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**Dr. Wenlin Wang**

Professor, Department of  
Chest Wall Surgery,  
Guangdong Second Provincial  
General Hospital, Guangzhou,  
China

**Dr. Weiguang Long**

Associate Professor,  
Department of Chest Wall  
Surgery, Guangdong Second  
Provincial General Hospital,  
Guangzhou, China

**Dr. Yang Liu**

Resident Doctor, Department  
of Chest Wall Surgery,  
Guangdong Second Provincial  
General Hospital, Guangzhou,  
China

**Dr. Bin Cai**

Resident Doctor, Department  
of Chest Wall Surgery,  
Guangdong Second Provincial  
General Hospital, Guangzhou,  
China

**Dr. Juan Luo**

Resident Doctor, Department  
of Chest Wall Surgery,  
Guangdong Second Provincial  
General Hospital, Guangzhou,  
China

**Corresponding Author:**

**Dr. Wenlin Wang**

Professor, Department of  
Chest Wall Surgery,  
Guangdong Second Provincial  
General Hospital, Guangzhou,  
China

## Wenlin procedure: An ideal minimally invasive surgery for barrel chest

**Dr. Wenlin Wang, Dr. Weiguang Long, Dr. Yang Liu, Dr. Bin Cai and Dr. Juan Luo**

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### Abstract

Barrel chest is often seen in patients with chronic lung diseases. It is a secondary lesion and generally does not require treatment. Teenagers or adults with barrel chest are primary deformities. Its harm mainly comes from two aspects, one is physiological harm, the other is psychological harm. If the harm is obvious, surgical treatment is required. No one has ever treated this deformity before. Through a large-scale study of chest wall deformities, we found that there were similar structural changes between barrel chest and pectus carinatum, and they all belonged to protrusion deformity. The similarity of the structures make it possible to use for reference in surgical treatment. We designed an ideal operation for pectus carinatum, that is, Wenlin procedure. After research, it was found that this operation can also be used in the treatment of barrel chest. We performed the operation on barrel chest with this procedure and achieved satisfactory results. This paper introduces the operation of a tall barrel chest patient. During the operation, Wenlin procedure was used, and the results turned out to be satisfactory.

**Keywords:** Barrel chest, minimally invasive surgery, Wenlin procedure

### Introduction

Barrel chest is a common thoracic deformity, but it is often seen in patients with chronic lung diseases [1]. This deformity is considered to be a secondary lesion. Because the etiology persists, treatment is not possible and necessary. Additionally, barrel chest can also occur in adolescents or adults [2, 3]. They have no definite underlying disease and no definite etiology, so they are primary lesions. Like other types of thoracic deformities, the harm of primary barrel chest also includes two aspects, one is physiological harm, the other is psychological harm [4, 5]. The physiological harm of barrel chest is not serious, but the psychological harm is obvious. The reason of psychological harm comes from the appearance of chest wall. Many patients are not satisfied with the appearance and are eager to undergo surgery, but no one has ever operated on barrel chest before. In 2018, we took the lead in using minimally invasive technology to correct barrel chest and achieved satisfactory results [3]. In these operations, the technology we used was Wenlin procedure [3, 4]. In the subsequent work, we continuously used this technology and gained a lot of experience. This paper reports the operation of a tall barrel chest patient. We still use Wenlin procedure during the operation.

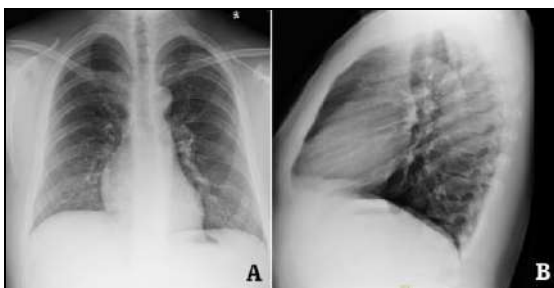
### Case Report

The patient was a 16-year-old boy, who was found to grow faster than his peers in early childhood. No obvious chest wall abnormality was found in the early stage. At the age of 13, he was found that his chest wall looked like a barrel. With the increase of age, the deformity became more obvious. The patient was not satisfied with the appearance of the chest wall, always felt low self-esteem in the early stage, and then gradually became autistic. In order to treat the deformity, the patient was admitted to our hospital. The preoperative physical examination showed that the patient was tall, with a height of 195 cm, weight of 115 Kg, chest circumference of 103 cm, vertical distance from the anterior chest wall to the posterior chest wall of 27 cm, and a barrel like appearance of the chest, but he had an additional protrusion at the left front of the chest wall (Fig 1). Preoperative imaging showed barrel chest (Fig 2, 3). The preoperative diagnosis of the patient was barrel chest. After adequate preoperative preparation, the patient's operation was performed under general anesthesia. The operation was performed using standard Wenlin procedure [2, 3, 6].

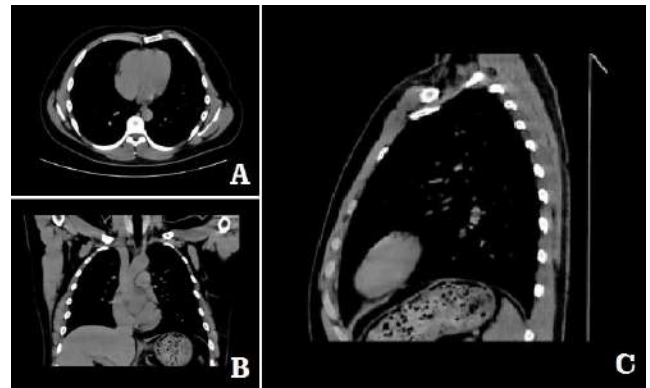
The incisions were located on both sides of the lateral chest wall respectively, and three bars were used to complete the correction. The operation was smooth without any complication. The deformity disappeared completely after operation, and the vertical distance from the anterior chest wall to the posterior chest wall was 21 cm (Fig 4). The appearance of chest wall was normal, and postoperative imaging examination showed that the positions of the bars were satisfactory (Fig 5, 6). He was discharged 8 days after operation.



**Fig 1:** Appearance of chest wall before operation.



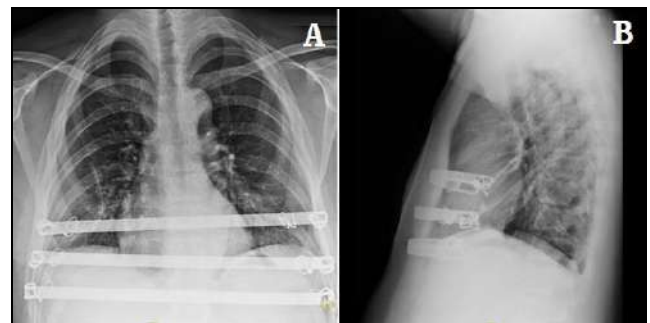
**Fig 2:** X-ray examination of chest wall before operation.



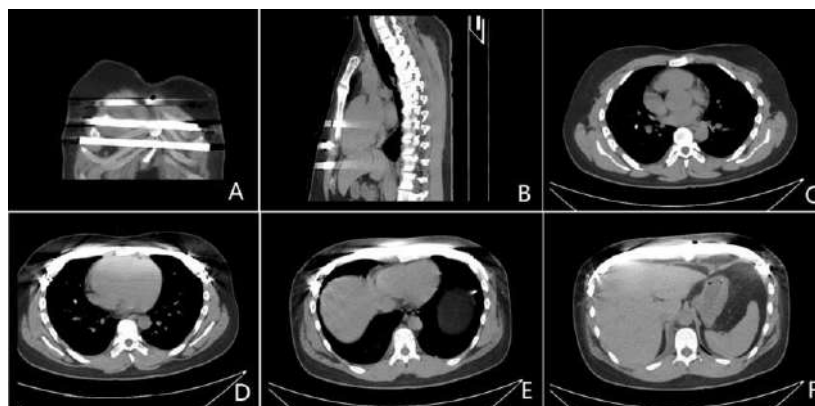
**Fig 3:** CT examination of chest wall before operation.



**Fig 4:** Appearance of chest wall after operation.



**Fig 5:** X-ray examination of chest wall after operation.



**Fig 6:** CT examination of chest wall after operation. A, The coronal plane shows the position of the three bars; B, The sagittal plane shows the position of three bars; C, The cross-sectional view of the chest wall above the plate; D, E, F, The cross-sectional plane shows the positions of three steel bars.

## Discussion

Thoracic deformity is a major kind of disease in thoracic wall surgery, which mainly refers to the abnormal shape of the bone structures of the chest wall [3, 4]. The most common thoracic deformities are pectus excavatum [7, 8] and pectus carinatum [9, 10], in contrast, barrel chest is less common. However, barrel chest is common in patients with chronic lung disease [11]. This lesion is considered to be a

compensatory lesion after long-term hypoxia, so it is a secondary lesion. Considering its special etiology, this secondary deformity generally does not need treatment. There is another kind of barrel chest patients in clinic, they are teenagers or adults [2, 3]. There was no clear reason for their thoracic changes, so they were primary barrel chest. Because this kind of deformity has definite psychological harm, it needs surgical treatment.

Barrel chest has been known for a long time, but no one has noticed the treatment of this deformity. Therefore, the treatment of this deformity has been blank for a long time [2, 3]. Our department is the first and only chest wall surgery department in China [4, 5]. We usually contact patients with various types of thoracic deformities, many of which are primary barrel chest patients. We are well aware of their suffering. In order to treat these patients, we did in-depth research and designed a special surgical method, namely Wenlin procedure.

Our design of Wenlin procedure was inspired by the recognition of the structural features of thoracic deformities. There are many kinds of thoracic deformities. If they were observed from a macroscopic perspective, they can be divided into two categories, one is protrusion deformity, and the other is depression deformity [11]. The typical representative of protrusion deformity is pectus carinatum, which can be seen as a local protrusion of the anterior chest wall. Although there is no local protrusion on the anterior chest wall of the barrel chest, it can be regarded as the overall protrusion of the chest wall. If the barrel chest is observed from this perspective, this deformity will be similar to the pectus carinatum in structure. Since the structure is similar, the surgical methods of pectus carinatum can be used for barrel chest for reference.

Wenlin procedure is designed for pectus carinatum [6]. This kind of operation is different from the general pectus carinatum operation [12]. Its biggest advantages include two points, one is the steel bar fixation technique, namely Wang technique [13-15], and the other is the template plastic technique [4, 5]. When Wenlin procedure is used for barrel chest, because the area of protrusion increases, more bars are needed to complete the treatment. In addition, due to the wide range of lesions, the spacing of the bars should also increase accordingly, so that the anterior chest wall can be uniformly stressed and finally get ideal correction.

The patient is only 16 years old, but he is very tall. The protrusion area of his anterior chest wall is large and uneven. There is additional protrusion on the left anterior chest wall. The patient's deformity was severe and complex. But in general, it is still barrel chest. Therefore, Wenlin procedure can still be used for treatment. In order to obtain good results, we used three steel bars during the operation, and finally achieved ideal results.

## Conclusion

Although Wenlin procedure is designed for pectus carinatum, it is also suitable for protrusion deformities. Barrel chest is one of the this kind of deformity, so this procedure can also be used. When the template plastic function of Wenlin procedure is fully exerted, very satisfactory results can be obtained in barrel chest surgery.

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