the sternal depression, and bending of the sternum to straighten its course, securing the corrected position of the sternum [2]. Based on these steps, in 1987, Shamberger and Welch [3] reported their experience of 14 pectus arcuatum cases among 152 pectus carinatum cases, with satisfactory overall results of 98%. In 2009, Wurtz et al. [4] reported their surgical outcomes of chest wall deformity including 5 pectus arcuatum cases out of a total 205 cases. They proposed their technique as a less invasive and simplified one, characterized by small skin incisions and the discontinuation of both xiphoid process resection and extensive retrosternal dissection. Although they did not detail specific results with pectus arcuatum, satisfactory results were acquired in 97.5% of the whole patient group.

The Ravitch technique has a risk of growth limitation to the thoracic cage due to wide resection of the rib cartilages [5]. However, in an adult with rigid skeletal structure, this conventional chest wall repair technique and its modification can be a useful surgical option, especially for complex chest wall deformity including pectus arcuatum.

In this case we achieved a satisfying clinical result with minimal mid-sternal skin incisions, double horizontal osteotomies, subperichondrial chondrectomy, and bone graft re-implantation to the osteotomy defect. Pectus arcuatum can be successfully corrected by a Ravitch-type chondrosternoplasty.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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