Case report

Simultaneous pectus excavatum repair using sternal plate in a patient undergoing the Bentall procedure

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Abstract
Objective: Pectus excavatum is a deformity that occurs at the lower part of the sternum of the thorax, including the xiphoid process. Deformity generally causes cosmetic and psychosocial problems. Life-threatening conditions may ensue in patients with severe deformities. Ravitch surgery and Nuss's minimally invasive surgical procedures are the main procedures for correcting the pectus excavatum. A rare method of pectus excavatum is the stabilization of the sternum by using sternal plates. In this report, we present a case; successful pectus excavatum repair using the sternal plate simultaneously in a 48-year-old male patient who underwent Bentall operation due to ascending aortic aneurysm and aortic valve insufficiency.
Case presentation: The patient was admitted with complaint of dyspnea. Examinations including clinical examinations, echocardiography, computed tomography and pulmonary tests revealed pectus excavatum, with Haller index>3.5, reduced forced vital capacity 72% and ascending aorta aneurysm of 5.7 cm and moderate aortic valve regurgitation. The decision to proceed with simultaneous aortic root and aortic valve replacement with pectus excavatum correction was taken. The operation were performed successfully under cardiopulmonary bypass without complications. Patient was discharged on 9th postoperative day.
Conclusion: In patients with pectus excavatum deformity who undergo cardiac surgery (in our case ascending aorta and aortic valve replacement) with median sternotomy, simultaneous sternal repair using a sternal plate is safe and preferable because it positively affects cardiac and pulmonary surgical outcomes. Therefore, we recommend simultaneous sternal plate application in patients with pectus excavatum who will have a cardiac operation.

Key words: Bentall procedure, pectus excavatum, sternal plate
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Introduction

Pectus excavatum is a common thorax deformity that characterizes depression of the chest wall and sternum inward because of abnormal development of costochondral conduction (1). There is no consensus in the literature on its etiology and pathogenesis, but it is considered a costal hyaline cartilage structural defect (2, 3). Typically, sternum is depressed to the vertebral column at the xiphoid process level. Patients with pectus excavatum deformity are most often asymptomatic, but may encounter respiratory problems when depression is significant, and this circumstance reduces the capacity of the chest cavity and causes pressure on the heart (4).

Different surgical techniques are described in the treatment of pectus excavatum. It is reported that surgical treatment has positive effects on the respiratory functions of the patients and improvement in cardiac functions (5). Therefore, in patients with pectus excavatum deformity who will undergo cardiac surgery with median sternotomy, repair of pectus excavatum with sternal fixation is particularly important in postoperative cardiopulmonary functions.

In this case report, we aimed to present the surgical management and results of a patient with pectus excavatum who underwent Bentall procedure with median sternotomy.

Case report

A 48-year-old male patient was admitted to the cardiology clinic with a dyspnea complaint. On the examinations, electrocardiography showed signs of tachycardia and left ventricular hypertrophy.

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Transthoracic echocardiography revealed 57 mm dilatation of the ascending aorta and moderate aortic valve regurgitation. In addition, the patient's ejection fraction was 60%, aortic root 35 mm, left ventricular end-systolic diameter - 37 mm, left ventricular end-diastolic diameter - 56 mm, interventricular septum thickness - 14 mm, posterior wall thickness - 13 mm, and vena contracta size - 0.4 cm.The patient was accepted to the cardiac surgery clinic for surgery as he had indication for aorta surgery (ascending aorta aneurysm - 5.7 cm) (6, 7).

On the examination performed by the pulmonologists, it was seen that the patient had a restrictive type of respiratory pattern (forced vital capacity: 72%) in pulmonary function tests and the pectus excavatum was in an advanced size (Haller index, width of the chest divided by distance between the posterior surface of manubrium and the body of the sternum, > 3.5 (8)) (Fig. 1A).

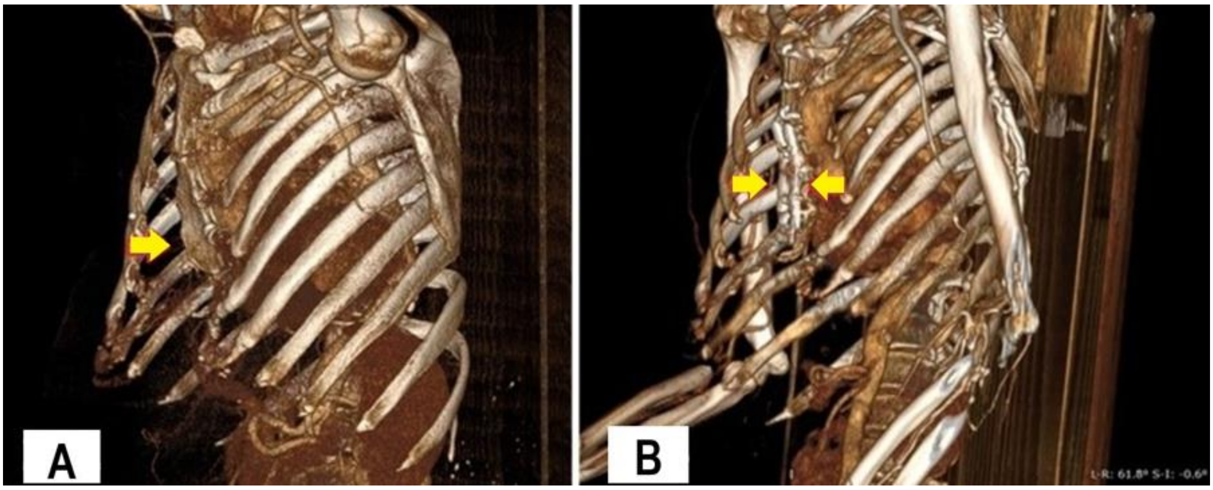

Figure 1. A: Preoperative tomographic image of the patient, pectus excavatum shown with the arrow, B: The tomographic image of the patient after the operation, the plates used for the repair are shown with an arrow

Simultaneous ascending aorta and aortic valve replacement with correction of pectus excavatum deformity was advised because the latter affected respiratory functions and caused cardiac compression. The operation was conducted under general anesthesia, arterial and venous cannulation was perpetrated through the femoral artery and vein. Cardiopulmonary bypass was initiated after exploring the mediastinum with median sternotomy.

The button Bentall procedure was performed: ascending aorta replacement and aortic valve replacement with composite graft containing metallic aortic valve prosthesis. Then, the coronary artery ostiums, which were liberalized in the formation of buttons, were implanted into the graft. In the patient who was weaned off the cardiopulmonary bypass without any problem, the sternum was fractured bilaterally at the level of the manubrium sterni after bleeding control. Ribs 4, 5, 6 and 7 were freed. Sternal elevation was achieved by fixing the lower end of the sternum. The free ribs were connected with a 2-sided sternal plate, and screws inclined approximately 120 degrees (Fig. 2A). Then, eight sutures were placed with a sternal wire, and the sternum was joined (Fig. 2B). Histopathological examination of aneurysmatic aortic tissue revealed findings consistent with cystic medial degeneration and Ehler-Danlos syndrome.

The patient, who underwent postoperative respiratory physiotherapy, was discharged on the ninth postoperative day without any problem. The control examination performed in the second postoperative month confirmed that sternal stability was achieved (Fig. 1B) and respiratory parameters were close to normal (forced vital capacity: 94%).

Discussion

There are very few reported cases of severe pectus excavatum repair with concomitant aortic root replacement. Pectus excavatum is the most common chest wall deformity, with an incidence of 0.1–0.3%, caused by the posterior collapse of the sternum and lower costal cartilages (4).

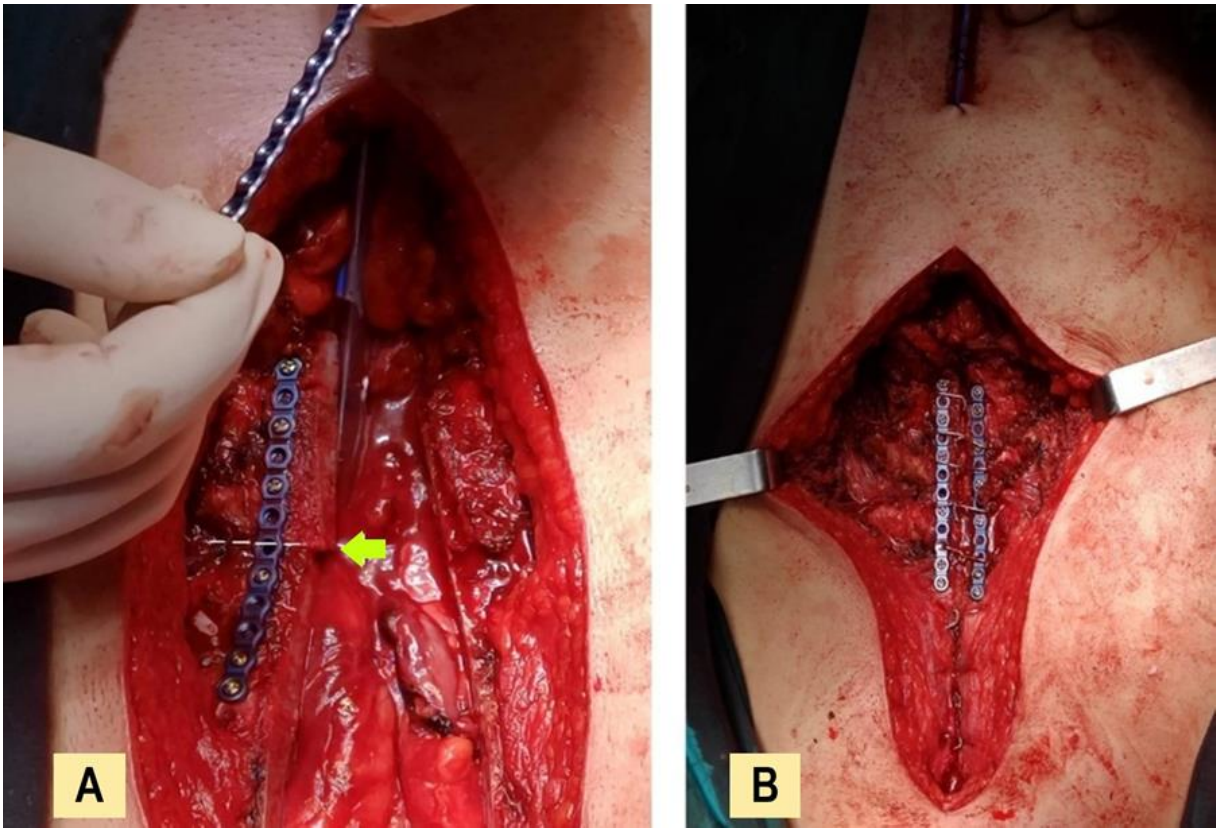

Figure 2. A: Osteotomy of the sternum and the use of a sternal plate. The osteotomy performed is indicated by the white line and arrow, B: Surgical view of the sternum after applying for the sternal plate

Coexisting aortic root dilatation and aortic aneurysm are relatively common in pectus excavatum cases. Connective tissue diseases such as Ehlers Danlos syndrome,

Osteogenesis imperfecta, and Marfan syndrome are predisposing influential factors in pectus excavatum aortic aneurysms (9). In the case we demonstrated, histopathological examination of aneurysmatic aortic tissue revealed findings consistent with cystic medial degeneration and Ehler-Danlos syndrome.

Surgical repair is recommended in patients with restrictive lung disease, cardiac compression, pulmonary atelectasis, and symptomatic pectus excavatum with a Haller index greater than 3.25 determined by tomography (10). The transverse diameter ratio at the most in-depth level of the deformity and the anterior-posterior diameter at the same level is called the Haller index, which is greater than 3.25 in patients with severe clinical findings (8). In our case, the Haller index was above 3.5, with restrictive deterioration in respiratory functions and cardiac compression findings. These results necessitated the simultaneous repair of the chest deformity with the aortic aneurysm.

Classically, two main techniques are utilized in the surgical repair of pectus excavatum. The first is the "Ravitch open surgical procedure" introduced in 1949. In the original Ravitch procedure, the perichondrium and all deformed costal cartilage are removed, and the xiphoid process is separated. Then, the sternal elevation is achieved by transverse osteotomy at the sternomanubrial junction. The second technique is the minimally invasive pectus excavatum repair with the Nuss procedure. In this application, intercostal incisions are executed in both hemithorax, and a stainless-steel bar is directed to pass behind the sternum and cartilage (11). There may be 7% cardiac injury during the insertion of the steel bar and 2% during its removal after recovery (12).

Sternal healing problems are common after median sternotomy in patients with pectus excavatum. In these patients, the possibility of sternum instability and pseudoarthrosis is high due to extensive tissue dissection and cartilage resection in the classical Ravitch procedure. This probability is higher, especially in procedures performed simultaneously with median sternotomy. It was documented that 8% of these patients develop instability after sternotomy.

Modified Ravitch technique was used to repair pectus excavatum in our patient. Unlike the classical Ravitch procedure, a titanium plate is performed to fix the sternal osteotomy. It is anticipated that the method we performed theoretically causes less pain after surgery, and the risk of nonunion or malunion decreases (13).

Pectus excavatum compresses the lung and prevents thoracic relaxation during inspiration. Decreased thoracic volume can cause restrictive respiratory failure. For these reasons, correction of the existing sternal deformity, especially with cardiac surgeries that affect the functional capacity of the patient, is important in terms of postoperative hemodynamic results. In patients undergoing pectus excavatum and concomitant cardiac surgery, performing a one-stage procedure reduces the risks associated with anesthesia. In addition, postoperative hemodynamics and respiratory kinetics improve, due to elimination of organs compression.

Conclusion

In patients with pectus excavatum deformity who undergo cardiac surgery surgery (in our case ascending aorta and aortic valve replacement) with median sternotomy, simultaneous sternal repair using a sternal plate is safe and preferable because it positively affects cardiac and pulmonary surgical outcomes. Therefore, we recommend simultaneous sternal plate application in patients with pectus excavatum who will have a cardiac operation. The pulmonary tests and evaluation of the degree of deformity by computed tomography should be carried out in cases with sternum malformation in patients referred to cardiac surgery.

Ethics: Written patient consent form was obtained before all procedures

Peer-review: External and internal

Conflict of interest: None to declare

Authorship: M.T.G, A.A.P, S.A.S, M.E, A.B.T and I.B.S. equally contributed to the preparation of manuscript and management of patient

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