Early results of 18 adults, following a modified Nuss operation for recurrent pectus excavatum

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Abstract

OBJECTIVES: The minimally-invasive Nuss operation has been widely used for correcting pectus excavatum in children. However, a number of adult patients require reoperations for recurrence or other complications. This work aimed to investigate the early results of recurrent pectus excavatum repair using a modified Nuss procedure, which were seldom reported in adult patients.

METHODS: A retrospective chart review was conducted on 18 adult patients who underwent modified Nuss procedure in the age range of 18–31 years. The Haller index of the patients ranged from 3.2 to 6.5. In the modified Nuss technique, a small auxiliary incision was made below the xiphoid process and one finger was inserted instead of a thoracoscope. The introducer was guided by the finger, slowly advanced across the mediastinum and raised the sternum and the anterior chest wall to the desired position. The Lorenz correction bar was introduced through the tunnel, placed in position, and turned over so that the convexity faced anteriorly.

RESULTS: The operations were performed successfully and no operative mortality occurred. The mean operating time was 68.5 ± 15.5 min. The postoperative results were excellent in 77.8% of patients and good in 22.2%. Early complications were mild and no late complications occurred.

CONCLUSIONS: The modified Nuss procedure is an excellent reoperative correction for adult patients and has outstanding early results, considering that it is technically challenging.

Keywords: Pectus excavatum • Reoperation • Minimally-invasive • Nuss procedure

INTRODUCTION

Pectus excavatum (PE, also known as ‘funnel chest’) is the most common congenital chest wall anomaly associated with anterior chest deformity and depression [1, 2]. The initial repair for PE commonly includes the open Ravitch technique and the Nuss Procedure. The standard Ravitch technique involves bilateral subperiosteal resection of abnormal costal cartilages and stabilization of the sternum, which has been improved from the original techniques described by Ravitch in 1949 [3]. Nowadays the Nuss procedure, which is the minimally-invasive pectus bar repair for correction of PE, has gained popularity since its introduction in 1998 [4]. However, clinical observations have reported that recurrent pectus excavatum (RPE) occurs with a recurrence rate of 2% to 37% [5–8]. RPE usually occurs after open Ravitch surgery. In this open surgery, subperiosteal resection of deformed costal cartilages is performed and there is probably a recurrence of the deformity during the healing process. Thus the volume of endochondral ossification is increased, scar-like fibrosis of the intercostal surgical region occurs and thoracic elasticity further reduces [9]. When the thoracic deformity continues to adulthood, difficulty of surgery could be greatly increased. Reoperative repair is technically more challenging. There are few reports on repair of RPE and these studies include mostly children and few adults [5, 10–12]. Here we summarize our clinical experience in the surgical management and postoperative outcomes of adults who underwent reoperation for recurrent pectus deformity.

MATERIALS AND METHODS

Clinical data

From June 2007 to October 2010, 430 patients with PE were admitted to thoracic surgery and 310 of them were over 18 years of age. Eighteen adult patients had PE caused by treatment failure or improper treatment, which accounted for 5.8% of the adult patients over the same period. Among eighteen RPE patients, there were 15 males and three females (male : female ratio of 5:1) in the age range of 18–31 years (mean age: 21.39 ± 4.83 years). Initial repair of PE before recurrence included 13 open Ravitch surgeries, three sternal turnover operations, one Nuss procedure and one thoraco-abdominal incision for thoracic and abdominal injury in a traffic accident. Seventeen RPE patients had their initial repair at other hospitals and one in our...
Modified Nuss operation

After general anaesthesia, patients were placed in a supine position with both arms abducted and the chest elevated. A correction bar of appropriate length and shape was selected according to the distance between both mid-axillary lines on the surface of the thorax. The transverse lines were drawn from the deepest point of the sternum to mid-axillary lines at both sides. Two skin incisions of 3 cm length were made along the intersections of the transverse and mid-axillary lines. A third small auxiliary incision was made below the xiphoid. Kelly clamps were inserted from both incisions, to penetrate the pleura, and separated along the anterior skeletal chest wall. The retrosternal adhesions were blunt dissected by the finger below the xiphoid. Clamps from both sides were brought together by finger guidance. The introducer was slowly inserted from the right incision, advanced across the mediastinum and toward the left incision, and raised the sternum and the anterior chest wall to the desired position, again with finger guidance. Then the correction bar was introduced to its proper position and turned over so that the convexity faced anteriorly. Finally, the bars were fixed on both sides using stabilizers that were fixed to the surrounding muscles. The number of correction bars depended on whether the deformity was limited or extensive. There were 16 patients with one bar and two patients with two bars.

RESULTS

The modified Nuss operation was successfully performed in all 18 RPE patients with no heart or lung injury (Fig. 1). The operative mortality was 0%. The operative time was 68.5 ± 15.5 min on average (range: 60–110 min).

Nine (50%) out of 18 RPE patients had mild postoperative complications, which included local atelectasis in four cases (22.2%) and, in five (27.8%), pneumothorax and small amounts of pleural effusion, which were asymptomatic and required no treatment. There were no postoperative complications of hemothorax, wound infection, or Nuss bar displacement.

The mean postoperative hospitalization was 6 days (range: 6–9 days). All patients were followed up after 12 to 36 months with an average of 19 months. The original symptoms disappeared after surgery and postoperative pain lasted for 4–6 weeks.

Postoperative evaluation used the following criteria [5]: ‘excellent’ if preoperative symptoms were resolved and chest appearance was normal; ‘good’ if preoperative symptoms were resolved and chest appearance was improved and ‘unsuccessful’ if preoperative symptoms recurred and chest appearance was deformed. A total of 14 patients (77.8%) showed excellent results with postoperative local atelectasis and no patient had unsuccessful results (Table 2). All patients had a postoperative mean HI of 2.83 ± 0.34 (range: 2.32–3.64). There were significant differences between postoperative and preoperative HI (P < 0.001) (Table 2).

DISCUSSION

Most of the adult RPE patients underwent their initial repair using open Ravitch technique, in which subperiosteal resection of deformed costal cartilages was performed. The appearance of pectus excavatum was improved in many patients by open surgery. However, there are still some patients who have continued to experience preoperative symptoms such as chest tightness, depression of the sternum and heart palpitations after activity, due to severe depression of the sternum. Some recurrent PE patients insisted on reoperation because of the mental strain and clinical depression caused by the condition.

Clinical observations have reported that RPE occurs with a recurrence rate of 2% to 37% [5–8]. There are few reports on repair of RPE and these studies include mostly children and few adults [5, 10–12]. There is no report of the modified Nuss technique described in these studies [1, 5, 13].

The reasons for recurrence were as follows: (i) operation either too early or too late; (ii) dissection in open techniques...
either too extensive or too little; (iii) removing the bar too early or bar displacement in minimally-invasive techniques; (iv) pseudarthrosis development between the two fragments of the costal cartilage; (v) local infections [1, 5].

Here we report 16 patients with subperiosteal resection of deformed costal cartilages, whose sternum and costal cartilages were extensively dissociated in Ravitch surgery and sternal turnover operation. Thus costal cartilage showed nutrition disorder, ossification, and malunion (Fig. 1A and B). Three further cases suffered recurrence after sternal turnover operation, experiencing deformity at the sternal angle of the transverse sternum (Fig. 1C). Eleven other patients underwent their initial repair too early, before the age of eight, and consequently developed a second depression of the sternum during the growth period in adolescence. Improper positioning of the correction bar in the Nuss operation caused unrectified depression of the sternum in one patient. There was no report of traumatic PE. However, in this study, one case suffered thoraco-abdominal injury after a traffic accident in childhood. Steel wire used for sternal closure was over-tightened, thus causing pectus excavatum.

The reoperation for recurrent PE remains controversial. Antonoff reported that those patients who underwent reoperative repair using an alternative approach to the initial procedure seemed to have more successful outcomes than those patients who underwent repetition of the original procedure [8]. Redlinger et al. published their experience that there is a greater than 95% success rate for a secondary PE repair via the minimally-invasive Nuss technique, regardless of what technique was used at the initial repair [1].

The key points of the modified Nuss technique were how to separate lung and retrosternal adhesion before the introducer was guided to advance across the mediastinum and toward the incision at both sides. The difficulties in surgery were intercostal fibrosis, hard ossification, narrowing of the intercostal space and retrosternal adhesion. The intercostal incision was made by electric knife. Retrosternal adhesion was addressed by making a small auxiliary incision below the xiphoid, which was much safer and easier. Sharp separation was used when necessary by pulling the sternum forward and looking directly. Both strength for lifting the sternum and pericardial traction were reduced by retrosternal separation, which was also convenient for finger guidance. The correction bar was placed in a low position in the Nuss procedure and a satisfactory remedy was achieved by re-locating the correction bar in a proper position. In this study, there was no superficial wound infection or displacement of the steel bar, which had been reported previously [15]. There were no other severe complications: pleural effusion and atelectasis exhibited a higher prevalence, which remained better than a previously study [16].

In this study, patients sought treatment because of either physical symptoms or psychological effects. One patient had
clubbed finger and cyanosis of the fingertip but these were probably caused by poor lung development since, at the second preoperative examination, he had no accompanying pulmonary-vascular or cardiovascular disease. A similar condition had not been found in the literature.

Patients were divided into three treatment categories: excellent, good, and unsuccessful. According to previous study, excellent if preoperative symptoms were completely resolved and chest appearance was normal; good if preoperative symptoms were completely resolved and chest appearance was improved and unsuccessful if preoperative symptoms re-occurred and chest appearance was deformed [17]. The rate of excellent results was 77.8% (14 of 18 cases) in this study, which was in accordance with the results of initial repair for children patients and better than the results of initial repair for adult patients [14, 18]. The good results of four patients were associated with costal cartilage ossification, intercostal fibrosis and severe reduction of thoracic elasticity. The results of our study show that patients who had undergone initial, failed repair of pectus excavatum can safely undergo reoperation by the modified Nuss procedure and show satisfactory post-operative results. However, a definitive conclusion cannot be drawn, owing to the small number of cases and further studies will be needed.

Conflict of interest: none declared.

REFERENCES


