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Simultaneous Correction of Pectus Excavatum During Median Sternotomy for Cardiac Surgery: A Case Series of Four Patients

Pektus Ekskavatumun Median Sternotomi ile Kardiyak Cerrahi Sırasında Eş Zamanlı Onarımı: Dört Olguluk Seri

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ABSTRACT

Aim: Simultaneous surgical correction of pectus excavatum (PE) and cardiac pathology has been increasingly considered in recent years. This approach may reduce the technical challenges and complication risks compared to performing chest wall correction as a separate procedure in patients with a history of median sternotomy. Although the literature on its feasibility, safety, and long-term outcomes is limited, current evidence suggests potential benefits when applied in appropriately selected patients.

Materials and Methods: This single-center retrospective study included four patients who underwent simultaneous correction of PE and open-heart surgery via median sternotomy between 2015 and 2023. Demographic, operative, and postoperative data were collected. All patients underwent the Nuss procedure after intracardiac intervention.

Results: The cohort comprised four males, mean age 37.0±26.2 years (range: 20-78). Concomitant procedures were atrial septal defect repair, aortic root replacement, mitral valve replacement, and multi-vessel coronary artery bypass grafting. One or two pectus bars were placed in each case, with no intraoperative complications. One patient (25%) died postoperatively from cardiac arrhythmia unrelated to chest wall repair. Among survivors, complications were limited to one pleural effusion. Two patients underwent elective bar removal. Median follow-up was 58 months (range: 14-108).

Conclusion: Simultaneous PE repair during median sternotomy for cardiac surgery is technically feasible and safe. It eliminates the need for staged procedures, minimizes retrosternal dissection risks, and optimizes surgical exposure. Careful planning and intraoperative coordination are critical for successful outcomes. These findings support the broader adoption of this strategy in selected patients with coexisting thoracic and cardiac anomalies.

Keywords: Pectus excavatum, sternotomy, cardiac surgery, Nuss procedure

ÖZ

Amaç: Pektus ekskavatum (PE) ve kardiyak patolojilerin eş zamanlı cerrahi olarak düzeltilmesi son yıllarda giderek daha fazla gündeme gelmektedir. Bu yaklaşım, daha önce median sternotomi uygulanmış hastalarda ikinci seansta gerçekleştirilecek göğüs duvarı düzeltme ameliyatlarına kıyasla teknik zorlukları ve komplikasyon risklerini azaltabilir. Literatürde bu yöntemin uygulanabilirliği, güvenliği ve uzun dönem sonuçlarına dair veriler sınırlı olmakla birlikte, mevcut bulgular uygun hasta seçiminde potansiyel faydalar sağlayabileceğini düşündürmektedir.

Gereç ve Yöntem: Bu tek merkezli retrospektif çalışmaya, 2015-2023 yılları arasında median sternotomi yoluyla PE onarımı ile açık kalp cerrahisi eş zamanlı olarak yapılan dört hasta dahil edildi. Demografik, operatif ve postoperatif veriler incelendi. Tüm hastalara intrakardiyak girişim sonrası Nuss prosedürü uygulandı.

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Bulgular: Dört hastanın tamamı erkekti; ortalama yaş 37,0±26,2 yıl (dağılım: 20-78). Eş zamanlı girişimler atrial septal defekt onarımı, aort kökü replasmanı, mitral kapak replasmanı ve çoklu damar koroner arter bypass idi. Her hastada bir veya iki pektus barı yerleştirildi ve intraoperatif komplikasyon olmadı. Bir hasta (%25) postoperatif dönemde, onarımla ilişkili olmayan kardiyak aritmi nedeniyle kaybedildi. Sağ kalanlarda komplikasyon yalnızca bir plevral efüzyon ile sınırlıydı. İki hastada elektif bar çıkarıldı. Medyan takip süresi 58 ay (dağılım: 14-108) idi.

Sonuç: Kardiyak cerrahi sırasında median sternotomi ile eş zamanlı PE onarımı teknik olarak uygulanabilir ve güvenlidir. Bu yöntem, aşamalı cerrahi gereksinimini ortadan kaldırır, retrosternal diseksiyonla ilişkili riskleri en aza indirir ve cerrahi görüş alanını optimize eder. Başarılı sonuçlar için dikkatli planlama ve ameliyat sırasında ekip koordinasyonu kritik önemdedir. Bulgularımız, torasik ve kardiyak anomalileri birlikte bulunan seçilmiş hastalarda bu stratejinin daha geniş ölçekte uygulanmasını desteklemektedir.

Anahtar Kelimeler: Pektus ekskavatum, sternotomi, kardiyak cerrahi, Nuss prosedürü

INTRODUCTION

Pectus excavatum (PE) is the most common congenital anterior chest wall deformity, characterized by a depression of the sternum and adjacent costal cartilages. The minimally invasive repair of PE (MIRPE) was first introduced by Donald Nuss in the late 1990s and has since become the standard technique for surgical correction[1]. PE constitutes over 90% of congenital chest wall anomalies and is estimated to occur in approximately one in 400 live births, with a male predominance of up to 5:1[2]. Although PE is usually an isolated deformity, it may coexist with congenital or acquired cardiac conditions[3]. When PE coexists with cardiac pathology, mechanical compression of the right heart chambers may exacerbate hemodynamic compromise, leading to worsened clinical status and supporting the necessity of chest wall correction[4]. Performing MIRPE after previous median sternotomy poses significant technical challenges and carries an increased risk of life-threatening complications, particularly iatrogenic cardiac injury[5]. Dense retrosternal adhesions, distortion of anatomical planes, and limited visualization may contribute to intraoperative cardiac injury, which has been reported in up to 7% of patients with previous sternotomy undergoing MIRPE[6]. To overcome the challenges and risks associated with delayed repair, several authors have proposed performing PE correction concurrently with cardiac surgery. This combined approach offers direct access to the retrosternal space, eliminates the need for re-entry through a previously operated field, and may reduce the risk of complications such as adhesions and cardiac injury. Furthermore, simultaneous correction can shorten the overall treatment course, reduce hospitalization time, and avoid repeated anesthesia exposure. Case reports and small series have demonstrated that this strategy is feasible, even in pediatric patients, with acceptable safety and satisfactory functional and cosmetic outcomes[7-10]. In this study, we present our experience with four patients who underwent simultaneous repair of PE and cardiac pathology via median sternotomy. The primary aim was to evaluate the feasibility and safety of the combined approach, while also highlighting key aspects of the surgical technique and procedural sequence. By sharing our results and operative details, we aim to contribute to the growing body of evidence supporting single-stage repair in selected cases with coexisting thoracic and cardiac anomalies.

MATERIALS AND METHODS

Selection and Description of the Cases

This retrospective study included patients who underwent simultaneous repair of PE and cardiac pathology between August 2015 and May 2023 at a single tertiary care institution. Inclusion criteria comprised patients diagnosed with PE who also required surgical correction of congenital or acquired cardiac disease via median sternotomy. Patients with previous chest wall surgery, incomplete medical records, or those undergoing isolated pectus or cardiac procedures were excluded. The indication for simultaneous repair in all four patients was hemodynamically significant cardiac compression due to PE, confirmed by imaging and intraoperative findings. The multidisciplinary heart team concluded that correcting the chest wall deformity during the index cardiac operation would optimize postoperative cardiac function and prevent persistent right heart compression. This study was approved by the Institutional Ethics Committee of Memorial Ataşehir Hospital (approval number: 2025/19, date: 13.08.025).

Data Collection and Outcome Measures

Demographic and clinical variables including age, sex, PE symmetry, associated anomalies, family history, and coexisting cardiac diagnoses were reviewed. Operative data such as the type of cardiac procedure performed, number of pectus bars implanted, and whether bars were subsequently removed were recorded. Postoperative outcomes were assessed in terms of hospital stay duration, complication rates, and any observed morbidity or mortality.

Technical Information

Prior to median sternotomy, standard marking for the pectus repair was performed with the patient in the supine position. The point of maximal sternal depression was identified as the

central axis for bar passage. In addition, the bilateral entry and exit points for the pectus bar along the lateral chest wall were marked. After determining the appropriate length and curvature on the aluminum model, the pectus bars were bent accordingly to achieve their final shape. Two 2 cm vertical skin incisions were made at the mid-axillary lines on both sides, and subpectoral tunnels were developed to facilitate bar passage. Cardiac surgery was then performed via median sternotomy. Upon completion of the intracardiac procedure, the sternal wires were placed but left untied, allowing sufficient space for the subsequent insertion of the pectus bars. The prepared pectus bars were then advanced along the pre-positioned guide under thoracoscopic guidance (Figure 1a). Bar fixation was performed using stabilizers, which were secured in synchronization with sternal wire closure to prevent tension-related failure or loosening of either fixation system (Figure 1b). Special care was taken to avoid mechanical interference between the bar construct and the sternal wires.

Statistical Analysis

Given the small sample size, only descriptive statistics were used. Continuous variables were expressed as mean ± standard deviation or median (range), and categorical variables as counts and percentages.

RESULTS

Patient Characteristics

Four male patients underwent simultaneous repair of PE and cardiac pathology during the study period. The mean age at the time of surgery was 37.0±26.2 years (range: 20-78 years). Two patients presented with symmetric PE, while the remaining two had asymmetric deformities. One patient had a history of surgically treated severe scoliosis as an associated musculoskeletal anomaly, whereas the other three had no additional congenital or acquired anomalies. A positive family history of pectus deformity was documented in one patient.

Operative Details

The surgical indications varied among the patients and included atrial septal defect (ASD), aortic root dilatation with valve insufficiency, coronary artery disease, and mitral valve prolapse. Accordingly, the concomitant cardiac procedures performed were: ASD repair (n=1), aortic root replacement using the David procedure (n=1), coronary artery bypass grafting (5-vessel, n=1), and mitral valve replacement (n=1). All patients underwent simultaneous Nuss repair in the same operative session. The mean operative time was 385±192 minutes (range: 250-690 minutes). Two patients required two

Figure 1. (a) Placement of the pectus bar after positioning sternal wires but before tightening, illustrating the sequence to avoid interference between sternal closure and bar insertion. (b) Final position of the pectus bar after 180° rotation, with stabilizers secured in place prior to sternal wire tightening

pectus bars, while the other two were treated with a single bar. In all cases, one stabilizer per bar was used, and no additional fixation such as wires or secondary stabilizers was needed. No intraoperative complications were encountered in any of the patients.

Postoperative Outcomes

One patient (25%) died on postoperative day 2 due to malignant arrhythmias and cardiac fibrillation, despite resuscitation. Among the remaining three patients, one developed a left-sided pleural effusion during the first postoperative month, which was successfully managed with tube thoracostomy. No postoperative complications were observed in the other two patients. Postoperative hospital stay durations for the surviving patients were 15, 19, and 6 days, respectively. During follow-up, pectus bars were electively removed in two patients, while one patient still retains the implanted bar. A summary of individual patient characteristics, surgical procedures, and postoperative outcomes is presented in Table 1. Representative preoperative and postoperative clinical and radiological images from two patients are presented in Figure 2. The median follow-up period for surviving patients was 58 months (range: 14-108 months).

DISCUSSION

PE, while often regarded as a cosmetic concern, may have functional cardiopulmonary implications, especially in patients requiring cardiac surgery[4]. In this single-center retrospective study, we present our institutional experience with four patients who underwent simultaneous open-heart surgery and PE repair using the Nuss procedure. Our findings suggest that simultaneous repair using this approach is technically feasible and can be performed safely in selected patients, though further studies with larger cohorts are needed to confirm its generalizability. These results add to the growing body of literature supporting the combined correction of chest wall deformities and cardiac pathology in selected patients[7-10]. Surgical correction of PE after prior median sternotomy remains technically challenging due to retrosternal adhesions, distorted mediastinal anatomy, and potential cardiac injury during bar placement[5,6]. In a multi-institutional analysis of 77 patients with prior sternotomy undergoing the Nuss procedure, Jaroszewski et al.[6] reported intraoperative cardiac injury in 7% of cases, while also concluding that MIRPE can be performed safely in experienced centers—highlighting the importance of careful planning in reoperative settings[6]. In our cohort, MIRPE was performed concurrently with median sternotomy (i.e., without prior sternotomy), and no intraoperative complications related to bar passage were observed. Simultaneous correction of PE and cardiac pathologies during a single surgical session offers notable clinical and logistical advantages. Compared to staged procedures, this approach eliminates the need for a second general anesthesia, reduces the cumulative operative burden,

Table 1. Demographic, operative, and postoperative details of patients undergoing simultaneous pectus excavatum and cardiac surgery

Variable	Patient 1	Patient 2	Patient 3	Patient 4
Age (years)	20	21	78	29
Sex	Male	Male	Male	Male
PE symmetry	Symmetric	Symmetric	Asymmetric	Asymmetric
Associated anomaly	None	Scoliosis (op) + Marfan	None	None
Family history of PE	No	No	No	No
Haller index	6.8	16.6	3.8	4.5
Cardiac diagnosis	ASD	Aortic root dilatation	CAD	Mitral valve prolapse/ regurgitation
Cardiac procedure	ASD repair	David procedure (aortic root replacement)	CABG ×5	Mitral valve replacement
Number of pectus bars used	2 bars	2 bars	1 bar	1 bar
Operation time (min)	250	690	290	310
Intraoperative complications	None	None	None	None
Postoperative complications	None	Malignant arrhythmia (exitus POD2)	None	Pleural effusion (drained)
Hospital stay (days)	15	2 (exitus)	19	6
Follow-up (months)	108	-	25	14
Bar removal	Yes	-	Yes	No

PE: Pectus excavatum, ASD: Atrial septal defect, CAD: Coronary artery disease, CABG: Coronary artery bypass grafting, POD: Postoperative day

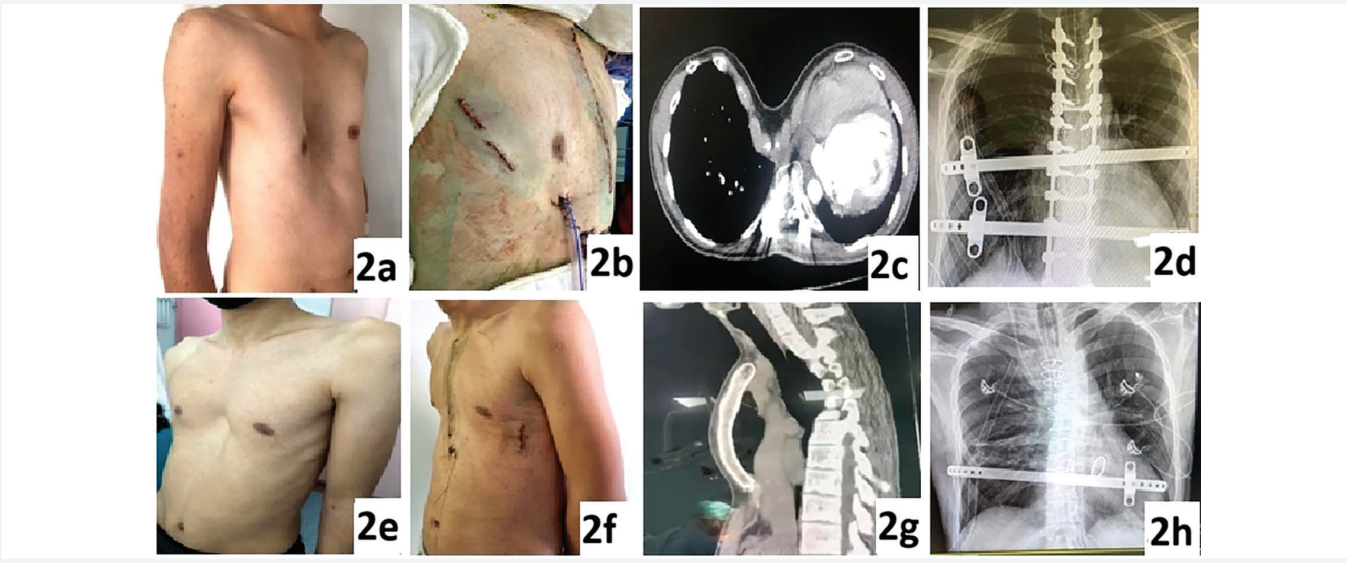

Figure 2. Representative images from two patients undergoing simultaneous cardiac surgery and MIRPE

2a, 2e: Preoperative clinical appearance, 2b, 2f: Postoperative clinical appearance, 2c, 2g: Preoperative chest CT, 2d, 2h: Postoperative chest X-rays showing bar position

MIRPE: Minimally invasive repair of pectus excavatum, CT: Computed tomography

and prevents the development of retrosternal adhesions that may complicate later pectus repair[7,8]. Additionally, performing the Nuss procedure in an untouched mediastinal plane provides optimal anatomical exposure and minimizes the risk of iatrogenic injury. These benefits are especially valuable in pediatric and young adult patients, in whom early repair may provide both cosmetic and cardiopulmonary improvements[7,8]. The feasibility and safety of such simultaneous interventions have been documented in various institutional series. Willekes et al.[11] reported a 26-year review including simultaneous intracardiac and chest wall deformity repairs, highlighting favorable outcomes in selected patients. Similarly, Javangula et al.[12] described successful correction of severe pectus deformity and aortic root pathology in a single-stage operation. In our series, simultaneous repair allowed optimal exposure for both procedures and eliminated the need for a second intervention, with no intraoperative complications observed. Bar preparation was performed while the cardiac procedure was ongoing, and the additional operative time attributable to bar placement and fixation was approximately 30 minutes. Thus, combining both procedures in a single session avoided reoperation and a second exposure to general anesthesia without increasing perioperative risk. One patient in our series died postoperatively due to complications related to the underlying cardiac condition, not the PE repair. During simultaneous cardiac surgery and pectus repair, care must be taken to avoid mechanical interference between the sternal wires and the pectus bar stabilizers. In our technique, bar fixation was synchronized with sternal closure, allowing for secure anchoring of both systems without complication. This approach eliminated the need for additional fixation methods such as supplemental sutures or bilateral stabilizers, thereby reducing hardware burden and operative complexity. Prior reports have similarly emphasized the importance of careful intraoperative planning in combined procedures to ensure structural integrity and minimize complications[8]. During a median follow-up of 58 months, no cases of sternal instability, bar displacement, or chronic pain were observed. Cosmetic outcomes were satisfactory in all surviving patients, with no residual chest wall deformity or functional limitation reported. Notably, the prolonged operative times observed in this cohort were primarily due to the complexity of the cardiac surgeries rather than the pectus repair itself, which typically requires approximately 60 minutes when performed in isolation. Based on our experience, simultaneous repair may be considered in carefully selected patients, particularly when the chest wall deformity is expected to cause persistent cardiopulmonary compromise despite successful cardiac surgery. This approach can optimize postoperative recovery by addressing both structural and functional issues in a single session.

Study Limitations

This study has several limitations. First, the small sample size and retrospective nature of the analysis limit the ability to draw definitive conclusions or perform statistical comparisons. Second, the absence of a control group precludes direct comparison with staged repair strategies. Additionally, this is a

single-center experience, and surgical expertise or institutional preferences may influence the reproducibility of the results in other settings.

CONCLUSION

Simultaneous correction of PE and cardiac pathology using the Nuss procedure during median sternotomy is technically feasible and safe, even in complex cases. This combined approach eliminates the need for a second surgery, reduces operative risk associated with retrosternal adhesions, and ensures optimal anatomical exposure. Our experience demonstrates that with appropriate planning and surgical coordination, favorable outcomes can be achieved without additional morbidity. These findings support the broader implementation of single-stage repair in selected patients undergoing open-heart surgery.

Ethics

Ethics Committee Approval: This study was approved by the Institutional Ethics Committee of Memorial Ataşehir Hospital (approval number: 2025/19, date: 13.08.025).

Informed Consent: This is retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Ç,Ç, Concept: M.A., Design: L.Ç.O., Data Collection or Processing: T.B., Analysis or Interpretation: Ç.Ç., L.Ç.O., Literature Search: Ç.Ç., L.Ç.O., Writing: Ç.Ç.

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

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