

## Wang Procedure for Treatment of Pectus Excavatum

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### ABSTRACT

Nuss procedure is currently the most popular operation for pectus excavatum, but it is not suitable for pectus excavatum patients with low age. In order to get these patients managed satisfactorily, we designed a novel technique with a new principle. We placed a metal bar on the surface of bony structures of the chest wall, rather than under these structures during Nuss procedure. After lifting with steel wires, the depression on the chest wall is fixed in the middle of the bar, and the deformed chest wall can be well treated. Our experiences show that this procedure is suitable for the pectus excavatum children with low age.

After Nuss procedure was reported in 1998, it has been the most popular operation for pectus excavatum. However, due its disadvantages, Nuss procedure is considered unsuitable for patients with low age. Since most of the children are found to have pectus excavatum shortly after birth, and their families want to complete the operation as early as possible, it is necessary to design a new technique to get these children treated.

### Technique

The patient is placed in the supine position, with their double upper limbs in abduction. Skin incision is made in front of the xiphoid process, with a length of about 2 cm. The soft tissues and muscles are separated to the bottom of the depression just above the surface of the bone structures, then two tunnels for metal bar are made on both sides of the chest wall. The xiphoid process is exposed and split in the midline, and the connection between the diaphragm and the bottom of the sternum is cut off. Three steel wires were sutured through the deformed part of chest wall, two passing through the costal arches, and one passing through the lower end of the sternum, with the deformed chest wall being completely lifted (Figure 1,2). A metal bar is prepared, and its length is about 3 cm longer than the distance between the highest points on both sides of the depression. The bar is shaped with the radius of the normal chest wall, so that the shape of the bar is equivalent to the patient's chest. Put one end of the bar into the tunnel on one side of the chest wall at first, and then, after reasonable traction, put another end into the opposite tunnel. When the position of the bar is adjusted satisfactorily, the steel wires are pulled up and fixed to the middle part of the bar firmly, so that the depressed chest wall can be lifted up completely (Figure 1,2,3)).

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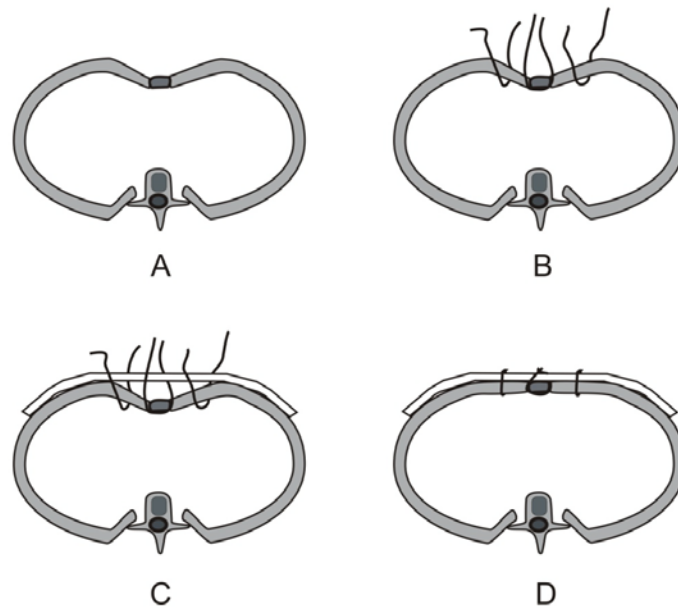
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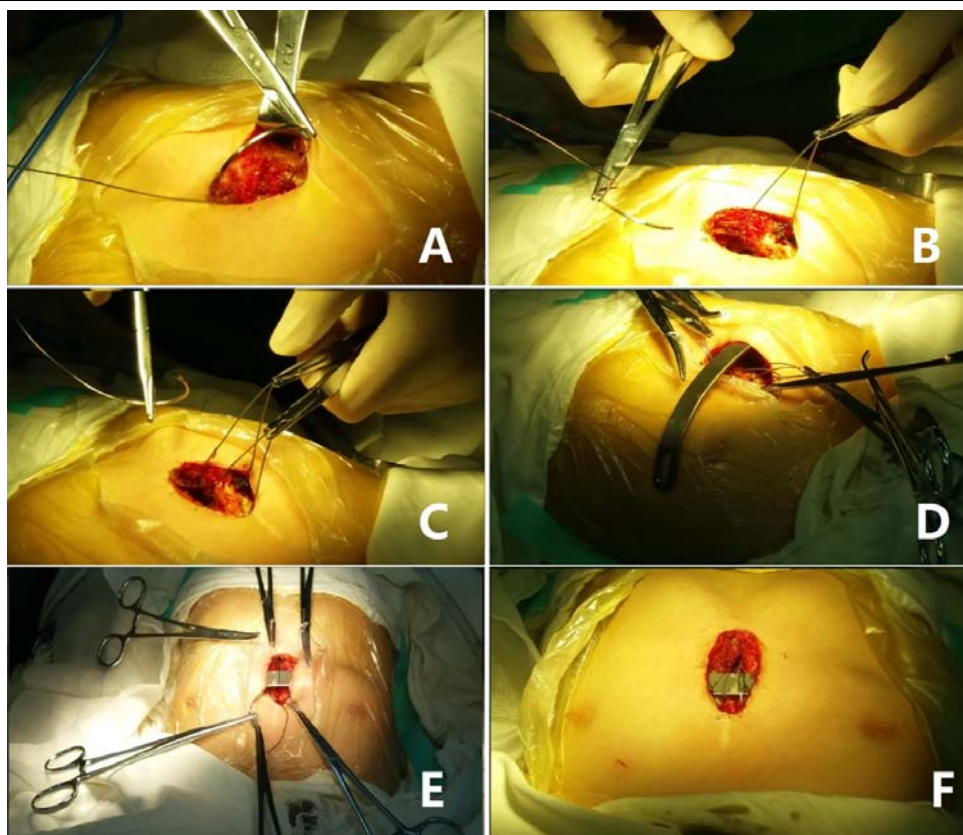
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The muscles and soft tissues were sutured to embed the bar. After the incision is sutured, the operation is completed.



**Figure 1:** (A) Before suturing with steel wires. (B) Three steel wires are sutured successively. (C) The metal bar was inserted into the tennel. (D) Steel wires are pulled up and fixed to the middle part of the bar.



**Figure 2:** (A), (B) and (C) Three steel wires are sutured successively. (D) and (E) The steel bar was inserted into the tennel. (F) Steel wires are pulled up and fixed to the middle part of the bar.

## Comment

Pectus excavatum is a common deformity of the chest wall, and its operation has more than 100 years of history. The earlier standard operation for pectus excavatum is Ravitch procedure. Since the trauma of this procedure was obvious, few people used it any more after Nuss procedure reported in 1998. Nuss procedure is a minimally invasive operation that has lots of advantages compared with the Ravitch procedure.

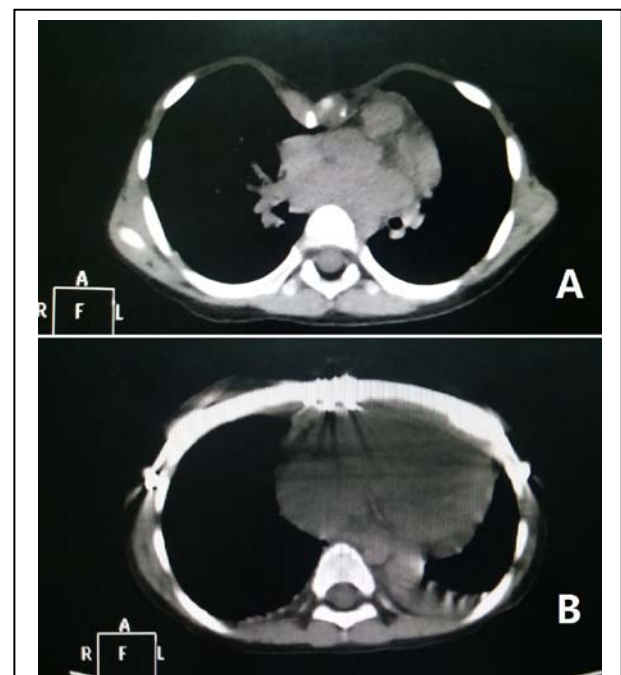
However, because of the particular design, there are some disadvantages in it, and one of the most important disadvantage is the restriction of age. It is generally believed that Nuss procedure is not suitable for children with low age. The main reason is regarded as the high recurrence rate caused by early operation [1,2]. In the long period before the Nuss procedure, the operation of the younger children did not show a significant high recurrence rate. Therefore, we think the main reason for the recurrence is the technology itself, but not the age of operation.

In clinical practice, we find that there are still more serious problems in the early use of Nuss procedure.

When Nuss procedure is performed, the metal bar need to be rotated to support the depression. Since the bar uses the lever principle to work, there must be a hard and rigid fulcrum for the bar, otherwise it will not work effectively, and even worse, the chest wall beneath the bar will be pressed into a new depression. For patients with low age, their bones were not completely ossified, and is not suitable to act as the fulcrum. Therefore, Nuss procedure will not be appropriate for these younger patients. In addition, the development of chest wall of younger patients had relatively rapid speed. If the bar is put into their body, as its size do not increase with age, the development of the chest wall will be restrained seriously. It is because of these reasons that Nuss procedure is rarely suggested using in younger patients, especially under 3 years old [3].

In our method, we used a completely different principle to complete the operation. We put the metal bar on the surface of the bone structures and complete the correction by pulling the depression with steel wires. In

children with low age, since their chest wall is very soft, a slight pull can eliminate the depression, which makes the operation very effective and simple. In addition, since the bar is placed on the surface of several ribs instead of being confined to only one rib just like using in Nuss procedure, the stress created by the compression from the bar will be dispersed and the chest wall will not be depressed obviously. Moreover, the bar in our procedure is relatively short, just beyond the edges of the depression, which make the bar is more like "floating" above the chest wall, unlike "clamping" in the chest wall in Nuss procedure. With this special short bar, the possibility of the constraint of chest wall is greatly reduced, and our procedure is more reasonable for younger children than Nuss procedure.



**Figure 3:** CT images before and after the operation. (A) Preoperation. (B) Postoperation. The depression of the anterior chest wall was raised and pressed to the steel bar, and the appearance of the chest wall was restored to normal.

Above all, our procedure also has other advantages: (1) only one small incision is adequate, which will reduce the related trauma correspondingly; (2) this procedure will not pass pleural cavity, and the related complications will be eliminated completely; (3) the placement of the bar will not be close to the heart, thus the risk of operation will be greatly reduced.

In our operation, the median incision seems to be less satisfactory. Compared with the lateral incision in Nuss procedure, the median incision is not very attractive. However, when the incision length is shortened as far as possible, this incision on the lower chest wall does not appear to cause major cosmetic problems. And especially, when surgery is performed at a very young age, the scar is often not obvious with age. Therefore, we do not think that the median incision is a big problem.

We have used our technique in 21 pectus excavatum patients under 6 years of age, and more than half of them are under 3 years of age. Our experiences show that this procedure is a simple, safe and effective technique (Figure 3). We have made follow-up for all these patients for more than 1 year, and no obvious postoperative complications, including obvious recurrence, have been found. These results indicate that our procedure is superior to Nuss procedure in many aspects. However, due to the limited clinical experience and relatively short follow-up, its long-term effect remains to be further demonstrated.

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