



Rib osteotomy with the Nuss procedure for the repair of adult pectus excavatum

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Abstract

For the Nuss procedure in adult patients with pectus excavatum, sufficient sternal elevation is difficult due to the rigid chest wall. To solve the problem, we present a novel rib osteotomy procedure. From the skin incisions on the lateral chest which are the common approach for the Nuss procedure, a surgical drill is used to incise bilateral anterior half of the rib cortex after installing the pectus bars. Osteotomy is done on the ribs next to the points where the bars penetrate the intercostal muscle. After making rib osteotomy, the ribs bend spontaneously like greenstick fracture. Elevation of the stiff anterior chest wall can be achieved by this procedure. Rib osteotomy is also beneficial for pain relief due to the reduction of the strain to the ribs. It could be expected that regression after bar removal is avoided.

Keywords Pectus excavatum · Adult · Rib · Osteotomy · Minimally invasive surgery

Introduction

The Nuss procedure was first reported in 1998. Initially, this operation was mainly performed for pediatric patients [1]. With the extension of this operation for adults, the risk of bar migration, prolonged pain and other complications has been raised [2–4]. However, recent reports demonstrated satisfactory results in adults [5, 6].

The chest wall of adult is rigid, which causes strong strain on the ribs and the sternum after the Nuss procedure. Prolonged postoperative pain and incomplete sternal elevation in adult patients could be explained by the rigidity of the chest wall [3]. To reduce the elevating force and to obtain good cosmetic results, open-cartilage resection and sternal osteotomy have been published [5]. In addition to these techniques, we innovated a rib osteotomy procedure for adults to reduce the strain on the ribs.

Operative technique

Under general anesthesia with epidural block, a midline incision, 3 cm in length, is made at the lower chest and bilateral parasternal costal cartilages from 5 to 7th are incised. With this incision, the sternum is elevated by a lifting hook using the crane technique [5]. Then, oblique skin incision, 4 cm in length, is made on both lateral chest wall. Under the thoracoscopic view, the mediastinum is dissected and two bars are introduced in 4th and 5th intercostal space. After installation and fixation of two bars using connecting stabilizers (Fig. 1d), the bilateral 5th and 6th ribs are exposed through the same incisions. Semicircular osteotomy of the rib cortex is made using a surgical drill with a round tip, 3 mm in diameter (Fig. 2). Cutting position of the ribs is next to the penetrating points of intercostal muscle (Fig. 3). This procedure is aimed to make greenstick fractures and bend the ribs at these points.

A case presentation

A 63 years old man presented with chest discomfort and shortness of breath seeking for surgical repair. He had symmetrical chest depression and flared lower chest (Fig. 1c). Haller index was 4.2. Because of the stiff chest wall with ossification of the rib cartilages, we attempted rib osteotomy

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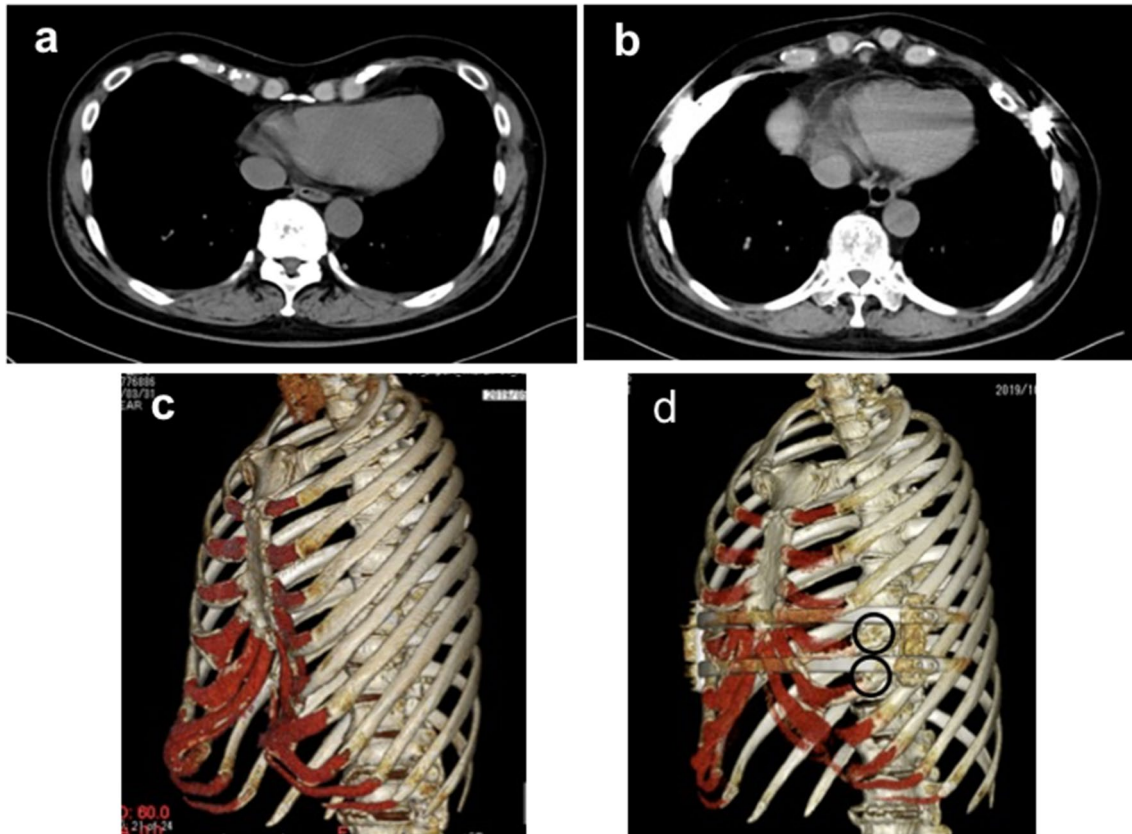


Fig. 1 Chest CT before and after the operation. **a** Preoperative CT image at xiphoid shows chest depression. Haller index is 4.2. **b** Postoperative CT image at the same level. Haller index is 2.5. The distance between xiphoid and anterior vertebra increased 46 mm. **c** Pre-

operative 3D CT image. Calcification of the costal cartilage is seen. **d** Postoperative 3D CT image shows improved chest depression. Flared lower chest is also improved. Rib osteotomy points are shown in circles

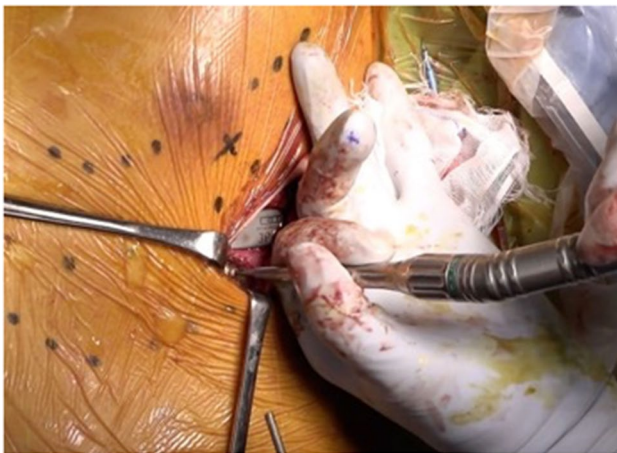


Fig. 2 Rib osteotomy procedure. A surgical drill was used to incise the anterior half of the rib cortex. The photo shows cutting point of the left 6th rib just below the pectus bar

along with the Nuss procedure. He also underwent bilateral flared 7th and 8th cartilages resection.

The patient recovered well after the operation with slight pain and discharged from the hospital on day 6 without any complications. At the outpatient clinic one month after the operation, he did not complain of chest pain and satisfied with the repaired chest wall. We examined his chest with a CT scan 6 months after the operation showing improved anterior chest wall (Fig. 1d). The lower sternum was lifted 46 mm compared to the preoperative CT scan (Fig. 1a, b) and Haller index improved to 2.5.

Discussion

Recently published reports regarding adult patients with the Nuss procedure [5, 6] revealed satisfactory results applying modified procedures; cartilage resection and sternal osteotomy. These modifications are reported to reduce rigidity of the adult chest wall [7]. We have also performed rib cartilage incisions and sternal osteotomy for adults showing satisfactory results. However, these modifications are not enough to reduce the strain on the ribs.

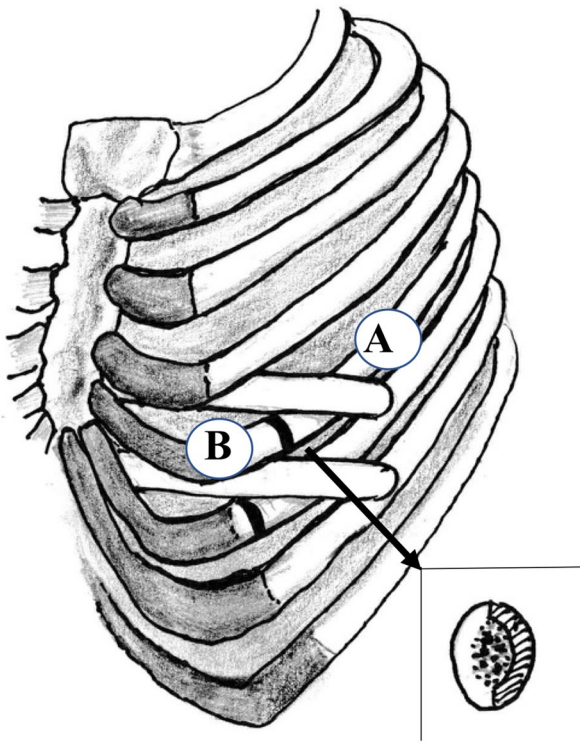


Fig. 3 The site of rib osteotomy in relation to the bar position. Two bars were used in this case. The upper bar was introduced at the 4th intercostal space. This bar pushes down the 5th rib at the crossing point of the bar (A) for the sternal elevation. The anterior part of the 5th rib and the costal cartilage connecting to the sternum (B) receives elevating force by the upper bar. In addition, the lower bar pushes up the 5th rib directly. Hence, the 5th rib suffers distortion at the osteotomy point. Therefore, half circle rib-cortex incision, 3 mm in width, at this point makes greenstick fracture and reduces the distortion force. Another osteotomy at the 6th rib is likewise effective to reduce the distortion force

The novel rib osteotomy procedure was aimed to reduce the strain to the ribs touching directly to the bars. The ribs on the posterior side of the bars suffer pushing down force and lifting up force on the median side, which causes twisting strain on the ribs. The strain may reduce in time in elastic bones of children. However, the ribs of older adults with less elasticity suffer strong force for a long time. Making a fracture close to the point of contact with the bar could reduce the twisting strain. In our case using the novel technique, prolonged postoperative pain was not observed and the postoperative recovery was quicker than we expected. In addition, an excellent elevation of the anterior chest wall was obtained in spite of a senior patient. Objective data was obtained from this case that postoperative sternal elevation was 46 mm. According to our clinical experience with more than 1200 operations of the Nuss procedure, an average sternal elevation was about 30 mm.

Technically, semicircular incision of the rib cortex using a surgical drill was simple without making an additional skin incision. Care has to be paid to avoid injury to the neurovascular band. The fractures are fixed with the bars, which look similar idea of the frail chest surgery using a pectus bar [8]. Body exercise should be postponed for 6 weeks to heal the fracture. It could be expected that regression after bar removal is avoided.

Our experience at this moment is limited and we have no long-term results. After accumulating cases and following patients long, the results of this technique will be reported.

Compliance with ethical standards

Conflict of interest Sadashige Uemura, Atsushi Yoshida, Hisako Kuyama have nothing to declare for the conflict of interest.

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