



ORIGINAL ARTICLE

# Comparison of the Nuss and sternal turnover procedures for primary repair of pectus excavatum



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**Summary** *Background:* Pectus excavatum (PE) is a common chest wall deformity. There are several surgical alternatives for the repair of PE. In our practice, the sternal turnover (STO) procedure had been performed for decades. In 2008, we started treating PE patients with the Nuss procedure. Our objective of this study is to compare these two procedures.

*Methods:* A retrospective chart review was conducted on 50 patients undergoing pectus excavatum repairs from March 2005 to January 2013, including 20 patients with the STO procedure and 30 patients with the Nuss procedure. Patients were evaluated for type of repair performed, operating time, drainage after operation, length of postoperative stay, complications, and cosmetic results.

*Results:* The mean age of the STO group was 11.0 years and that of the Nuss group was 15.0 years ( $p = 0.353$ ). The Nuss procedure had a much shorter mean operating time, a less mean drainage after operation, and a shorter mean time to drainage tube removal than those of the STO procedure. The rate of complication was 40.0% (8/20) in the STO group and 33.3% (10/30) in the Nuss group. Follow-up data indicated that 90% (18/20) of patients in the STO group and 96.7% (29/30) of patients in the Nuss group regarded the results as good or excellent ( $p = 0.965$ ).

*Conclusion:* Our data suggests that both the STO and Nuss procedures are equally safe and effective correction methods. However, less trauma, faster recovery, and better cosmetic results are the benefits of the Nuss procedure.

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## 1. Introduction

Pectus excavatum (PE) is a common chest wall deformity occurring in 8 per 1000 live births.<sup>1</sup> It is characterized by the posterior depression of the sternum and lower costal cartilages, and is four times more common in boys than in girls.

Most patients are asymptomatic, and they only suffer from a cosmetic point of view. Patients with severe deformities suffer from physical ailments such as frequent respiratory infections, decreased endurance, shortness of breath with exercise, and chest pain. Patients are often susceptible to restrictive lung disease, mitral valve prolapse, and significant problems with self-image, especially when they enter adolescence.

The only way for correction is surgery. Several surgical approaches have been designed for the repair of PE. Two traditional surgical methods widely used are: sternal turnover (STO) operation (mostly in Asian countries such as Japan and China) and Ravitch operation (in Europe and the United States). With the development of endoscopic techniques, Nuss introduced thoracoscopy-assisted minimally invasive repair for PE (Nuss operation) in 1998.<sup>2</sup> Owing to its simplicity, fewer complications, less pain, and satisfactory results, the Nuss operation has been well accepted by both surgeons and patients. Our study compares the Nuss procedure to the STO procedure in order to define their respective benefits, limitations, and case selection.

## 2. Materials and methods

When PE patients had a Haller index  $>3.2$ , it was seen as criteria for surgical indication and included in both of the groups. Fifty consecutive patients with PE, who underwent primary repair from 2005 to 2013 in the First Hospital of the China Medical University, were retrospectively reviewed. Twenty patients from March 2005 to April 2010 underwent repair by STO procedure, and 30 patients from September 2008 to January 2013 underwent the Nuss procedure.

As described elsewhere,<sup>3–5</sup> the STO repair, wherein the deformed sternum is cut at the second or third intercostal space and turned and restored, is an alternative surgical approach. We adopted STO with the pedicle of abdominal rectus muscle. The Nuss repair requires bilateral maxillary transverse incisions and placement of a substernal concave stainless steel bar, which is bent to conform to the patient's anterior chest wall.<sup>2</sup> At the end of the surgery, chest tubes are inserted, and will be removed postoperatively, whereas the chest roentgenogram shows no obvious pneumothorax or pleural effusion, and the drainage is under 100 mL in 1 day.

A retrospective chart review was performed to document the method of repair and clinical data, including patient characteristics, surgical data, complications, and cosmetic outcome. Patients were photographed prior to and after surgery and graded immediately by themselves after the operation as excellent, normal chest; good, mild residual pectus; fair, moderate residual pectus; and poor, severe recurrence requiring further treatment.<sup>9</sup> Statistical analysis was performed using SPSS 16.0 software (SPSS Inc.,

Chicago, IL, USA; Student *t* test and Chi-square test). A *p* value  $<0.05$  was taken to be statistically significant.

## 3. Results

### 3.1. Patient characteristics

Among patients with concomitant flat chest in each group, 3 (15%) were in the STO group and 8 (26.7%) in the Nuss group ( $p = 0.095$ ). The STO group had higher rates of decreased exercise endurance than the Nuss group (26.7% vs. 75.0%).

The median Haller index in the Nuss group was 4.0, ranging from 2.6 to 6.2. In the STO group, the median Haller index was 4.3, ranging from 2.8 to 6.5 (Table 1).

### 3.2. Hospital course

The clinical courses for the two groups were dramatically different. Table 2 provides clinical information for both groups. In 30 patients undergoing Nuss repairs, a single bar was inserted in 23 (76.7%) patients and two bars were inserted in seven (23.3%) patients (Table 2).

### 3.3. Complications

Table 3 summarizes the complications that occurred during the initial hospital stay. There were no deaths or any cardiac perforations during the 50 repairs. The overall complication rate was 36.0% (18/50), which was not significantly different between the groups. In the STO group, the rate of complications was 40.0% (8/20). Among the patients undergoing the Nuss repair, 10 (33.3%) experienced postoperative complications, containing one (3.3%) delayed brachial nerve temporary paralysis. This rare complication appeared 15 days postoperatively and the patient returned to normal after a short period of physical rehabilitation and oral antibiotics (Table 3).

### 3.4. Cosmetic results

Data were available for all patients (Table 4). There was no statistical significance between the two groups ( $p = 0.965$ ).

**Table 1** Patient characteristics.

	Nuss ( <i>N</i> = 30)	STO ( <i>N</i> = 20)	$\chi^2$	<i>p</i>
Gender (M/F)	29/1	18/2	0.0002	0.965
Mean age at operation (range)	15 (6–23)	11 (3–36)	17.519	0.353
Older than 18 y	2 (6.7%)	3 (15.0%)	0.592	0.296
Decreased exercise endurance	8 (26.7%)	15 (75.0%)	7.077	0.008
The median Haller index	4.0	4.3	0.795	0.463

M/F = male/female; STO = sternal turnover.

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