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Surgical treatment of severe complex thoracic deformity with Wenlin procedure and Wung procedure

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Abstract
The complex thoracic deformity has both protrusion and depression on the chest wall, and its appearance is complex. It is difficult to complete the correction by ordinary surgical methods. In the early years, this kind of deformity needed to be treated by open surgery. After entering the era of minimally invasive surgery, its operation is also gradually minimally invasive, and it can be completed through the combination of different operations. Mild complex deformities can be treated by sandwich surgery. However, for severe complex deformities, the most ideal combination should be Wenlin procedure combined with Wung procedure. This paper introduces the treatment of a case of severe complex thoracic deformity with this ideal combined operation.

Keywords: Complex thoracic deformity, Wenlin procedure, Wung procedure, operation

Introduction
Thoracic deformity is an abnormality of the shape of the chest wall [1-3]. Generally speaking, it can be divided into protrusion deformity and depression deformity [3]. The common pectus excavatum is a simple depression deformity [4], and the pectus carinatum is a simple protrusion deformity [5]. In addition to these simple depression or protrusion deformities, there are also some complex deformities. They have both protrusion and depression, so the treatment of this kind of deformity is relatively complicated.

The early deformity operations were open operations, which could eliminate the deformity to the greatest extent, and could directly shape the protrusion or depression. From the perspective of treatment, it is not significant to excessively subdivide the types of deformity. After the concept of minimally invasive surgery appeared in the clinic, the principle and method of correction of protrusion and depression are completely different, so the distinction between protrusion and depression is particularly important. At present, there are mainly two kinds of operations for correction of depression deformity, namely Nuss procedure [6] and Wang procedure [7, 8], while the operations for protrusion deformity mainly include Abramson procedure [9] and Wenlin procedure [5, 10, 11]. When the abnormal lesions are simple protrusion and depression, a single operation can be selected for correction. However, if it is a complex deformity, that is, when there are both protrusion and depression on the chest wall, it needs to use two different types of operation at the same time to complete the treatment [12-17]. This article introduces a patient with severe complex deformity. We adopted two methods to correct it and achieved satisfactory results.

Case Report
The patient was a 17-year-old boy. Since childhood, his chest wall was found to be deformed, and the anterior chest wall was medially convex, but it was not serious at that time. After puberty, his deformity worsened, and his anterior chest wall was convex forward in a large area, with local depression in the middle and lower part. He had no obvious symptoms, but was not satisfied with the appearance. He was admitted to our hospital for surgical treatment. The physical examination before the operation showed that the anterior chest wall was severe protrusive, with local depression in the middle and lower part.

Preoperative imaging examination showed severe complex deformity of the anterior chest wall. The patient's operation was performed under general anesthesia. Supine position was adopted and both upper limbs were abducted. The details of operation were completed according to the details of Wenlin procedure [5] and Wung procedure [18]. Skin incisions were made on both sides of the chest wall, with a length of 4cm. The muscle tissues were dissected to expose the nearby ribs. Two tunnels on the highest plane of the protrusion were made, which were located between the soft tissues and the bone structures of the chest wall. The two tunnels are 3 cm apart. An incision was made between the fifth intercostal space of the bilateral chest wall, and a third tunnel was made behind the sternum. Steel wire traction lines and steel bar guiding tubes were placed respectively, and 3 steel bars were pulled into three tunnels in sequence. The upper two bars were used for Wenlin procedure, while the lower one is used for Wung procedure. After the steel bars were firmly fixed, the deformity disappeared completely and the appearance of the thorax was basically normal. The total operation time was 65 minutes, and the operation was smooth without complications. The chest X-ray film was reexamined after the operation, and the position of the steel bars was normal. The patient was discharged 7 days after surgery.

Fig 1: Appearance of chest wall before operation.

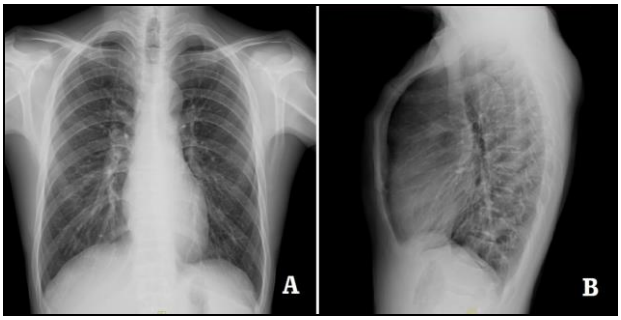

Fig 2: Preoperative chest X-ray examination.

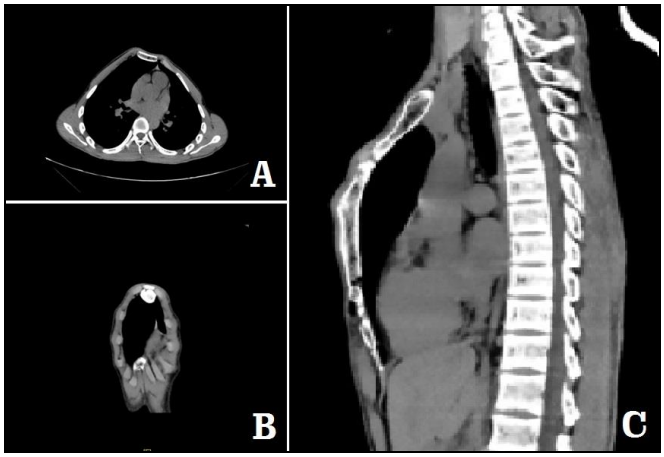

Fig 3: Preoperative chest CT examination.

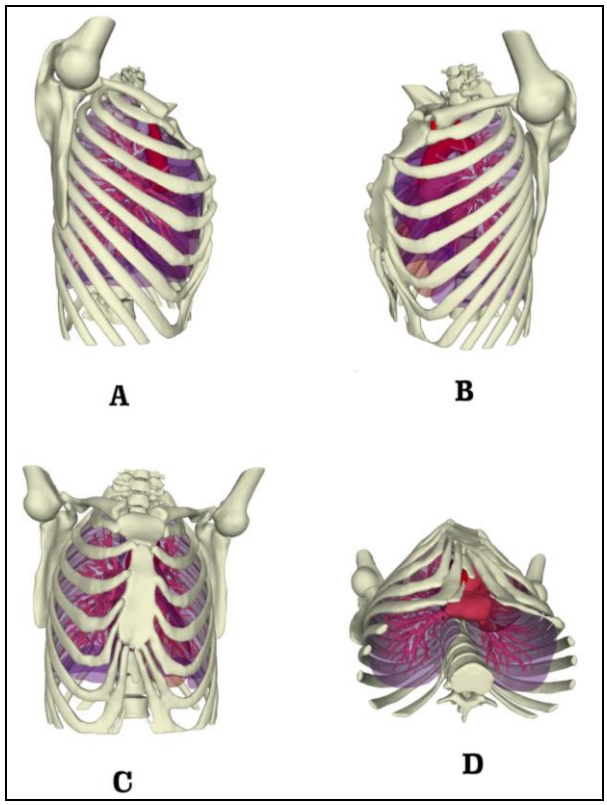

Fig 4: Three-dimensional view of chest wall before operation.

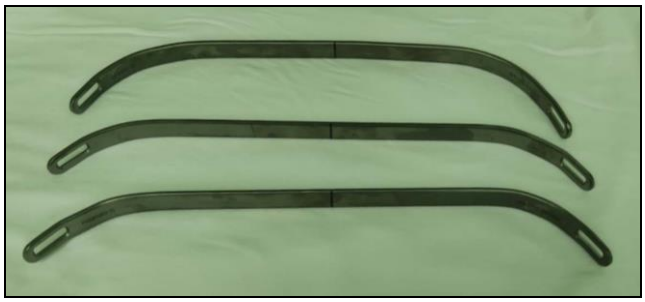

Fig 5: Three bars used in the operation.

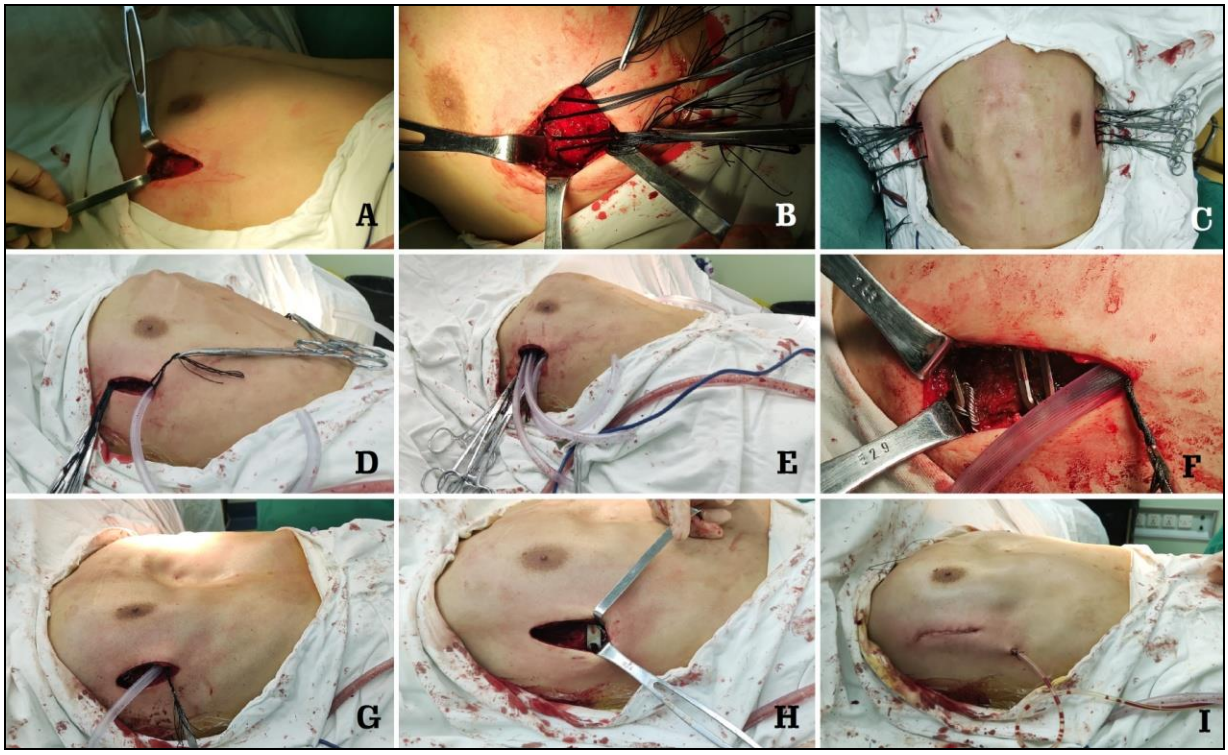

Fig 6: Surgical figures. A, The ribs were exposed through incision; B, The steel wire traction lines were placed; C, Steel wire traction lines were placed on both chest walls; D, The Wung procedure bar guiding tube was placed; E, The Wenlin procedure bar guiding tubes were placed; F, Two bars of Wenlin procedure were placed; G, After Wenlin procedure, the anterior chest wall had obvious depression; H, Wung procedure was completed and the anterior chest wall depression was eliminated; I, The operation was completed.

Fig 7: Appearance of chest wall after operation.

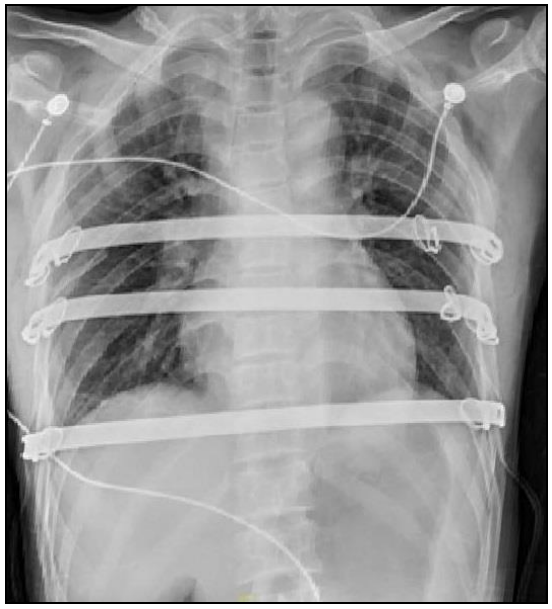

Fig 8: Postoperative chest X-ray examination.

Discussion

Thoracic deformity is an abnormality of the appearance of the chest wall, and the origin of it is the abnormality of the bone structures of the chest wall [1-4]. According to the integral classification of deformities, there are two kinds of deformities, one is protrusion and the other is depression [3]. This classification method can include the vast majority of deformities. However, some deformities are not single protrusion or depression, they may have two kinds of lesions at the same time. Therefore, they belong to complex deformities, which are completely different from the simple kinds.

In the early years, because of the open surgery, there was no essential difference between the treatment of complex deformity and simple deformity. From the nature of the operation, they were all destructive plastic surgery [1, 2]. Such surgeries are effective for all types of deformities. However, when the concept of minimally invasive surgery enters the clinic, the division of protrusion and depression becomes necessary, because they need to adopt completely opposite concepts and methods to complete the correction [4, 5]. The main method of protrusion is compression, while the method of depression is propping or pulling. There are mature techniques for the treatment of both deformities. For simple protrusion or depression deformity, a single operation can basically achieve good results. However, for complex deformities, especially severe cases, since two types of lesions with different properties are included at the same time, it is necessary to use different methods in combination to obtain good results [13-17].

Because the surgical methods for protrusion and depression are different, different authors choose different operations for treatment of complex deformity. Some authors choose sandwich surgery [19], including Abramson procedure and Nuss procedure. Considering the defects of the two procedures, we will choose Wenlin procedure combined with

Wang procedure or Wung procedure for treatment [13-17]. Because these procedures have many advantages, the combination of is obviously superior to sandwich surgery.

This patient is a severe complex thoracic deformity. The main lesion of the anterior chest wall is protrusion, but there are obvious depressions locally. Protrusion can be corrected by compression. Because the depressions are located in many places and the positions are irregular, special surgery is required for the depressions. The depression in the middle cannot be corrected by general Nuss procedure or Wang procedure, but it can be corrected by Wenlin procedure. This is the biggest difference between this procedure [5] and Abramson procedure [9]. The lower depression already exists before the upper protrusion is flattened. However, the depression will be more obvious after flattening. The depression at this time is different from the depression of pectus excavatum, so it is impossible to complete the treatment with the general Nuss procedure. We used Wung procedure for correction and achieved satisfactory results [18].

Conclusion

Severe complex deformity is a great challenge to surgical technique. If minimally invasive surgical method is considered, it should be designed carefully. The method we use is Wenlin procedure combined with Wung procedure. Because these two procedures have distinct advantages, we can ensure the success of the operation.

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