Simultaneous Aortic Valve Replacement and Pectus Excavatum Correction in a 76-Year-Old Man

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A 76-year-old man was admitted to our department to undergo surgical treatment for aortic valve regurgitation. On physical examination, a bowl-shaped concavity was noted. Chest computed tomography revealed left-sided heart displacement by severe pectus excavatum with a Haller index of 6.40. Considering the postoperative cardiopulmonary complications that may result from mechanical compression due to uncorrected sternal deformities, we decided to perform a simultaneous aortic valve replacement and pectus excavatum correction. The operation time was long (570 min) and involved a high-volume transfusion due to excessive bleeding caused by resection of the deformed costal cartilages and sternal osteotomy under the use of heparin. The endotracheal tube was removed on the fifth postoperative day, but reintubation was required because of hypercapnea and difficulty in sputum discharge. With the aid of tube feeding for nutritional management, his cardiopulmonary function gradually ameliorated and his general condition improved. Consequently, he was weaned from mechanical ventilation on the 14th postoperative day. The patient is doing well 1 year after surgery. We report on the surgical management for pectus excavatum in adult patients.

Keywords: pectus excavatum, modified Ravitch procedure, cardiac surgery, surgical management, adult patient

Introduction

Pectus excavatum (PE) is a congenital chest wall deformity characterized by a posterior depression of the sternum and adjacent costal cartilages. Most patients are asymptomatic and undergo cosmetic surgical treatment at a younger age. However, adult patients with PE with uncorrected sternal deformities can gradually develop clinical symptoms such as palpitations and shortness of breath, although their clinical picture is still unclear. On the other hand, some adult patients have symptomatic PE accompanied by cardiovascular disease and require surgical treatment for each disorder. In these cases, staged operations were formerly recommended; however, single-stage operations have been reported with favorable results in recent years. In this case report, we present an adult patient who successfully underwent simultaneous aortic valve replacement (AVR) and PE correction using the modified Ravitch procedure and discuss surgical management for PE in adult patients.
Case Report

A 76-year-old man with a medical history of gastrectomy at the age of 33 years, left nephrectomy at 65 years, and tumor extirpation in the right kidney following the creation of an arteriovenous fistula for hemodialysis at 75 years, visited a cardiologist in our hospital complaining of dyspnea on exertion over the past 2 months. Transthoracic echocardiography revealed moderate aortic valve regurgitation (AR) with an extremely dilated left ventricle and reduced left ventricle ejection fraction of 32.8%. Aortography showed Seller’s grade III AR. Consequently, the patient was referred to our department to undergo surgical treatment for AR.

His height and weight were 165 cm and 53 kg, respectively. On physical examination, a grade 2/6 diastolic murmur was audible at the third left sternal border. In addition, a bowl-shaped concavity was noted: his sternum and adjacent costal cartilages were posteriorly depressed. Chest X-ray showed scoliosis and cardiomegaly with a cardiothoracic ratio of 59.8% without pulmonary congestion. Chest computed tomography (CT) disclosed cardiac compression and left-sided heart displacement resulting from severe PE with a Haller index of 6.40 (Fig. 1A). A preoperative pulmonary function test showed moderate restrictive respiratory dysfunction: the forced vital capacity was 64.8% and the forced expiratory volume in 1 second was 71.1%.

Surgical treatment for AR and PE was performed in a single-stage operation. First, a midline skin incision was made, and a pectoralis major musculocutaneous (PMM) flap and sternum bone (SB) flap with the left internal thoracic artery and vein were prepared as previously described.6,7) The SB flap was wrapped with wet gauze and turned over the head, resulting in good exposure of the heart. The left coronary cusp of the aortic valve (arrow) was particularly shrunken, which induced lack of co-adaptation of the valve (Fig. 2). AVR using a 25-mm bioprosthesis was performed under cardiopulmonary bypass (CPB). After an uneventful weaning from CPB, the SB flap was returned to its original position and elevated with two titanium plates. Finally, the chest wall was reconstructed with the SB flap and PMM flaps. The total volume of blood loss was 3990 ml. Hemostasis with tranexamic acid and a transfusion (14 units of packed red blood cells, 12 units of fresh frozen plasma)
were required. The durations of the CPB, aortic cross-clamping, and operation were 171 min, 102 min, and 570 min, respectively.

In the intensive care unit, the patient’s blood loss gradually decreased and his hemodynamic condition ameliorated with the hemostatic treatment, including a transfusion. Consequently, the endotracheal tube was removed on the fifth postoperative day (POD), but reintubation was required because of hypercapnea (PaCO₂ of 58.5 torr) and difficulty in sputum discharge. With the aid of tube feeding for nutritional management, his cardiopulmonary function gradually ameliorated, and he was weaned from mechanical ventilation on the 14th POD. After gradual rehabilitation for cardiopulmonary function, the patient was discharged on the 56th POD.

One year after surgery, the patient is doing well, with implanted plates remaining. Transthoracic echocardiography showed an ameliorated left ventricle ejection fraction of 52.2%, in addition to a correction of the sternal deformity and heart displacement with a Haller index of 3.35 on chest CT (Fig. 1B).

**Discussion**

Patients with symptomatic PE accompanied by cardiovascular disease often pose a clinical challenge regarding surgical treatment for the two different disorders. Successful staged operations were formerly recommended; however, single-stage operations have been reported with favorable results in recent years. We decided to perform simultaneous AVR and PE correction using the modified Ravitch procedure to avoid any postoperative cardiopulmonary complications that may result from mechanical compression due to uncorrected sternal deformities. The patient was substantially relieved of his complaint; however, the single-stage operation using the modified Ravitch procedure induced excessive bleeding and a high-volume transfusion secondary to the prolonged operation time and postoperative recovery.

Okay, et al. reported that a single-stage operation using the modified Ravitch procedure was performed without major complications such as excessive bleeding; the average total volume of blood loss in two patients who underwent Bentall’s operation was 1095 ml, although the average cardiac operation time was 250 min. In contrast, in our case, the total volume of blood loss was 3990 ml, regardless of the shorter CPB duration of 171 min. The modified Ravitch procedure involves preparation of PMM flaps, resection of the deformed costal cartilages, and sternal osteotomy. Blood loss derived from the peeled tissue, including the edges of the costal cartilages and the sternum, may have increased with the use of heparin in our case. Recently, the Nuss procedure has been extended into adult patients with PE. The Nuss procedure is associated with shorter operation time and minimal blood loss. On the other hand, in these patients, it has also been reported that the excessive force necessary to elevate the sternum leads to increases in recurrence and postoperative complication rates. Consequently, we would apply the modified Ravitch procedure rather than the Nuss procedure in our case irrespective of the risk of excessive bleeding. Considering the age of the patient (76 years), the excessive bleeding and postoperative pulmonary impairment may have been inevitable.

PE is likely to occur among patients with connective tissue disease such as Marfan syndrome, but characteristic of Marfan syndrome, such as spider fingers and subluxation of the crystalline lens, was not detected in our case. In adult patients with PE, the clinical picture remains unclear because there are few published reports on the therapeutic management of PE in these patients. Kragten, et al. reported that 19 (45%) of their 42 senior patients with symptomatic PE had started to complain of cardiovascular symptoms in their fourth and fifth decades of life. Moreover, symptoms such as tiredness and shortness of breath in elderly people could also reportedly be related to an already long-existing PE. The chest wall gets stiffer with increasing age. Subsequently, in elderly patients with PE, the heart is displaced into the left chest, and gradual development of symptomatic PE may result. In our case, the patient complained of dyspnea on exertion 2 months after the tumor extirpation in the right kidney; however, according to the medical history recalled by the patient, he had already suffered from tiredness and shortness of breath during work on electrical equipment, 5 years previously. If the grade of AR and heart displacement into the left thoracic cavity had been evaluated at that time, a meticulous therapeutic strategy might have been planned. A staged operation had priority in PE correction in consideration of the upcoming operation for AR as well as a report by Fukunaga, et al. Had this been planned, the operation for AR may have been more easily performed.

It is important to keep in mind that PE is more than a cosmetic deformity. Consequently, surgeons can judge whether acceptable surgical planning should comprise either a staged or a single-stage operation.
Conclusion

For adult patients with PE, it is important to keep in mind that PE is more than a cosmetic deformity and that meticulous therapeutic planning is required to achieve an adequate health-related quality of life. We believe that meticulous therapeutic planning will also allow for a favorable outcome in adult patients with symptomatic PE accompanied by cardiovascular disease.

Disclosure Statement

The authors declare no conflicts of interest associated with this study.

References