



Factors determining the complications in Nuss procedure

Nuss işleminde komplikasyonları belirleyen faktörler

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ABSTRACT

Background: This study aims to share our experiences in complications developing in patients who underwent Nuss procedure and the management of these complications.

Methods: In the study, files of 59 patients (50 males, 9 females; mean age 17.6±5.1 years; range, 2.5 to 33 years) who were applied Nuss procedure for pectus excavatum in our clinic between July 2007 and May 2016 were retrospectively assessed. Patients' age, gender, surgical method-complications and hospitalization durations were recorded. Fisher's chi-square test and logistic regression analysis were used for data evaluation.

Results: Nuss procedure was performed in all patients without severe complications such as death, organ injury or massive hemorrhage. The most frequently observed postoperative early-period complication was minimal pneumothorax (n=16, 27.1%), while bar dislocation was most frequently observed in the late-period (n=5, 8.3%).

Conclusion: Being male and/or over 23 years of age were determined as risk factors for complication development after Nuss procedure. Still, being a minimally invasive and manageable approach with its success in correcting the deformity, short operation duration, and low complication rates, Nuss procedure can be safely performed in selected patients.

Keywords: Complications; minimally invasive surgery; Nuss procedure; pectus excavatum.

ÖZ

Amaç: Bu çalışmada Nuss işlemi yapılan hastalarda gelişen komplikasyonlar ve bu komplikasyonların yönetimi ile ilgili deneyimlerimiz paylaşıldı.

Çalışma planı: Çalışmada Temmuz 2007 - Mayıs 2016 tarihleri arasında kliniğimizde pektus ekskavatum nedeniyle Nuss işlemi uygulanan 59 hastanın (50 erkek, 9 kadın; ort. yaş 17.6±5.1 yıl; dağılım, 2.5-33 yıl) dosyaları retrospektif olarak değerlendirildi. Hastaların yaşları, cinsiyetleri, cerrahi yöntem-komplikasyonları ve hastanede kalış süreleri kaydedildi. Verilerin değerlendirilmesinde Fisher'in ki-kare testi ve lojistik regresyon analizi kullanıldı.

Bulgular: Nuss işlemi tüm hastalarda ölüm, organ yaralanması ve masif kanama gibi ciddi komplikasyonlar olmadan gerçekleştirildi. Ameliyat sonrası erken dönemde en sık görülen komplikasyon minimal pnömotoraks (n=16, %27.1) iken geç dönemde en sık bar dislokasyonu görüldü (n=5, %8.3).

Sonuç: Erkek veya 23 yaşından büyük olmanın Nuss işleminden sonra komplikasyon gelişimi için risk faktörleri olduğu belirlendi. Buna rağmen, Nuss işlemi minimal invaziv ve yönetilebilir bir yaklaşım olması, deformiteyi düzeltmedeki başarısı, kısa ameliyat süresi ve komplikasyon oranlarının az olması ile seçilmiş hastalarda güvenle uygulanabilir.

Anahtar sözcükler: Komplikasyonlar; minimal invaziv cerrahi; Nuss işlemi; pektus ekskavatum.

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Among thoracic wall deformities, pectus excavatum (PE) is the most common, characterized by the depression of sternum and costal cartilages at various degrees.^[1] The aim of PE operation generally involves aesthetic concern, yet postoperative patients describe functional resolution.^[2] The classical surgical method for PE is the open surgical method described by Ravitch in 1949.^[3] However, the operation and hospitalization durations are long, and returning to normal life may be delayed. Patients experience scar problems due to large cuts, and the relapse rates may be higher compared to closed methods. Such disadvantages led to the development of a minimally invasive surgical method, namely the Nuss procedure.^[4] In Turkey, this thoracoscopic method started to be used over the last decade. Therefore, in this study, we aimed to share our experiences in complications developing in patients who underwent Nuss procedure and the management of these complications.

PATIENTS AND METHODS

In this study, data of 59 patients (50 males, 9 females; mean age 17.6 ± 5.1 years; range, 2.5 to 33 years) who were applied Nuss procedure for PE in Department of Thoracic Surgery, Medicine Faculty of Cumhuriyet University between July 2007 and May 2016 were retrospectively assessed. Diagnosis was established through physical examination. Posteroanterior chest X-ray, three-dimensional thorax computed tomography, complete blood count, coagulation tests, biochemistry and echocardiography evaluations were achieved preoperatively. Age, gender, surgical method-complications and hospitalization durations of the patients were recorded. The study protocol was approved by the Medicine Faculty of Cumhuriyet University Ethics Committee (Letter no. 2017-11/19). A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Thorax was entered with a port through the 4th-6th intercostal space to visualize the right hemithorax, and was evaluated with a 0- or 30-degree optic. After the steel bars were placed and turned with the aid of the optic, an absorbable or steel stabilizer was placed and immobilized at the left site, while on the right site, the bars were mounted to the costa with absorbable sutures, except for one patient (stabilizer was also placed at the right site). Operation was terminated by positive pressure ventilation and air discharge through a narrow aspiration catheter that was passed through an incision, made for the optic on the right site. Deformity resolution was achieved in all patients who underwent Nuss procedure with one bar except

for three patients, whose deformity improved with two bars. Absorbable stabilizer was used in eight patients, while steel versions were used in other patients.

Statistical analysis

Data achieved in our study were registered in the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Data evaluation was performed using significance between two means test (Kolmogorov-Smirnov) when parametric test estimations met, and Fisher's chi-square test and logistic regression analysis were used when data were obtained by counting. An error level was set at 0.05.

RESULTS

Among the PE patients, nine had dyspnea, 29 had chest pain and almost all had psychosocial problems. All operations were carried out without severe complications such as death, organ injury or massive hemorrhage. While the deformity improved in most patients ($n=56$) with one bar, two bars were mounted in three patients, since insufficient recovery was achieved. All the bars mounted were made of steel; however, eight of the stabilizers of the first cases were absorbable. One of these stabilizers broke after one month postoperatively. The broken stabilizer was removed and replaced by a metal one. No intraoperative complication occurred and there was no mortality. The most common postoperative complication was minimal

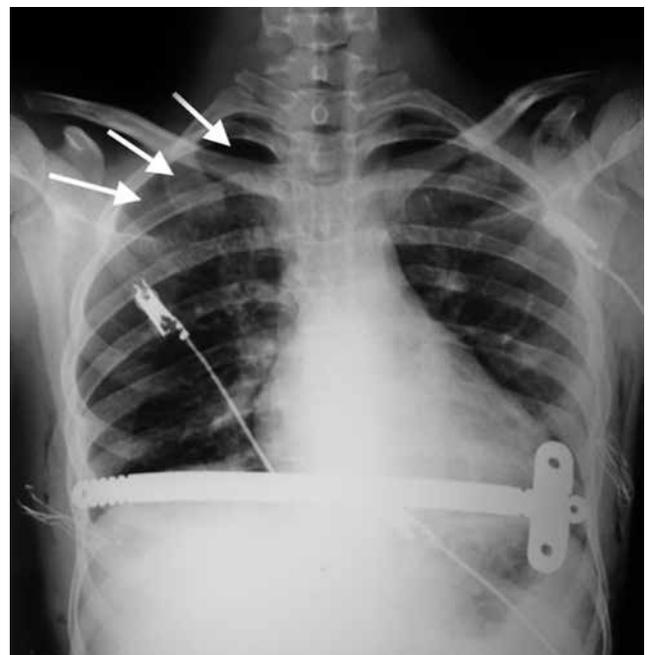


Figure 1. Pneumothorax is shown in chest X-ray on postoperative first day.

Table 1. Early and late period postoperative complications

	n	%
Early complications		
Pneumothorax	16	27.1
Wound site infection	4	6.7
Late complications		
Bar dislocation/ revised	5	8.5
Absorbable stabilizer breakage	1	1.7
Overcorrection	3	5.1
Wound site infection	3	5.1
Recurrence	3	5.1
Pain intolerance	1	1.7

pneumothorax (n=16, 27.1%) (Figure 1). All of them resorbed spontaneously and tube thoracostomy was unnecessary. Four patients experienced wound site leakage after one week postoperatively. These patients recovered with recurrent dressing and antibiotics. Table 1 shows the early and late postoperative complications and number of patients. The most common late complication was bar dislocation (n=5, 8.3%) (Figure 2). All patients who experienced bar dislocation were revised and while four patients underwent correction, one patient had to undergo bar removal due to serious dislocation in the ninth month. In one patient, bar had to be removed because of pain intolerance. This patient also experienced wound site infection in the acute phase. When evaluating the demographic data of the patients with postoperative -particularly late-period- complications, there was no statistically significant difference between genders (p=0.642). But the difference in age between the groups was significant. Age of the complication-developed group was 22.0±4.3 years while age of the group that developed no complication was 16.4±4.6 years (p=0.001; p<0.05). The age of complication-developed individuals was high and the odds value was significant (95% confidence interval, 1.08-1.61).

The mean hospitalization duration was 4.6 days (range, 3 to 6 days). Particularly, the hospitalization duration of patients aged 15 and below was much shorter. For the first 20 cases, bar removal was planned after two years, and after three years for the further cases. The earliest bar removal was at 24th month and the latest at 42nd month. During bar removal, nine cases were problematic, most commonly due to fibrosis, ossification and bar displacement to the intrathoracic field. Patients who underwent bar removal were discharged after 24 hours.

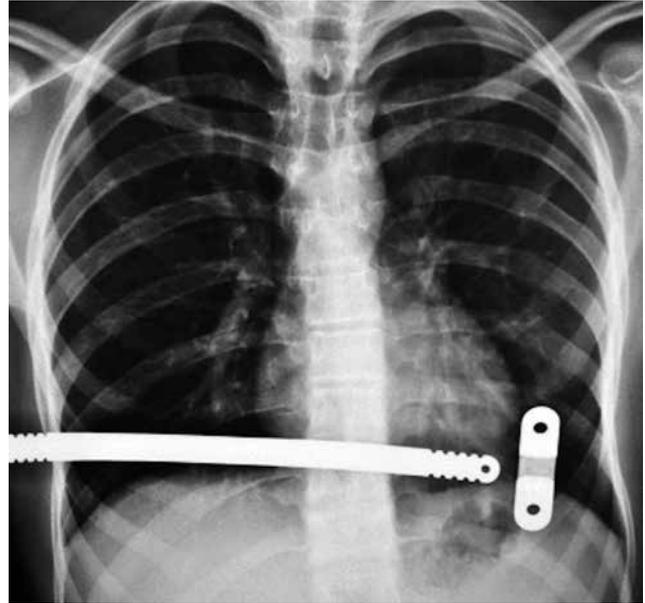


Figure 2. Bar dislocation is shown in chest X-ray in late period.

DISCUSSION

The pathophysiology of PE is not fully understood. The generally accepted theory is the displacement of cartilage costae to the posterior of the sternum due to abnormal development.^[5] Congenital heart diseases and orthopedic deformities may accompany.^[1,6] Pectus excavatum treatment is surgical.^[3,7] The classical surgical treatment method is the Ravitch technique. With this method, a large incision is made to the front thoracic wall, the deformed costal cartilages are removed, wedge osteotomy is performed to the sternum and a Kirschner chord is placed. Therefore, operation and hospitalization durations are prolonged for these patients. However, with the minimally invasive Nuss procedure, two little incisions are made on the lateral thorax, thus shortening both operation and hospitalization durations. Based on these advantages, this method is commonly accepted in many clinics.^[2,8] Large incision on the front thoracic wall is unnecessary with the Nuss procedure. The non-necessity of raising the pectoral flap, cartilage resection and osteotomy is a significant advantage. Moreover, short operation duration, minimal mortality, and early onset of daily activities are other advantages. Hence, patient and physician satisfaction is high.^[3,4] Surgical treatment indications are patients with functional disorders and cosmetic-psychologic reasons. When respiratory and cardiac evaluations are performed, no objective functional sign is found in most cases. In our cases, the most frequent reason for operation was psychosocial reasons.

In the literature, various ages have been reported for the age of operation,^[9] but the main opinion unites for between 10 and 16 years. Pediatric cases aged below 10 years may be asymptomatic, while experiencing serious sternal depression or serious cardiopulmonary impression that may be rarely operated. Thus, one of our cases was a three-year-old, who was operated due to serious sternal depression. Post-pubertal operations have higher risk of recurrence due to increasing bone rigidity.^[10,11] In fact, all of our patients with bar dislocation, broken stabilizer or recurrence were above 20 years of age.

The decision of the number of bars to be mounted intraoperatively is established according to the degree and scale of the deformity. In some cases, one bar may not be sufficient since the degree of excavation may be too high, and require more than one bars to be mounted.^[11] The operation age may change the number of bars mounted.^[5] In our cases, only three patients were mounted a second bar, because the deformity recovery was insufficient. While one steel bar was adequate in one patient, a second stabilizer was mounted since one stabilizer was insufficient. In this patient, steel stabilizers were mounted on both right and left sites. At the first eight operations, absorbable stabilizers were used for stabilization for being efficient and reliable.^[9] Yet, upon the breakage of one stabilizer in one patient, absorbable stabilizer was not used in the following cases.

The most common complications in the literature involving Nuss procedure are related to the bar and pneumothorax.^[12-14] Compatibly with the literature, the most common early-period complication in our patients was pneumothorax (n=16, 26.6%). There was no need of tube thoracostomy in any of these patients. In addition to pneumothorax, many early-period complications were reported in the literature, including simple wound infection, seroma, pleural effusion, multiple rib fracture, hemothorax, thoracic outlet-like syndrome, pericarditis, diaphragmatic hernia and life-threatening cardiac perforation.^[15-17] A study by Hebra et al.^[18] reported that after Nuss procedure, life-threatening complications including heart injury and pericardium damage, cardiac arrhythmia, lung injury, large vessel injuries, diaphragm and other organ injuries were observed, and that seven unpublished death cases are present. In our cases, no life-threatening complications were observed.

Late-period complications (after one month) after Nuss procedure are not common. Those most common are bar dislocation, pericardial effusion, pericarditis and hemothorax.^[19] Among these, the most common

is bar dislocation.^[2,4] Similarly, in our patients, the most frequently seen late-period complication was bar dislocation (n=5, 0.08%). These patients were revised and all were corrugated, except for one. In our study, an evaluation of the demographic data of the patients with postoperative -particularly late-period-complications revealed no statistically significant difference in terms of complication development between genders (p=0.642), while complications were more common in males. Only two of our female patients developed a late-period complication, and this was overcorrection. Similar to a study by Demirkaya et al.,^[13] in our study, complications were less common in females. Particularly, the fact that overcorrection was more common suggested that this may be due to a more flexible thorax. An evaluation of the age distribution of the patients showed that the age of the complication-developed group was 22.0±4.3 years while the age of the group that developed no complication was 16.4±4.6 years. The difference in age between the groups was significant (p=0.001; p<0.05). According to multivariate analysis, the risk of complication was 1.32 times higher as age increased, and the risk of complication increased independently only in patients aged 23 years or above. Thus, although minimally invasive PE correction may be carried out in adults, it has to be noted that the risk of complications may be higher in cases aged 23 years and above, and that precautions against bar placement should be taken. The increase of thorax rigidity at later ages may lead to increased complications. However, further studies are needed regarding this issue. The limitation of our study was the small sample size.

In conclusion, being male and/or over 23 years of age were determined as risk factors for complication development after Nuss procedure. We think that this high risk is due to the increased rigidity of the thorax and the presence of more muscular tissue in males. Therefore, preventive measures should be taken considering these risk factors in Nuss procedure. Still, being a minimally invasive and manageable approach with its success in correcting the deformity, short operation duration, and low complication rates, Nuss procedure can be safely performed in selected patients.

Declaration of conflicting interests

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