

Journal of Surgery and Medicine

e-ISSN: 2602-2079

Is it easy to remove the bar fitted with Nuss procedure?

Nuss prosedürü ile takılan barların çıkarılması kolay mıdır?

Özgür Katrancıoğlu¹, Yücel Akkaş², Ekber Şahin¹, Şule Karadayı¹, Melih Kaptanoğlu¹, Tuba Şahinoğlu³, Nurkay Katrancıoğlu⁴

¹ Department of Thoracic Surgery,
Cumhuriyet University School of
Medicine, Konya, Turkey

² Department of Thoracic Surgery,
Konya Numune State Hospital, Konya,
Turkey

³ Department of Thoracic Surgery,
Ankara Numune Research and Training
Hospital, Ankara, Turkey

⁴ Department of Cardiovascular Surgery,
Cumhuriyet University School of
Medicine, Sivas, Turkey

Abstract

Aim: Minimally invasive repair for pectus excavatum (PE) has become a popular approach since 1998. Convex bar is placed into the substernal position to leverage the deformity and left for approximately 24 to 36 months. We have noticed difficulties during some of these bars at removal. So we presented difficulties during the bar removal in this study.

Methods: The medical files of 39 patients who removal of the bars at our clinic between June 2011 and March 2017 were reviewed retrospectively. The medical files were reviewed retrospectively and 9 cases involving difficulty removed the bar were included in this study. Patients were evaluated in terms of gender, age, the bar duration time on the body, duration of hospital stay, morbidity and mortality.

Results: Mean patients age was 24.1 (range, smallest 19 and greatest 36) years. The overall mean duration of pectus bar maintenance was 35.5 (range, minimum 34 and maximum 38) months. While the mean duration of surgery was 50 minutes (range 38-52) in the non-difficulty group, the mean duration was 90 (range 74-110) minutes in the difficulty group. The causes of difficulties are mostly fibrosis, ossification and displacement of the intrathoracic region.

Conclusion: Careful attention and multidisciplinary work are important for the removal of bars attached due to PE. Emerging difficulties can be overcome with the experience gained over time.

Keywords: Pectus excavatum, Nuss procedure, Bar removal

Öz

Amaç: Pektus Ekskavatum (PE)'un minimal invaziv yöntemle onarımı 1998'den beri popüler hale gelmiştir. Deformiteyi kaldırmak için substernal alana konveks şekil verilmiş bar yerleştirilir ve yaklaşık 24-36 ay arası kalır. Bu barların bazılarının çıkarılması esnasında zorluklarla karşılaştık. Bu nedenle çalışmamızda karşılaştığımız zorlukları sunmak istedik.

Yöntemler: Haziran 2011 ile Mart 2017 tarihleri arasında kliniğimizde barları çıkarılan 39 hastanın verileri retrospektif olarak incelendi ve 9 hastada bar çıkarılması esnasında zorluk tespit edildi. Hastalar cinsiyet, yaş, barın vücutta kalma süresi, hastanede yatış süreleri, morbidite ve mortaliteleri açısından değerlendirildi.

Bulgular: Ortalama hasta yaşı 24,1 (en küçük 19, en büyük 36) idi. Pektus barların ortalama kalış süresi 35,5 (en kısa 34, en uzun 38) aydı. Zorluk olmayan grupta ortalama ameliyat süresi 50 dakika iken, zorluk olan grupta 90 dakika idi. Zorluk sebepleri sıklıkla fibrozis, ossifikasyon ve barın intratorasik bölgeye yer değiştirmesi idi.

Sonuç: PE nedeniyle takılan barların çıkarılmasında dikkatli ve multidisipliner yaklaşım önemlidir. Görülen zorluklar zamanla kazanılan deneyimle aşılabılır.

Anahtar kelimeler: Pektus ekskavatum, Nuss prosedürü, Bar çıkarılması

Introduction

Minimally invasive repair of Pectus excavatum has been announced to the whole world by Nuss the first time in 1998 [1,2]. This technique is very successful with the length of the incisions, blood loss, operating time, recovery time, and the length of hospital stay [3,4]. The minimally invasive technique uses incisions in the lateral thoracic wall. Convex bar is placed into the substernal position to leverage the deformity. Stabilizers are placed on the end of the bar to keep the chest wall in the normal position [1,5]. The bar is left in place for 24 to 36 months. To remove bars are used replace the previous lateral incision [1]. Although we encountered some difficulties about bar removal, we didn't find more knowledge about this topic in the literature. So we presented difficulties during the bar removal in this study.

Corresponding author / Sorumlu yazar:

Özgür Katrancıoğlu

Address / Adres: Göğüs Cerrahi Bölümü,
Cumhuriyet Üniversitesi, Tıp Fakültesi, 58140
Sivas, Türkiye

Tel: +3462191300

E-mail: ozgursongur@gmail.com

Ethics Committee Approval: The study was approved by Ethics Committee of University (No 2016-05/25).

Etik Kurul Onayı: Çalışma için onay Üniversite Etik Kurulundan alınmıştır (No 2016-05/25).

Conflict of Interest: No conflict of interest was declared by the authors.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Financial Disclosure: The authors declared that this study has received no financial support.
Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

Received / Geliş Tarihi: 28.02.2018

Accepted / Kabul Tarihi: 20.03.2018

Published / Yayın Tarihi: 20.03.2018

Copyright © 2018 The Author(s)

Published by JOSAM

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License 4.0 (CC BY-NC-ND 4.0) where it is permissible to download, share, remix, transform, and build upon the work provided it is properly cited. The work cannot be used commercially without permission from the journal.



Materials and methods

After obtaining approval Ethics Committee of University (Letter no 2016-05/25), the medical files of 39 patients who removal of the bars at our clinic between June 2011 and March 2017 were reviewed retrospectively. The medical files were reviewed retrospectively and 9 cases involving difficulty removed the bar were included in this study. Demographic data and reasons for the difficulties are shown in table 1.

Patients were evaluated in terms of gender, age, the bar duration time on the body, duration of hospital stay, morbidity and mortality. Nuss procedure was done by video thoroscopically with double lumen intubation. We generally use shortest possible bar to avoid excessive postoperative pain and ossification of the curved bar's tip. For the placement of the bar in all cases used 2 symmetric lateral thoracic incisions. A pocket was done in either the submuscular (SM) or a subcutaneous (SC) tissue for placement of the bar ends. While in the first made cases inserted into the subcutaneous pocket, subsequent cases submuscular pocket was preferred due to more aesthetically. We followed the Nuss depiction in similar shape except the two differences. Firstly we preferred to create a SM pocket, whereas Dr Nuss' initial technique using an SC pocket. Secondly we prefer smaller bars contrary to what is described in the Nuss technique. We have fixed the bar to the chest wall with stabilizers to prevent bar migration.

For bar removal, incisions were made along previous incision scars, and skin and subcutaneous tissue dissection was done to uncover both bar tips and the stabilizer. Initial cases, as a standard approach, we exposed the bar tips in left side, whereas in later cases, we exposed bilaterally and straightened both ends before removal. In all difficult cases, bilateral incisions were made. All bar removal was done by the same surgeon. Bar removal was performed via subcutaneous tissue dissection in all patients without intrathoracic imaging. While there was no significant bleeding during surgery, there was significant prolongation of the operation. Only one patient needs to be taken to surgery twice. All patients were discharged within 24 hours after surgery.

Results

Mean patients age was 24.1 (range 19-36) years. The overall mean duration of pectus bar maintenance was 35.5 (range 34-38) months. All patients who participated in this study were male and over 18 years of age. The minimum stay of the implanted bars was 34 months. No significant hemorrhage occurred during the removal of the bars. While the mean duration of surgery was 50 minutes (range 38-52) in the non-difficulty group, the mean duration was 90 minutes (range 74-110) in the difficulty group. When investigating the reasons of difficulties, the most causes were fibrosis, ossification and displacing to the intrathoracic site (Figure 1). There was difficulty in finding the bar and stabilizer after excessive weight gaining and bodybuilding practices in two patients. Among the 9 troublesome patients, 3 (33.3%) required to use fluoroscopy to find the bar tip. In one case, we needed to perform surgery twice, because at the first surgery, the bar tip was out of reachable

distance due to severe ossification on the right site and considering that the stick might be fixed in the pericardium, the surgery was terminated in order not to cause any complications. The subsequent thorax CT scan revealed that there was no retrosternal ossification and the patient underwent a second surgery and the bar was removed using fluoroscopy. All patients were discharged 24 hours after surgery. No morbidity or mortality was seen.

Table 1: Demographic data and reasons for the difficulties

	Age	Gender	Length of stay of the bar (month)	Difficulty Reason	S	Attachment
1	27	Male	38	Migration to the intrathoracic site	+	Removed in second surgery
2	26	Male	36	Migration to the intrathoracic site + fibrosis	-	Not necessary
3	21	Male	34	Fibrosis	-	Not necessary
4	22	Male	36	Weight gain, muscle hypertrophy	-	Not necessary
5	22	Male	34	Migration to the intrathoracic site + fibrosis + ossification	-	Not necessary
6	36	Male	36	Weight gain, muscle hypertrophy	+	Not necessary
7	26	Male	36	Fibrosis + ossification	-	Not necessary
8	18	Male	34	Migration to the intrathoracic site + ossification	-	Not necessary
9	19	Male	36	Ossification	+	Not necessary

S: Scopy

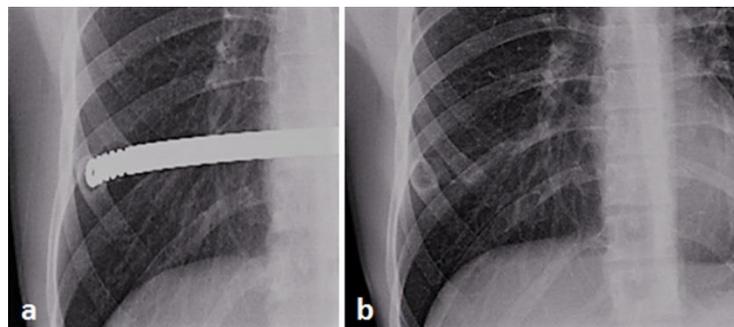


Figure 1: Image of the ossification on posteroanterior chest x-ray (a: preoperatif, b: postoperatif)

Discussion

The Nuss surgery which is performed for patients with pectus excavatum has been modified in time in order to improve the safety and cosmetic outcomes of the operation [6]. In the first described method by Nuss, SC tunnel for the molded bar tip was created. In the first Nuss operations of our clinic, SC tunnel was used, but later, SM tunnel was introduced due to better cosmetic outcomes. In Nuss surgery, a metal bar is placed under the sternum of the patients and the bar has to stay in the patient for at least 3 years [1,7]. This process usually coincides the rapid growth period and this might cause some unintentional effects. Some of these effects are fibrosis in the tissue around the bar, ossification of the fibrous tissue, displacement of the bar into the intrathoracic site and erosion on the ribs and/or the sternum [5].

These kinds of effects may lead to difficulties in removing the bars, as it was the case in our series of 9 cases.

When investigating the reasons of difficulty in removing the bars in the patients we included to this study, the most common reasons were fibrosis, ossification and displacing to the intrathoracic site (Table 1). In our cases with fibrosis, if ossification did not accompany, freeing was made through bilateral opening of the former incision without the need for scopy. Some authors suggest that a unilateral incision (site of the stabilizer) is sufficient for the bar removal and that the bar tip of the other site could be mobilized with a dissection on the incision site and flipper maneuvers [8]. In our clinic, previous approaches used unilateral incision in the first bar removal surgeries. However, in the case of severe fibrosis and ossification, there was difficulty in freeing the other site and considering that this would threaten the patient's life safety, we used bilateral incisions in our subsequent surgeries.

There are numerous publications in the literature suggesting that new bone development may occur around the implants due to trauma. In most cases, the implant is placed near the surface or the periost. This ossification is also an advantage in fixing the instrument [5,9]. While new bone development may be seen on the bar tips, some patients may develop a more aggressive ossification and ossification may also even be seen on the whole bar. This might also prevent the access to the bar [5]. In one case (No. 5) in our study, we could only reach the bar with scopy due to the density of the ossification (Figure 2). We established that patients whom we placed the bar SM developed a denser ossification.



Figure 2: Intraoperation image of ossification

This ossification around the bar had a complicating affect in removing the bar; however, placing the bar carefully without damaging the fascia may decrease this ossification [5]. When there is suspect of ossification, a chest CT scan is indicated to assess the retrosternal ossification (that also may adhere on the pericardium) along the bar tract [10]. As so, we perform a thoracic CT scan to all patients that are suspicious of ossification in our clinic. Up to now, no retrosternal ossification was seen in any of our cases. Another common reason for difficulty during removal of the bar was the displacement of the bar tip or the stabilizer into the intrathoracic site. There are also some reports about the difficulty caused by the migration of the

bar to the intrathoracic site [11-14]. After the bar has been placed over time, it can migrate to the intrathoracic area. Since the stabilizer is frequently placed on the left site, the migration to the intrathoracic site is more commonly seen on the right edge [10]. We required scopy in one patient (No. 1) who we had difficulty in removing the bar due to displacement to the intrathoracic site and the bar could only be removed two-staged. The other bars could be carefully dissected single-staged. Physical changes of the patient including weight gain, muscle hypertrophy, height increase rate may cause problems in bar removal. In our study group, there was difficulty in removing the bars in two (22.2%) cases due to excessive weight gain and body building. In one of these cases, the muscle hypertrophy was so severe that the bar could only be removed with scopy. We are in close contact with cardiac surgeons during bar removal procedures at our clinic. Plans are made together so they are prepared, if necessary. All of our preoperative patients were consulted since it is likely for unpredictable complications to occur during the process of bar removal by the nature of the Nuss procedure [15,16].

All together, these don't have a significant effect on pectus repairment; however, they may complicate the bar removal, leading to a requirement of a longer surgery duration. Emerging difficulties may be handled with multidisciplinary and experience achieved over time. Despite these types of complications, we consider that the Nuss procedure should be preferred as the most efficient and, according to patient satisfaction, the best surgery in patients with pectus excavatum.

References

1. Nuss D, Kelly Jr RE, Croitoru DP, et al. A 10-year review of a minimally invasive technique for the correction of pectus excavatum. *J Pediatr Surg.* 1998;33:545-52.
2. Noguchi M, Fujita K. A new technique for removing the pectus bar used in the Nuss procedure. *J Pediatr Surg.* 2005;40:674-7.
3. Miller KA, Woods RK, Sharp RJ, et al: Minimally invasive repair of pectus excavatum: A single institution's experience. *Surgery.* 2001;130: 652-7.
4. Hebra A, Swoveland B, Egbert M, et al: Outcome analysis of minimally invasive repair of pectus excavatum: Review of 251 cases. *J Pediatr Surg.* 2000;35:252-7.
5. Ostlie DJ, Marosky JK, Spilde TL, Snyder CL, St Peter SD, Gittes GK, Sharp RJ. Evaluation of Pectus Bar Position and Osseous Bone Formation. *J Pediatr Surg.* 2003;38:953-6.
6. Bilgi Z, Ermerak N.O, Laçın T, Bostancı K, Yüksel M. Previously Complicated Nuss Procedure Does Not Preclude Blind Removal of the Bar. *Thorac Cardiovasc Surg.* 2016;64:83-6.
7. Fallon SC, Slater BJ, Nuchtern JG, et al. Complications related to the Nuss procedure: minimizing risk with operative technique. *J Pediatr Surg.* 2013;48(5):1044-8.
8. Liu W, Kong D, Yu F, Yin B. A simple technique for pectus bar removal using a modified Nuss procedure. *J Pediatr Surg.* 2013;48:1137-41.
9. Schon R, Schmelzeisen R, Shirota T, et al: Tissue reaction around miniplates used for the fixation of vascularized iliac crest bone grafts. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 1997;83:433-40.
10. Giacomo T.D, Diso D, Francioni F, Anile M, Venuta M. Minimally invasive pectus excavatum repair: migration of bar and ossification. *Asian Cardiovascular & Thoracic Annals.* 2012;21: 88-9.
11. Nuss D. Minimally invasive surgical repair of pectus excavatum [Review]. *Semin Pediatr Surg.* 2008;17:209-17.
12. Vegunta RK, Pacheco PE, Wallace LJ, Pearl RH. Complications associated with the Nuss procedure: continued evolution of the learning curve. *Am J Surg.* 2008;195:313-7.

13. Park HJ, Lee SY, Lee CS. Complications associated with the Nuss procedure: analysis of risk factors and suggested measures for prevention of complications. *J Pediatr Surg.* 2004;39:391–5.
14. Morimoto K, Imai K, Yamada A, Fujimoto T, Matsumoto H, Niizuma K. Migration of pectus bar into the ribs. *J Plast Reconstr Aesthet Surg.* 2008;61:225–7.
15. Jemielity M, Pawlak K, Piwkowski C, Dyszkiewicz W. Life-threatening aortic hemorrhage during pectus bar removal. *Ann Thorac Surg.* 2011;91(2):593–5.
16. Haecker FM, Berberich T, Mayr J, Gambazzi F. Near-fatal bleeding after transmyocardial ventricle lesion during removal of the pectus bar after the Nuss procedure. *J Thorac Cardiovasc Surg.* 2009;138(5):1240–1.