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Minimally invasive operation for pectus excavatum after cardiac operation

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Abstract
Secondary pectus excavatum may occur after cardiac surgery, the operation of which is extremely challenging, and the main challenge is adhesion behind the sternum. Because of the serious adhesion, Nuss procedure is risky and difficult. We used Wung procedure combined with Wang procedure to reduce the risk and difficulty of the operation, and achieved satisfactory results. Herein, we report a operation of a 16-year-old girl. She had undergone cardiac surgery in childhood and developed pectus excavatum postoperatively. We used Wang procedure and Wung procedure to implement the correction and obtained satisfactory results.

Keywords: Pectus excavatum, reoperation, cardiac surgery, wang procedure, wung procedure

Introduction
Secondary pectus excavatum may occur after cardiac surgery [1], which is not significantly different from primary pectus excavatum, but the treatment is risky and difficult [1, 2]. The main challenge is adhesion behind the sternum [1, 3, 4]. As the space between the heart and chest wall disappears, Nuss procedure will be very dangerous. To eliminate the risk, we designed a special surgical method. We used Wang procedure and Wung procedure together and achieved good results [1]. This paper reports the reoperation of a 16-year-old female patient with pectus excavatum. The patient had undergone cardiac surgery and had pectus excavatum after surgery. We performed another operation for her.

Case Report
The patient was a 16-year-old girl. She had undergone cardiac surgery at the local hospital for congenital heart disease at the age of 5. After the operation, the heart disease was thoroughly treated, but a depression of the anterior chest wall gradually appeared. She was diagnosed with pectus excavatum in the local hospital. Early after the cardiac surgery, the depression was not serious, and the patient had no discomfort. After puberty, the depression gradually deepened with no discomfort, and she was admitted to our hospital on January 21, 2020. Preoperative physical examination revealed a central depression in the anterior chest wall, with a long surgical scar at the bottom of the depression (Fig 1). Imaging examination: the chest wall was depressed and the heart was compressed obviously (Fig 1, 2). The Wenlin index was 0.58 (Fig 3) [5]. No cardiac abnormality was found by cardiac ultrasound examination. The patient was diagnosed as moderate secondary pectus excavatum. The operation was carried out under general anesthesia. The main operations included Wung procedure [6, 7] and Wang procedure [8-10]. A longitudinal incision was made at the scar under the xiphoid process to separate the posterior sternal space. Two incisions were performed on both laterals of chest wall with a length of 2cm respectively. Soft tissues and muscle tissues were dissected to complete two tunnels. The upper tunnel passed through the thoracic cavity and mediastinum, and the lower tunnel was located on the surface of the bone structures. Two steel bars were placed respectively in the two tunnels. The upper steel bar was put at the depression bottom. After it was turned over, the central depression was corrected. This was the content of Wung procedure [6, 7]. The lower steel bar was located in front of the depression, and the depressed bone structures were pulled and fixed on the steel bar by steel wires. This was the content of Wang procedure [8-10]. Drainage tubes were placed in the bilateral thoracic cavity, the incisions were closed, and the operation was completed. The deformity disappeared completely after operation (Fig 4). Postoperative X-ray examination displayed that the position of the steel bars were normal (Fig 5). Follow up for 2 years showed no chest wall appearance change and the patient has no discomfort.

Fig 1: Appearance of chest wall before operation. A. Lateral view; B. Positive view

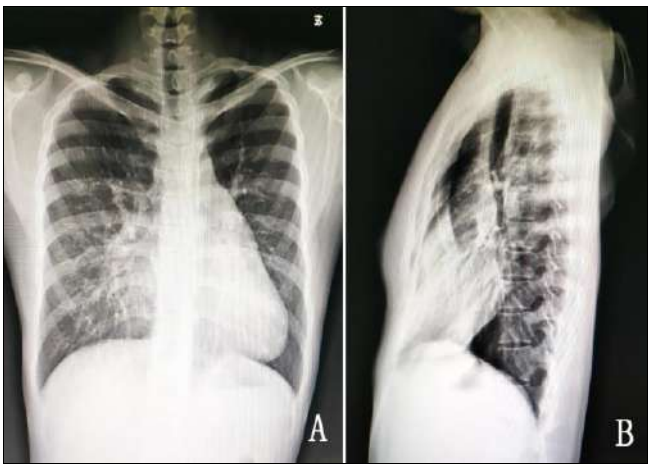

Fig 2: Preoperative X-ray examination. A. Posterioanterior view; B. Lateral view

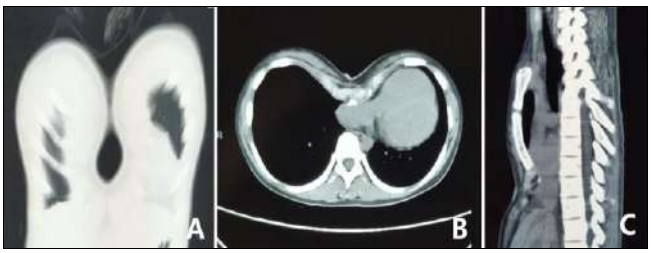

Fig 3: Preoperative CT examination. A. Coronal plane; B. Horizontal plane; C. Sagittal plane

Fig 4: Appearance of chest wall after the operation. A. Positive view; B. Lateral view

Fig 5: Postoperative X-ray examination

Discussion

Cardiac surgery is generally completed through the median sternotomy. Secondary pectus excavatum sometimes occurs after this operation [1]. Morphologically, there is no obvious difference between it and the primary deformity [1, 2]. However, due to the obvious adhesion behind the sternum, the operation for this kind of deformity has become a challenging operation [1, 3, 4]. The main challenge comes from the risks and difficulties of surgery. If Nuss procedure is employed, it will be difficult to perform because of the increased risk of heart damage. To find a safe and simple surgical method, we designed a special operation, which is a combination of Wung procedure and Wang procedure [3]. This operation not only avoids the adhesion behind the sternum, but also transfers the main operation to the surface of the bone structures, which greatly reduces the risk of heart damage, makes the operation easier, and finally ensures the operation effect.

The Wung procedure essence is a modified Nuss procedure [6, 7]. Although the steel bar is still placed behind the sternum, many technical details have been improved, so the risk has been greatly reduced, and the operation has become extremely simple.

Wang procedure is new technique for treatment of pectus excavatum, which is totally different from Nuss procedure [8-10]. Since the bar is put on the bone structures surface, it will hardly damage the heart. This kind of surgery is considered to be the first choice for the reoperation of pectus excavatum or operation after cardiac surgery [4].

The Wenlin index of this patient was 0.58, thus the deformity was a moderate pectus excavatum [5]. Although there was no obvious symptom, the patient was not satisfied with her appearance, and she had clear indications for surgery. During the operation, we jointly used two procedures with different operating principles. This method follows the special principle that we have always advocated, that is, the only purpose of the operation should be the correction of the deformity, and should not be limited to a specific procedure [11, 12]. It is precisely because of this principle that the effect of correction is guaranteed.

In this special combination, Wung procedure is a typical mechanical external force plastic surgery [13-15]. Its biggest

advantage is that it can provide strong support. Wang procedure is a template plastic surgery [13-15], which is the most ideal plastic technique, but due to the limited lifting force, it plays a auxiliary role in operation. The natures of the two procedures are different, but they play complementary roles, which make the effect of correction perfect, thus realizing the ultimate goal of the operation [13-15].

Since our department is the first and the only independent chest wall surgery department in China, we have treated many patients with various thoracic deformities [13-15]. Many of these patients were pectus excavatum after cardiac surgery. Although these patients have obvious depressions, their performances are not necessarily the same, which require different surgical methods. There are mainly two kinds of surgical methods we use, one is simple Wang procedure, the other is the combination of Wang procedure and Wung procedure. It can be seen from these two methods that Wang procedure is the basic surgical method for treating such secondary deformity, which also demonstrates the advantages of this procedure [4].

Conflict of Interest
Not available

Financial Support
Not available

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