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Wung procedure: A minimally invasive operation for pectus excavatum

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Abstract
Pectus excavatum is the most common thoracic deformity. At present, the popular surgical method for this deformity is Nuss procedure. This kind of operation has many advantages, but it also has many defects. Among these defects, the main defects include heart damage and unsatisfactory fixation. In order to eliminate these defects, many authors try to improve the operation, but the effect is not ideal. After long-term observation and trial, we also improved this operation and finally designed a new operation, which we called as Wung procedure. Our improvement involves many aspects to eliminate the disadvantages of Nuss procedure. Our experience shows that this kind of operation is a safe and reliable new type of pectus excavatum minimally invasive surgery.

Keywords: Wung procedure, nuss procedure, thoracic deformity, minimally invasive surgery

Introduction

Pectus excavatum is the most common thoracic deformity, which was recognized hundreds of years ago [1]. Its operation has a history of more than 100 years [1, 2]. Early operations were mainly open techniques [1-4]. Because these operations had large injuries and long scars, they were not satisfactory choices. In 1998, Nuss proposed a new surgical method, which was simple and minimally invasive, and had many advantages compared with the traditional open surgeries [1, 2]. However, this kind of operation also has many defects, the biggest defect of which is the possibility of heart damage [3]. Because a steel bar needs to be placed on the surface of the heart, if the operation is not careful, the heart may rupture, leading to serious consequences. Another defect of Nuss procedure is related to the fixation of steel bar. Due to the need of using short fixing bars at both ends of the main steel bar for fixation, the short fixing bar itself may bring many disadvantages. Because of these disadvantages and defects, it is necessary to improve the total procedure. So far, a large number of improved surgical procedures have been applied in clinic [3, 5, 6]. Although these procedures have certain advantages, they cannot fundamentally eliminate the disadvantages of Nuss procedure. In the past work, we have done a lot of pectus excavatum surgeries, and we have designed a new useful operation, namely Wang procedure [7, 8]. This procedure can be used in many patients with pectus excavatum and has good results. Since Nuss procedure is a necessary operation for many patients with pectus excavatum, we have also done relevant work to improve this operation. Our improved method is completely different from that of other authors, so we named our modified operation as Wung procedure. Here we report a case of pectus excavatum treated with Wung procedure.

Case Report

The patient, a 5-year-old boy, was diagnosed as pectus excavatum due to depression of anterior chest wall shortly after birth. There was no discomfort, but the depression gradually aggravated. The family was not satisfied with the appearance of the chest wall, so he was admitted to our hospital for surgery. The physical and imaging examination before operation showed that the patient's anterior chest wall was sunken in the middle, and the heart was obviously compressed and moved to the left [Fig 1, 2]. The operation was performed under general anesthesia [Fig 3, 4, 5]. Both upper limbs were abducted in the supine position. Incisions were made at the opposite parts of the chest walls on both sides, with a length of 1.5cm, near the intersection of the axillary front and the plane passing through the deepest depression. The chest wall muscles were dissected to reveal the highest position of the rib in the plane of the deepest depression, which was used as the fulcrum of the steel bar. After the intercostal muscles above the fulcrum were cut, the thorax was opened.

A right angle pliers was used to pull the steel wire guiding line into the thoracic cavity and then pull it out to surround the rib at the fulcrum. When the operations in the incisions on both sides were completed, a guider was put into the right thoracic cavity from the chest wall incision, moving forward to the mediastinum, with its tip closing to the back of the sternum. The operator stretched out the left index finger into the left thoracic cavity through the left chest wall incision and extended to the mediastinum to meet the tip of the guider. After confirming that there was no special tissue between the index finger and the tip of the guider, the guider was pushed across the mediastinum to the left thoracic cavity, and then came out of the left chest wall incision. The tip of the guider was connected with a steel bar guiding tube, and the tube is dragged into the thoracic cavity with the guider, passing through the mediastinum and the right thoracic cavity, and being pulled out from the right chest wall incision. One end of the guiding tube was connected with an arc-shaped steel bar. The steel bar was dragged into the thoracic cavity with the guiding tube and out from the contralateral chest wall incision. The steel bar was turned over to flatten the depression of the anterior chest wall. The position of the steel wire guiding line was adjusted so that the rib and the steel bar could be surrounded simultaneously. The steel wire was placed under the guidance of the guiding line, and the rib and the steel bar were surrounded. After the steel wire was tightened, and the steel bar was fixed at the fulcrum position. The incisions were closed, and the operation was completed. The total operation time was 20 minutes, and there were no complications during the operation. The anterior chest depression disappeared and the appearance of chest wall returned to normal shape after operation [Fig 6]. He was discharged 5 days postoperatively. Follow up for 1 year showed that the appearance of chest wall was normal and no depression recurrence was found.

Fig 1: Appearance of the chest wall before operation

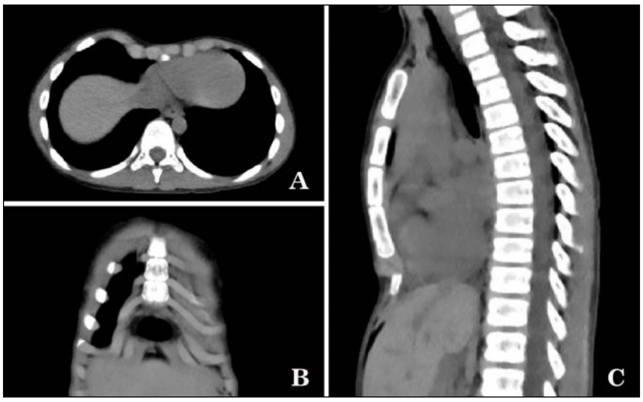

Fig 2: Chest CT scan image. The anterior chest wall is obviously sunken, and the heart is compressed and moved to the left

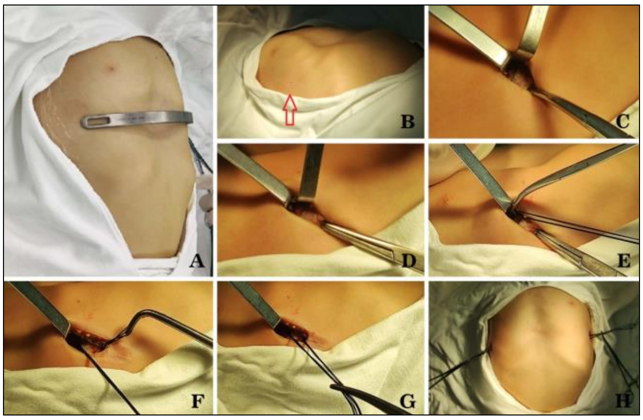

Fig 3: Operation pictures. A, Target position of steel bar placement; B, 1.5 cm incision on the lateral chest wall; C, Expose the fulcrum of the rib; D, Right angle pliers was used to cross the fulcrum of the rib; E, The steel wire guiding line was clamped and delivered to the right angle pliers; F, The steel wire guiding line was pulled out with right angle pliers to surround the rib at the fulcrum; G, The rib was surrounded by the steel wire guiding line; H, The operations in both chest wall incisions were performed in the same way, and the steel wire guiding line was used to surround the rib fulcrum

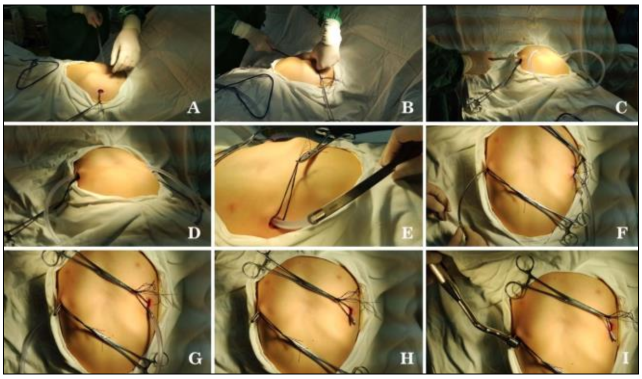

Fig 4: Operation pictures. A, The guider was put into the right thoracic cavity from the chest wall incision; B, The left index finger was stretched out into the left thoracic cavity to meet the tip of the guider; C, The tip of the guider was connected with a steel bar guiding tube; D, The steel bar guiding tube was placed in the thoracic cavity; E, The guiding tube was connected with the steel bar; F, G, H, The bar was pulled into the thoracic cavity; I, The steel bar was rotated

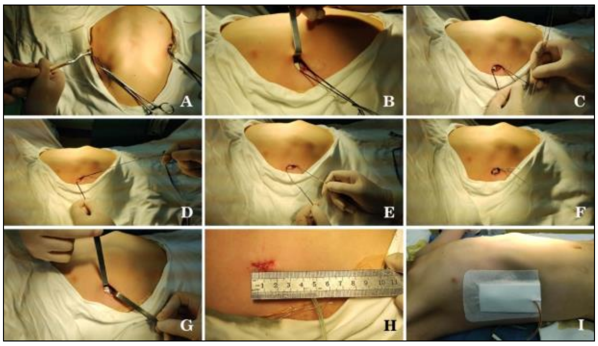

Fig 5: Operation pictures. A, The steel bar was rotated to the target position; B, The position of the steel wire guiding line was adjusted to surround the rib and the steel bar simultaneously; C, D, E, The steel wire was placed under the guidance of the guiding line; F, The steel wire was tightened; G, The steel bar was fixed at the target position; H, The length of the incision after operation; I, Appearance of the chest wall after operation

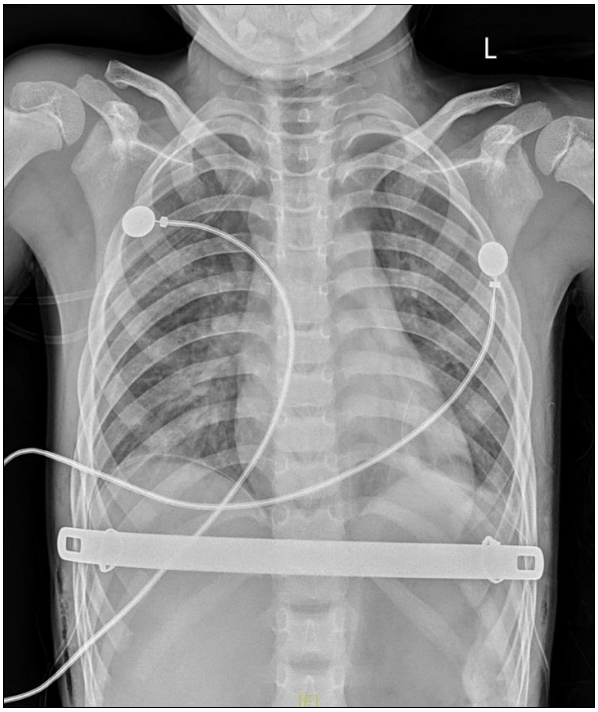

Fig 6: Postoperative X-ray examination showed the position and the fixation techniques of the steel bar

Discussion

The main disadvantages of Nuss procedure can be summarized as two aspects [3, 7, 8]: one is the possibility of damaging the heart, and the other is the defect of fixation method. In order to eliminate the two disadvantages, many authors have improved the operation method. In order to reduce the possibility of heart damage, thoracoscopy is widely used [3]. The original intention of using this device is to improve the visual field and increase the safety of operation [3]. However, when the camera is placed in one side of the thoracic cavity, it is difficult to see the heart structure on the other side. This makes the risk of heart damage impossible to eliminate fundamentally. In our method, we do not use thoracoscopy. We believe that the touch of finger is more conducive to avoid heart damage. Our experience shows that this is a safer method. In Nuss procedure, there are many defects in the design of fixation of the bar: (1) Defects in the design of short fixing bar. The short fixing bar has a large volume and needs to occupy a considerable space. It not only increases the length of the incision, but also may affect the healing of the incision. Therefore, this kind of fixing bar is not an ideal design; (2) Defects in fixing methods. The fixation of the bar mainly relies on the vertical relationship between the fixing bar and the two adjacent ribs. When they are completely vertical, the fixation effect is satisfactory. However, there are few real vertical relationships in practice. This will seriously affect the fixation effect. In order to eliminate the disadvantages of this fixation method, we do not use the short fixing bar, but directly fix the steel bar to the rib. In order to make this operation easier, we use the steel wire guiding line to assist the placement of the steel wire. The results show that this method is not only very simple, but also very effective.

In our operation, we also improved the other details of Nuss procedure, such as the method of placing the steel bar. Instead of directly pulling the steel bar with the guider like others, we used the guiding tube to place the steel bar, which can avoid the damage of the concave teeth at both ends of the steel bar to the mediastinal structures, and make the operation more operable.

Conclusion

Nuss procedure is the most popular operation method at present. However, due to some obvious defects, it needs to be improved technically. Wung procedure has made various improvements on the details of Nuss procedure, which greatly improves the safety factor of pectus excavatum operation and makes the operation easier. Our experience shows that this improved surgical method is a satisfactory surgical method.

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