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ABSTRACT

Abstract – CWIG-2025

Prevalence of Pectus deformities in School going children of Delhi and National Capital Region: A Cross Sectional, Observational Study

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Background and Aim: Pectus deformities are the commonest anterior chest wall deformities. Most of the published literature on pectus deformities is from the western world and there is paucity of such literature form Low- and middle-income countries. There is no study from India on the prevalence and demography of pectus deformities in children. This study was performed to assess the prevalence and other relevant demographic parameters associated pectus deformities in school going children of Delhi, the capital of India, and adjacent National Capital Region (NCR). This information is crucial for optimizing healthcare strategies, improving patient outcomes, and contributing to global medical research.

Method: A Google form questionnaire seeking the basic details regarding chest wall deformities was developed and internally validated. The study was approved by the Ethics committee of the Institute. The Heads of schools were contacted personally and through e-mail. The questionnaire was distributed to the parents of school children of classes 1st to 12th standard through school-Enterprise Resource Planning Software (ERP), and e-mail. Submitted responses were analyzed to ascertain the prevalence of pectus deformities, age and gender distribution and association in family members. The affected children were offered management in the chest wall clinic of the Institute.

Results: 5943 children were approached. 5773 (97.1%) agreed to participate in the study. There were 3452 (59.8%) males. The mean age was 11.6 years (range 5-18 years). 238 (4.1%) children had chest wall deformity. 150 (63%) were males. The gender distribution was 1.7:1. Parents of 20 affected children (8.4%) had chest wall deformity. Other family members (excluding parents) of 14 children (5.9%) had some form of chest wall deformity. Pectus excavatum was reported as the commonest deformity in 126 patients (53%).

Conclusion: A significant number of children had chest wall deformities. Males were more commonly affected than females. Pectus excavatum was the predominant deformity.

Keywords: Pectus deformities, chest wall deformities, prevalence, epidemiology

DECENTRALIZED MINIMALLY INVASIVE PECTUS REPAIR IN GERMANY

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Background and Aim: Performing minimally-invasive repair of pectus excavatum (MIRPE) successful requires experience. This procedure is mostly done by pediatric or thoracic surgeons. In Germany, the situation of MIRPE is currently unknown. The aim of this study was to provide an overview of the current MIRPE situation in Germany, mainly regarding distribution of the hospitals and their caseload.

Method: Ethical approval has been obtained by the local ethics committee of the Hannover Medical School (11391-BO_K_2024). We analyzed health insurance claims data provided by the Verband der Ersatzkassen e.V. (VDEK) that comprises six health insurance companies and covers 34% of the German population. Departments were classified for pediatric or thoracic surgery and academic status was analyzed. Pseudomized data of all patients <18 years were extracted from January 2020 until December 2023.

Results: We identified 344 MIRPE cases between 2020 and 2023 that were performed in 60 hospitals. 75% of all cases were performed by pediatric surgeons. The caseload per hospital was just 1 – 3 in 61.7% of all hospitals, only 14 hospitals performed seven cases and more. 55% of all patients were 15 or 16 years old. During the hospital stay for MIRPE, 33 complications were encoded in 29 patients, mostly pneumothorax and pleural effusion. Readmission to the hospital was identified for 23 complications in 17 patients, including five revisions. Mostly non-academic hospitals seem to insert a chest tube during MIRPE as standard.

Conclusion: The situation of MIRPE in Germany is currently decentralized with many hospitals performing just very few cases. Further discussion is needed regarding centralization.

Keywords: centralization, complications, chest tube

Minimally invasive treatment of pectus excavatum: 25 years of experience in Beijing, China

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Background and Aim:

This study aims to summarize the 25-year clinical experience of applying minimally invasive surgery treatment of pectus excavatum (PE) in a single center and systematically evaluate its technological evolution and clinical value in Beijing.

Method:

A retrospective analysis was conducted on the data of 7200 patients with PE admitted from 2000 to 2025. Ten Nuss procedural variations were evaluated based on: incision count (single to four incisions); thoracoscopic assistance (non-thoracoscopy, posterior thoracoscopy, bilateral thoracoscopy, and full thoracoscopy); operative approach (traditional thoracic approach and the external pleural approach). The entry and exit points of the bar at are selected at the rib inflection points, and the bar and the ribs were fixed at multiple points through steel wires.

Results:

Two technical evolution trends emerged: incision count decreased from multiple to single/double incisions, and thoracoscopic assistance progressed from exploratory stages to mature bilateral/full thoracoscopy. Key findings included: the extrapleural approach theoretically reduced cardiopulmonary injury risks but exhibited intraoperative pleural rupture (62.9%) and increased internal mammary vessel injury risk, showing no significant advantage over conventional approaches; full/bilateral thoracoscopy significantly reduced lung compression injuries; and the two-incision technique achieved optimal balance between operative exposure and minimal invasiveness, becoming the mainstream choice. The bar displacement rate at the mature stage of surgical techniques is 0%.

Conclusion:

Thoracoscopy is very important for surgery, and the selection of entry and exit points and fixation methods is of great significance. Different types of pectus excavatum require single-bar or multi-bar techniques.

Keywords:

Chest wall deformity; Minimally invasive treatment

Analysis of Costosternal Angle Changes in Patients who Underwent Minimally Invasive Repair of Pectus Excavatum

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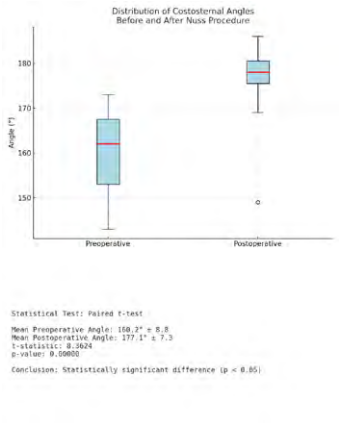
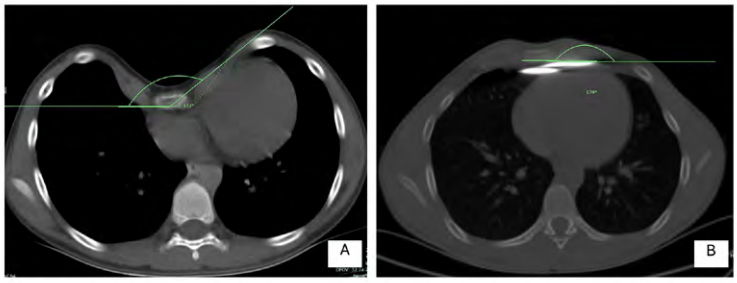
Background and Aim: The minimally invasive repair of pectus excavatum (MIRPE) is a well-established technique for correcting anterior chest wall depression. Change in costosternal angle ia a new criteria that we started using to evaluate the correction degree in excavatum patients. This study aims to evaluate changes in costosternal angles using pre-MIRPE and pre-bar removal chest computerized tomography (CT) images.

Methods: Between September 2018 and May 2025, 397 patients with pectus excavatum underwent MIRPE. 107 out of 397 patients were enrolled in this study and received pre-MIRPE and pre-bar removal chest CT. 23 out of 107 patients underwent bar removal surgery. Only costosternal angle measurements were analyzed. Radiological correction and aesthetic satisfaction were used as success criteria.

Results: The mean pre-MIRPE costosternal angle degree was 160.2° ± 8.8° and the mean pre-bar removal costosternal angle degree was 177.1° ± 7.3°. The difference was statistically significant (p=0.00001). Significant remodeling was observed in 22 of the 23 patients (95.6%).

Conclusion: This study highlights a notable increase in the costosternal angle following MIRPE. The average angle improvement from 160.2° to 177.1° reflects not only an aesthetic benefit but also a structural remodeling of the anterior chest wall. CT-based measurement of the costosternal angle may serve as an objective indicator of surgical success.





A. CT image showing pre-MIRPE costosternal angle B. CT image showing pre-bar removal costosternal angle

Keywords: Pectus excavatum, costosternal angle, chest CT

Anterior-Posterior Insufficiency of the Chest Wall in Patients with Pectus Excavatum

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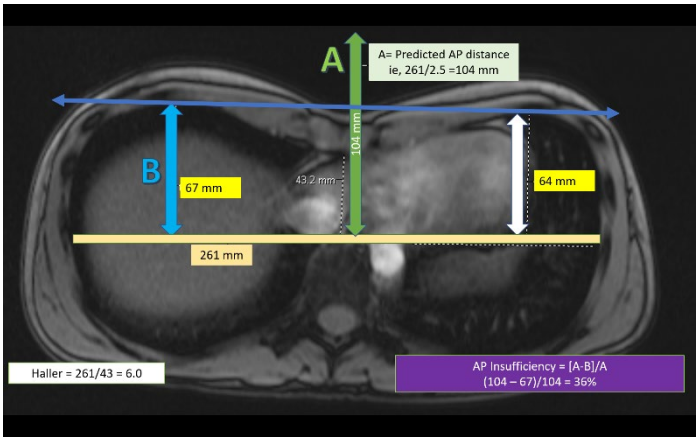
Background and Aim: The goal of Pectus Excavatum (PEx) repair is to attain normal chest anatomy and physiology with improvements in cardiopulmonary function and normal anatomic appearance. Many patients with PEx also have a narrow chest without sufficient anterior-posterior distance of any part of the chest. The purpose of this study is to quantitatively describe the frequency of anterior-posterior insufficiency (API) in patients with pectus excavatum.

Method: A retrospective analysis was done of 100 consecutive patients at a children's hospital with significant pectus excavatum (Haller >3.2) and 3-diminsional imaging of the chest. Anterior-posterior (AP) distance was measured from a line level with the anterior boney spine to the highest internal point of the anterior chest. This number was then subtracted from the expected distance anterior to the spine (based on width/2.5) and then divided by the expected height. ([A-B]/A (see figure)).

Results: When compared to an expected AP height (internal width/ 2.5), the AP measurements showed an insufficient distance of more than 20% in 45 (45%) of patients, and the AP distance was more than 30% deficient in 24 (24%) of severe pectus patients.

Conclusion: API is common in patients with severe PEx. The quantity of API needs to be considered when repairing PEx, as flat bars will result in continued API. With flat bars, 45% of patients will not reach the predicted mean AP distance and 24% will be more than 30% under the predicted values if bars are not appropriately constructed to lift the entire anterior chest wall.



HIGHER THAN EXPECTED PREVALENCE OF PECTUS DEFORMITIES IN NEWBORNS: A PROSPECTIVE OBSERVATIONAL STUDY

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Background and Aim:
Pectus excavatum and pectus carinatum are the most common congenital chest wall deformities, with an estimated prevalence of 1 in 300 to 400 live births. However, these figures are derived from observational assumptions rather than prospective neonatal screening. We aimed to investigate the true birth prevalence and clinical characteristics of pectus deformities through a structured neonatal screening program.

Method:
All live-born infants underwent routine physical examination, with additional assessment for chest wall abnormalities. Suspected cases were classified into pectus excavatum (PE), pectus carinatum (PC), or mixed deformities (both PE and PC). Deformity severity (mild, moderate, severe) was determined by inspection and ruler-based depth measurement (>1.5 cm for severe cases). Cardiac evaluations were performed in all cases via pediatric echocardiography. Data from the first 4 months (February–May 2025) are presented.

Results:
Among 960 live births, 57 newborns (5.93%) were diagnosed with chest wall deformities: 44 PE (77.1%), 8 PC (14%), and 5 mixed (8.77%). Of these, 27 were classified as mild (47.3%), 22 moderate (38.5%), and 8 severe (14%). Deformities were symmetric in 31 (54.3%) and asymmetric in 26 (45.6%) cases. Male predominance was observed (68.4%). Seventeen infants (29.8%) experienced respiratory problems requiring CPAP or intubation, most commonly in moderate-to-severe deformities. Cardiac anomalies were noted in 12 (21%) infants, including echogenic foci and right-to-left shunting PFOs.

Conclusion:
This is the first prospective study to report chest wall deformity prevalence at birth. Our preliminary results suggest that the actual prevalence is substantially higher than current textbook estimates. These findings may justify the incorporation of chest wall assessment into routine neonatal examination protocols.

Keywords:
Pectus excavatum, pectus carinatum, newborn screening, chest wall deformity, prevalence

Mechanisms of Posture-related Cardiovascular Compression in Pectus Excavatum Evaluated by Upright and Supine MDCT-Comparison with Healthy Subjects-

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Background and Aim:

We previously reported that thoracic anterior-posterior (AP) diameter shortens in the upright position and might cause cardiovascular compression in patients with pectus excavatum (PE). This study included more severe PE patients and healthy volunteers to investigate posture-related changes in thoracic and cardiovascular morphology.

Methods:

Upright and supine MDCT scans were analyzed in 23 preoperative PE patients (median age 22 years; 18 males, 5 females) and 35 healthy volunteers (50 years; 16 males, 19 females), including three severe PE patients with dyspnea in their upright position or on exertion. The minimum AP diameter, depression depth on horizontal sections, height of the right superior pulmonary vein (relative to the lowest edge of the sternum), and T6–T12 plumb line distance on sagittal sections were compared between positions.

Results:

In both groups, the minimum AP diameter was shorter in the upright than in the supine position (PE: 4.2 vs. 4.7 cm, $P<0.001$; volunteers: 8.8 vs. 9.2 cm, $P<0.001$). Changes in depression depth were within 0.1 cm in both groups, while the T6–T12 plumb line distance was longer in the upright position (PE: 2.3 vs. 0.8 cm; volunteers: 2.7 vs. 1.5 cm, $P<0.001$), indicating that anterior shift of lower thoracic vertebrae caused the AP diameter shortening. The height of the right superior pulmonary vein was lower in the upright position by 1.0 cm in both groups ($P<0.001$), suggesting cardiovascular descent. Two of the three severe PE patients showed right inferior pulmonary vein compression and the anterior vertebral shift. The remaining patient had the right superior pulmonary vein descend 1.9 cm to the more depressed level of the thorax and showed stenosis in the upright position.

Conclusions:

Two mechanisms, anterior vertebral shift with AP diameter shortening and cardiovascular descent, occurred regardless of PE but may cause cardiopulmonary compression in severe PE.

Keywords: Pectus excavatum, upright, posture-related changes, computed tomography

Echocardiographic Evaluation of Patients with Pectus Excavatum: A Retrospective Cohort Analysis

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Background and Aim: Pectus Excavatum (PE) is the most common congenital chest wall deformity and can cause extrinsic cardiac compression affecting the right heart chambers. Transthoracic echocardiography (TTE) is frequently used to evaluate cardiac morphology and function in these patients. This study aims to characterize the echocardiographic findings in a large cohort of individuals with PE undergoing chest wall repair.

Method: We performed a retrospective cohort analysis of patients who underwent PE repair between July 2017 and April 2024. TTEs were performed before surgery under the supervision of experienced cardiologists. All echocardiographic parameters were reported according to the American Society of Echocardiography guidelines.

Results: The cohort included 597 patients (61.6% male, median age 29.6 (range 13-69 years). Most patients had preserved left ventricular (LV) size and ejection fraction, although LV global longitudinal strain (GLS) was reduced (-15.8% ± 3.3).

Interventricular septal flattening was seen in 20.3% of cases. Structural distortion of the right ventricle (RV) was frequent (63%), with evidence of RV compression and altered flow in some cases. Positional imaging improved detection of dynamic RV compression in 13.4% of patients. The RV systolic function was mildly diminished (TAPSE 19.8 ± 4, S' wave 9.1 ± 2.7, RV-GLS -19.2% ± 6.3). Valvular heart disease was mostly mild or trivial. An increase in the length of the anterior mitral valve leaflet was detected in 65% of patients, and pericardial effusion was present in up to 15.2% of the cases.

Conclusion: In this cohort, the use of TTE identified only a minority of patients with functional alterations. The chronic cardiac adaptation to thoracic deformity likely hinders the identification of a single reliable echocardiographic parameter for patient assessment. Consequently, other patient evaluations, including exercise testing and transesophageal echocardiogram may be better suited to assess the true impact of PE on cardiac function.

Keywords: Pectus Excavatum – heart – transthoracic echocardiography

Why Some Chests Resist Elevation: The Roles of Age, BMI, and Titanic Index

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Background and Aim: Variations in thoracic flexibility have led to technical adaptations of minimally invasive repair of pectus excavatum (MIRPE), including hammocks and crossed bars. However, factors influencing chest wall rigidity remain poorly defined. This study aims to compare patients undergoing MIRPE in whom a dynamometer attached to a crane was used to quantify the force required for sternal elevation, and to identify variables associated with increased rigidity.

Methods: Since December 2023, patients undergoing MIRPE at our center were assessed with a dynamometer (Fig. 1) to measure the maximal force (in newtons, N—a unit of force) required to elevate the sternum without lifting the patient, used as a surrogate for chest wall rigidity. Patients were classified into a "Rigid Group" (RG) and a "Non-Rigid Group" (NG) based on a 164 N (75th percentile) cutoff and compared.

Results: Among 49 patients (mean age: 17.4 ± 6.0 years; 88% male), 12 were classified as RG and 37 as NG. Rigid Group patients were significantly older (22.2±7.4 vs 15.8 ± 4.5 years, p=0.001) and had higher BMI (21.0±2.5 vs 18.7±3.0 kg/m², p=0.018). No significant differences were found in Haller Index, Correction Index, or prevalence of banana sternum between the groups. The Titanic Index was significantly higher in RG (79.5 ± 12.0% vs. 66.1 ± 18.9%, p = 0.025).

Conclusion: Increased sternal elevation force was associated with older age, larger BMI, and higher Titanic Index. These patients may benefit from adjunctive techniques such as hammocks, additional bars, or hybrid surgical approaches.

Keywords: pectus excavatum, complications, MIRPE, sternal elevation

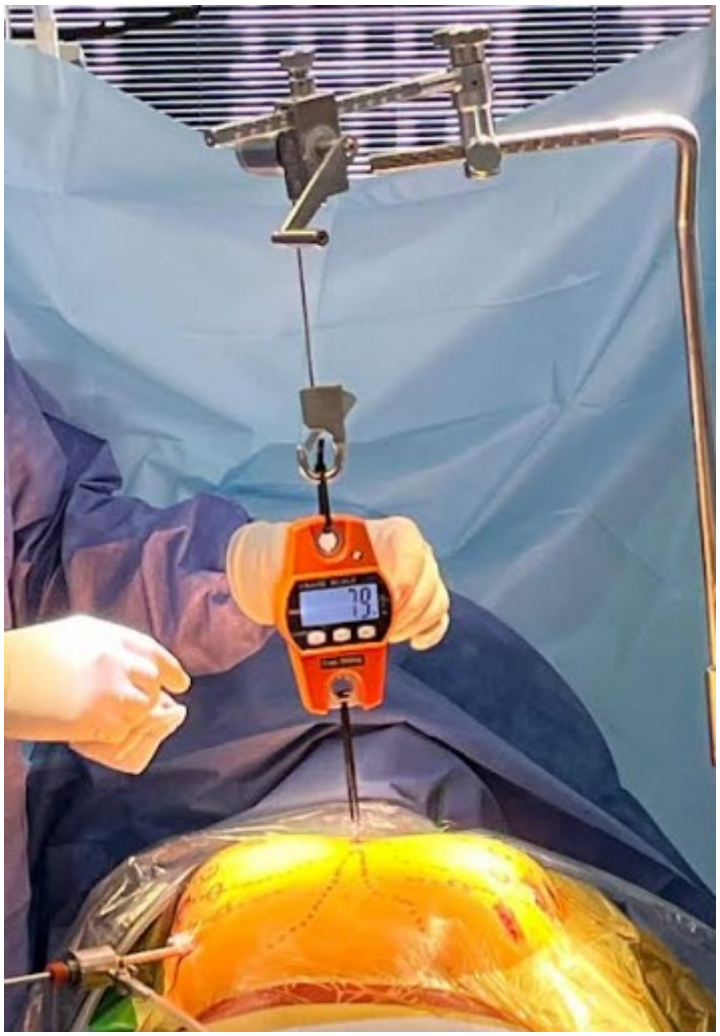

Fig 1. The figure illustrates the placement of the dynamometer between the sternal elevation device and the crane. The device registers a force of 7.9 kg (equivalent to 77.5 Newtons).

AS2-1 CW250057

Background and Aim: We performed our own version of sternocostal elevation (SCE) for the treatment of pectus excavatum (PE). Patient satisfaction with post-operative thorax shape is high. Limited data are available regarding changes in heart and lung volumes as surgical outcomes of PE. This study aimed to evaluate changes in cardiac and pulmonary volumes before and after SCE.

Methods: Of the 48 patients who underwent SCE for PE at our hospital from April 2022 to December 2023, 30 patients aged 16 years or older were included in the study. Cardiac and pulmonary volumes were measured using Ziostation 2® and Revorus® (Ziosoft Corporation) based on computed tomography scans taken pre-operatively and one month post-operatively. The cardiopulmonary (C/P) ratio was defined as the cardiac volume divided by the pulmonary volume. Pre- and post-operative values were compared using the Wilcoxon signed-rank test.

Results: The study included 25 male patients, with a mean age of 25.6 ± 9.8 years (range: 16–46). No significant difference in heart volume was observed (632.9 ± 96.8 vs 638.1 ± 102.3 ml, $p = 0.849$), while lung volume was significantly reduced after surgery (4266.5 ± 959.8 vs 3747.0 ± 759.9, $p < 0.0001$). Consequently, the C/P ratio increased significantly post-operatively (0.15 ± 0.03 vs 0.17 ± 0.04, $p < 0.001$).

Conclusion: The C/P ratio significantly increased one month after SCE, despite no significant change in heart volume, primarily due to a reduction in lung volume. Future studies will focus on evaluating the effects of our version of SCE on respiratory and cardiac function..

Measuring The Impact of Pectus Excavatum in Cardiopulmonary Function Using O2 Pulse as a Marker

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Background: Pectus excavatum impacts anatomically on the heart and the lung; however, the functional impact remains controversial. Cardiopulmonary exercise testing (CPET) can be and is often performed to assess functional impact in this patient population. Predicted peak oxygen uptake (VO2) has been used as a measure with variable results. We sought to evaluate the utility and association of O2 pulse as a cardiopulmonary marker of disease impact.

Methods: This is a single center retrospective study including patients diagnosed with pectus excavatum between 2017 and 2022. Patient demographics, symptoms, imaging, and cardiopulmonary function were evaluated.

Results: Of 678 patients who underwent CPET preoperatively, 441 were categorized into low <80% predicted (n=224) and normal >95% predicted (n=217) O2 pulse groupings. Patients were mean age 15.3 years, predominantly male (76%), white race (98%), and 594 (75%) were symptomatic. In univariate analysis, male patients, decreased lung capacity and severe pectus deformity (Haller and correction index) were related to worse O2 pulse measurements ($p<0.05$). There was no correlation with symptoms, age or race.

Conclusion: In patients with pectus excavatum, O2 pulse decreases with increased anatomical severity and pulmonary compromise. There is no correlation with cardiac function, age or race. O2 pulse might be another useful tool to assess cardiopulmonary function in patients with pectus excavatum. Further studies are warranted to assess the impact of repair.

Keywords: Pectus Excavatum, Cardiopulmonary Exercise Testing, Peak Oxygen Uptake, Cardiac Magnetic Resonance Imaging, Pulmonary Function Testing, Haller Index, Correction Index

Table 1. Demographic and Clinical Characteristics by O2 Pulse (Low, High) in patients with Pectus Excavatum.

	Low O2 pulse (<80%)	Normal O2 pulse (>95%)	p-value
N	224	217	
Age (years), mean (SD)	15.7 (3.74)	15.4 (4.64)	0.43
Age < 18 years, % (n)	82.6% (185)	84.8% (184)	0.53
Male, % (n)	89.7% (201)	63.1% (137)	<0.001
White race, % (n)	99.1% (222)	97.7% (212)	0.28
Haller, median (Q1, Q3)	4.9 (3.9, 6.7)	4.5 (4.0, 5.4)	0.018
Depression, mean (SD)	0.68 (0.34)	0.67 (0.51)	0.83
Correction, mean (SD)	35.1 (16.81)	30.9 (14.44)	0.005
CCI, mean (SD)	2.89 (1.46)	2.84 (1.24)	0.67
Sternal Torsion, mean (SD)	13.5 (10.54)	13.0 (9.73)	0.60
RVEF, mean (SD)	53.6 (4.97)	53.9 (4.54)	0.55
RVEF z-score, mean (SD)	-1.75 (1.74)	-1.73 (1.05)	0.89
LVEF, mean (SD)	58.9 (4.41)	58.3 (3.92)	0.16
LVEF z-score, mean (SD)	-1.08 (0.94)	-1.17 (0.80)	0.33
FEV1, mean (SD)	89.0 (12.34)	95.8 (12.65)	<0.001
FVC, mean (SD)	89.3 (12.78)	97.6 (12.86)	<0.001
FEV1/FVC, mean (SD)	90.3 (11.21)	88.1 (9.76)	0.030
TLC, mean (SD)	98.7 (12.68)	101.4 (14.11)	0.044

CCI (Calculated Correction Index), RVEF (Right ventricle ejection fraction), LVEF (left ventricle ejection fraction), FEV1 (Forced expiratory volume in 1 second), FVC (functional vital capacity), TLC (Total lung capacity).

Assessment of Right Ventricular Function in Pediatric Pectus Excavatum Using Real-Time Three-Dimensional and Speckle-Tracking Echocardiography

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Background and Aim: This study aimed to evaluate the clinical utility of real-time three-dimensional echocardiography (RT3DE) and speckle-tracking echocardiography (STE) in assessing right ventricular (RV) dysfunction in children with pectus excavatum.

Method: A retrospective analysis was conducted on 68 children (mean age: 13.1 ± 2.3 years; 79.4% male) who underwent minimally invasive surgical repair for pectus excavatum at Beijing Children's Hospital between July 2024 and February 2025. Clinical characteristics and imaging data were collected. Based on the Haller index (HI), patients were divided into two groups: mild-to-moderate (HI < 3.5, n = 17) and severe (HI ≥ 3.5, n = 51). RT3DE was used to measure right ventricular ejection fraction (RVEF), end-diastolic volume index (RVEDVI), end-systolic volume index (RVESVI), tricuspid annular plane systolic excursion (TAPSE), and RV longitudinal diameter (RV Ld). STE was applied to assess global longitudinal strain (GLS) of the RV and regional segmental strains. Differences in RT3DE and STE parameters between the two groups were compared.

Results: Among the 68 patients, the mean Haller index was 4.0 ± 0.8. The RVEF was reduced in both groups [35.50 (32.25–48.70)% vs. 41.50 (36.50–47.30)%, p = 0.492], with no significant intergroup difference. Compared with the mild-to-moderate group, the severe group showed a significantly larger RV longitudinal diameter (65.1 ± 11.2 mm vs. 56.8 ± 11.9 mm, p = 0.011), and significantly lower RV global longitudinal strain [−20.0 (−23.0 to −17.0)% vs. −23.0 (−25.0 to −20.2)%, p = 0.014] and RV free wall strain [−21.5 (−25.0 to −18.0)% vs. −25.0 (−28.0 to −21.7)%, p = 0.022].

Conclusion: Severe deformity was associated with more pronounced impairment in both global and regional myocardial deformation. RT3DE combined with STE provides a sensitive, noninvasive method for early detection of RV dysfunction and may serve as a valuable tool for preoperative evaluation and clinical decision-making in patients with pectus excavatum.

Keywords: Pectus excavatum; Right ventricular function; Real-time three-dimensional echocardiography; Speckle-tracking echocardiography

Cardiopulmonary characteristics of young pectus excavatum patients with lower versus higher exercise performance

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Background and Aim:

Pectus excavatum (PE) is a common chest wall abnormality often characterized by right heart compression by the sternum, possibly affecting cardiopulmonary function and exercise tolerance. This study sought to evaluate associations between cardiac MRI (CMR) parameters and exercise performance on cardiopulmonary exercise testing (CPET).

Methods:

A single-center, IRB-approved, retrospective review of 62 young PE patients (8-20yrs; mean 15.6yrs) was performed. CPET measurements included O2 pulse (surrogate for LV stroke volume) and VO2max. Two subgroups (high and low exercise performance) were selected, with 14 patients (64%) in the lower performance subgroup and 8 (36%) in the higher. Percent predicted VO2max and O2 pulse of >80% defined higher performance; ≤ 60% defined lower performance. Haller Index (HI), Correction Index (CI), Cardiac Compression Index (CCI), Sternal Torsion Angle (STA), cardiac axis (CA), IVC/RA junction compression, and biventricular volumes/function were obtained by CMR.

Results:
The cohort was 11 Hispanic (50%), 6 White (27%), 2 Asian (9%), and 3 Other (14%); a majority were male (86%). There were no differences in expiratory HI (8.1 vs. 6.1,p=0.29), inspiratory HI (5.3 vs. 4.4,p=0.30), CI (45.3% vs. 32.5%,p=0.11), CCI (3.68 vs. 3.34,p=0.50), CA (22.7 vs. 26.7 degrees,p=0.43), Sternal Torsion Angle (17.2 vs. 17.8degrees,p=0.89), or sternal tilt direction between the groups. The lower performance group tended to have more IVC/RA junction compression on CMR [7 (50%) vs. 1 (13%),p=0.079)]. Indexed RV end-systolic volume was greater

in the higher performance group (45.3 vs. 35.9 mL/m2,p=0.04), with a trend towards lower RV ejection fraction (51% vs. 55%,p=0.08).

Conclusions:
Widely-used and novel CMR-derived chest wall and cardiac measurements did not discriminate between level of exercise performance in our cohort. IVC/RA junction compression may be associated with worse exercise capacity. Higher exercise performance may mask subtle RV dysfunction. Larger studies are needed.

Keywords: Pectus excavatum, cardiac MRI, cardiopulmonary exercise test

The Nuss Procedure Improves Ventilatory Efficiency: A Retrospective Evaluation of a Japanese Cohort Using Cardiopulmonary Exercise Testing

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[1] Department of Pediatric Surgery, Osaka Metropolitan University Graduate school of Medicine, [2] Chest wall Center, Nishinomiya Watanabe CardioVascular Center

Background and Aim:

Individuals with pectus excavatum frequently report subjective symptoms, including dyspnea and chest discomfort. While these manifestations often ameliorate postoperatively, the direct effects of surgical intervention on exercise-induced respiratory function remain inadequately characterized. To address this gap, we conducted cardiopulmonary exercise testing both preoperatively and following bar removal to assess the influence of the Nuss procedure on exercise-related pulmonary performance.

Method:

This retrospective cohort study encompassed individuals aged 15 years and older who underwent the Nuss procedure for pectus excavatum at the Nishinomiya Watanabe Cardiovascular Center between April 1, 2020, and April 1, 2025. Cardiopulmonary exercise testing was conducted on these patients both preoperatively the Nuss procedure and postoperatively, the subsequent bar removal. Each test was performed under the supervision of a qualified physician, with individualized exercise protocols tailored to the patient's baseline functional capacity.

Results:

Postoperatively, at maximal exertion, no significant changes were observed in oxygen consumption, exercise capacity and minute ventilation. However, substantial increases were noted in average tidal volume. At the anaerobic threshold, the exercise capacity, minute ventilation and tidal volume increased substantially, while the respiratory rate decreased. Oxygen consumption during exercise is predominantly attributable to the lower limb and respiratory muscles. The observation that oxygen consumption at the anaerobic threshold remains unchanged despite increasing exercise intensity suggests that the increased oxygen demand in the lower limbs is offset by a corresponding reduction in oxygen consumption by other physiological

systems, such as those involved in ventilation and circulation.

Conclusion:

The Nuss procedure for pectus excavatum has been associated with enhanced ventilatory efficiency during exercise, a change that probably correlates with the alleviation of respiratory symptoms postoperatively.

Keywords:

Pectus excavatum, Cardiopulmonary exercise test, pulmonary function

Minimally invasive approach for rib fractures: a multi center 10 year experience, Feasibility and Safety

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Affiliations and authors roles: [1] Consultant Thoracic Surgeon Hospital Español, Consultant Thoracic Surgeon ABC Medical Centre . [2] Medical research from thoracic surgery. [3] Thoracic surgery resident ISSEMYM medical centre

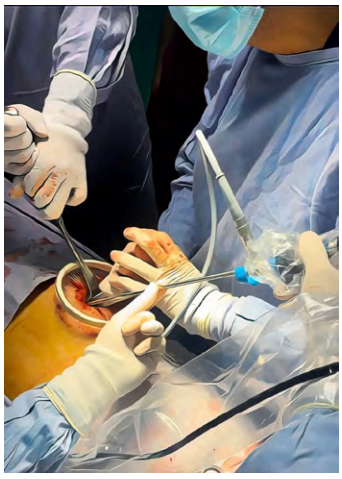
Background and Aim: At present the search for treatments by minimum invasion have shown benefits in the recovery of the patient as well as in the management of post-surgical pain. Surgical procedures worldwide seek to resolve in a minimally invasive way the pathology related to the thorax. The objective of the presentation is to describe the technique of rib fixation by minimum invasion (MARF Technique) and results .

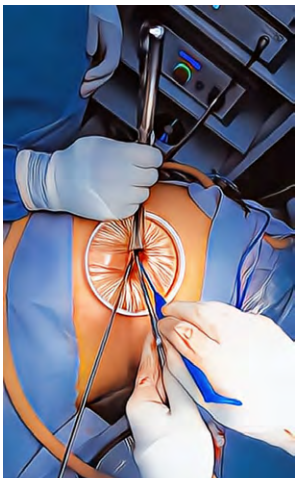
Method: We present the experience on the technique in minimally invasive rib fixation (MARF technique) from 2015 to 2025 performed in 4 hospital centers, with analysis of gender, age, number of rib fractures, days of hospital stay, days of pleural drainage, type of anesthesia and complications as well as a description of the technique. A review of a series of cases is presented in a retrospective, descriptive manner over a period of 10 years

Results: All medical records of patients in which ribs were fixed in a period of time from 2015 to 2025 were reviewed, finding 315 cases performed in 4 hospital centers in Mexico (State of Mexico, Mexico City), with analysis of gender, age, number of rib fractures, days of hospital stay, days of pleural drainage, type of anesthesia and complications as well as a description of the technique

Conclusion: The minimally invasive rib fixation (MARF technique) still a choice technique to reduce postoperative complications and reduce days of hospital stay, after the review carried out this technique is safe and a pioneer technique of chest surgery even in elderly patients.

Keywords:minimal invasive approach, thoracic surgery, rib fixation.





NDAYSASH

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<12 HRS	4	1.3	1.3	1.3
	24 HRS	45	14.3	14.3	15.6
	48 HRS	178	56.5	56.5	72.1
	3-5 DAYS	49	15.6	15.6	87.6

AnesthesiaType

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Intubated	236	74.9	74.9	74.9
	Non Intubated	79	25.1	25.1	100.0
	Total	315	100.0	100.0	

Timing of Surgical Rib Fixation and Its Impact on Clinical Outcomes: A Retrospective Analysis

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Background and Aim: Surgical rib fixation (SRF) has emerged as an effective treatment modality for selected patients with rib fractures, especially in cases involving multiple fractures or flail chest. However, the optimal timing of surgical intervention remains controversial. This study aimed to investigate the relationship between the timing of SRF and postoperative outcomes including length of hospital stay, complications, and pain levels.

Method: This retrospective single-center study analyzed 112 patients who underwent surgical rib fixation between May 2024 and May 2025. Demographic characteristics, comorbidities, trauma-related parameters, fracture characteristics (number, location), surgical timing (early ≤3 days vs. late >3 days), preoperative pain scores (VAS), and outcomes including complications and hospital stay were collected. Statistical analyses included Mann–Whitney U, Chi-square, and Spearman correlation tests.

Results: The median age was 60 years (IQR: 47.75–69.00), and 78.6% of patients were male. Median length of stay was 6 days. Postoperative pain was significantly reduced (median VAS 6.0 → 3.0, $p<0.001$). Female patients had a significantly higher 90-day mortality rate than males (29.2% vs. 10.2%, $p=0.042$). The presence of pneumothorax was significantly associated with 90-day mortality ($p=0.0478$). Clavicle fracture was the only associated injury that significantly increased preoperative pain ($p=0.001$). Rib fracture count was positively correlated with pain score reduction ($\rho=0.215$, $p=0.023$). Length of hospital stay was significantly associated with the number of fractured ribs ($r=0.248$, $p=0.008$) and preoperative pain scores ($r=0.264$, $p=0.005$). Age, timing of surgery, comorbidities, and associated injuries did not significantly affect hospital stay.

Conclusion: Surgical stabilization effectively reduces postoperative pain in patients with rib fractures. Certain clinical variables such as pneumothorax, female gender, and higher preoperative pain scores are associated with worse outcomes. These findings may help in risk stratification and postoperative management planning.

Keywords: Rib fracture, surgical stabilization, pain score, mortality, trauma, complication

Modified sternal wiring technique for closing clamshell incision in lung transplantation patients in Costa Rica.

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Background and Aim: Clamshell incision has been the standard access for lung transplantation, but it is associated with a high rate of sternal complications (8% to 46%), such as sternal dehiscence, chronic pain, and pseudoarthrosis[1,2]. Risk factors of sternal dehiscence include diabetes, chronic use of steroids, immunosuppression, obesity, heavy smoking, poor nutrition, osteoporosis, and reintervention[4,5]. Although there are multiple closure techniques, many of them are very expensive and are not available in our public health system [3,5,6,7]. In response to the high rate of sternal complications in our center, we hypothesized that a beveled cut in the sternum and three steel wires (central figure-of-eight with two longer lateral wires) could enhance stability and prevent sternal dehiscence[8].

Method: The transverse sternotomy was performed with a beveled cut in the superior edge of the sternum, and closing the defect using three stainless-steel wires, one figure-of-eight central wire for stability, with two longer lateral wires to minimize tension on the repair (Figure 1).

The closure was evaluated retrospectively at Hospital Dr. Rafael Angel Calderón Guardia using chest CT or lateral chest radiographs to assess adequate sternal alignment 6 months postoperatively and classified as normal, partial displacement, and total dehiscence (Figure 2).

Results: The first 5 cases were performed with our modified closure technique. 80% of the patients did not have a sternal complication; only one of them had an asymptomatic partial sternal displacement due to lateral wire rupture.

Conclusion: This modified technique for closing clamshell incision in lung transplantation patients has shown promising results in terms of sternal stability and prevention of sternal dehiscence, is easy to perform, with a low cost in a public health system.

Keywords: Sternal dehiscence, clamshell incision, lung transplantation.

Figure 1. Modified clamshell closure with 3 steel wires

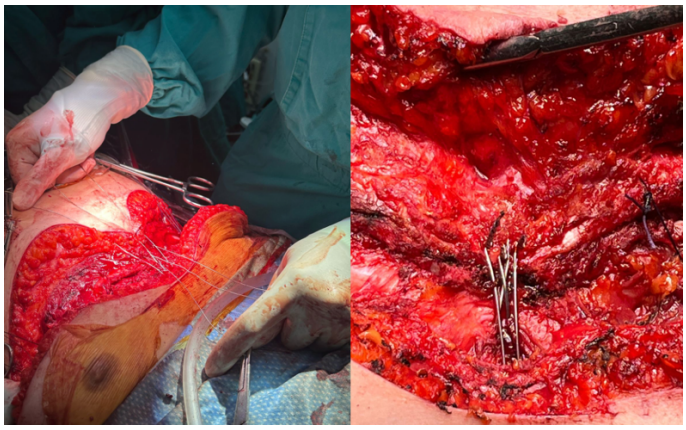
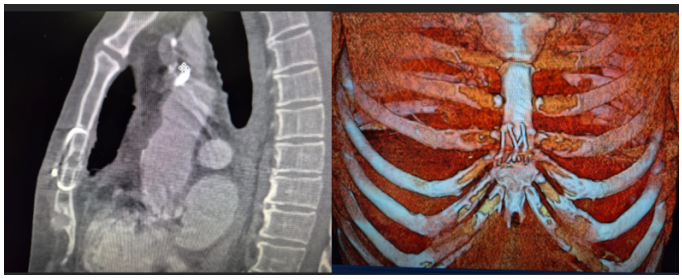


Figure 2. Sternal alignment evaluated in chest CT



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Myopericytoma of the Sternum A Rare Pediatric Case Report and Literature Review

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Background and Aim: Myopericytoma is a rare soft tissue tumor arising from perivascular myoid cells, previously classified as a variant of hemangiopericytoma. It typically presents in the superficial or subcutaneous tissues of the distal extremities. Occurrence in the chest wall, especially involving the sternum, is exceedingly rare. Here, we report a rare pediatric case of myopericytoma arising from the sternum, with a review of the literature to improve clinical recognition of this entity.

Case Presentation: A 15-year-old boy presented with a slowly enlarging anterior chest wall mass over two years, with rapid progression in the past six months. The lesion was firm, immobile, hemispherical, and mildly painful. Contrast-enhanced CT revealed an expansile, irregular lesion in the sternum with surrounding soft tissue thickening and heterogeneous enhancement. Core needle biopsy was suggestive of myopericytoma. The patient underwent complete surgical excision of the tumor and anterior chest wall reconstruction with a titanium mesh prosthesis. Intraoperatively, the tumor was found to involve the manubrium, sternal body, bilateral sternoclavicular joints, and adjacent musculature. Postoperative pathology confirmed the diagnosis of myopericytoma. The patient showed no signs of recurrence at six-month follow-up.

Conclusion: Sternal myopericytoma is extremely rare, particularly in the pediatric population. Accurate diagnosis requires correlation of imaging, histopathological, and immunohistochemical findings. Although typically benign, complete surgical resection is necessary to prevent recurrence.

Keywords: Myopericytoma; sternum; pediatric; chest wall tumor; case report; soft tissue neoplasm

Time Heals: The Impact of Waiting Times on Pediatric Patients' Decisions to Decline Pectus Surgery

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Background and Aim: This study investigates the impact of waiting times on patients' decisions to undergo surgery for pectus deformities.

Method: We conducted a cross-sectional study of patients (>18 years) on the waitlist for pectus surgery at the Amsterdam Pectus Centre. Patients were contacted in January 2025. Primary outcome was the proportion of patients still wanting surgery. Secondary outcomes included symptom progression, reasons and predictive factors for withdrawal (Ravitch surgery, age at waitlist entry, male sex, physical and psychosocial symptoms at waitlist entry). Predictive factors were analyzed using multivariable logistic regression.

Results: Of 141 contacted patients, 75.9% (107/141) were included. Age at waitlist entry was 16.0 years (IQR 15.0-17.0). After an average wait of 56.6 months (SD 22.2), only 52.3% (23/44) of pectus excavatum, 30.9% (17/55) of pectus carinatum/arcuatum and 37.5% (3/8) of flaring patients still wanted surgery. Reasons for withdrawal differed: pectus excavatum patients most often cited body acceptance, while pectus carinatum/arcuatum patients more frequently mentioned strength training. Patients who withdrew showed greater reductions in physical (69.6% versus 25.9%, P=.002) and psychosocial symptoms (95.2% versus 53.8%, P=.004) than patients still wanting surgery. Thirteen patients were treated conservatively while awaiting surgery, with a 35.5% success rate. Age (OR=.53, 95%-CI=.33-.86, P=.01) and physical symptoms (OR=.37, 95%-CI=.15-.94, P=.04) at waitlist entry were predictors of withdrawal from surgery.

Conclusion: After an extended waiting time, 59.8% of all patients withdrew from surgery, primarily due to body acceptance and physical development. Psychological counseling and strength training should be integrated into pectus care, particularly for young, asymptomatic patients.

Keywords: Waitlist, Nuss procedure, Ravitch surgery, Body Acceptance, COVID-19

Compression of ChatGPT-4o and Gemini 1.5 answers to questions about pectus treatment from the patient perspective

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Background and Aim:

This article aims to evaluate the quality of responses provided by AI systems ChatGPT-4o and Gemini 1.5 to frequently asked patient questions regarding pectus deformity.

Method:

In this cross-sectional survey study, 36 frequently asked questions about pectus surgery were posed using a new Google account with no search history. Responses from ChatGPT-4o and Gemini 1.5 were rated by 10 pectus surgeons for relevance, accuracy, clarity, and completeness using a 1–5 scale. The intraclass correlation coefficient (ICC) was used to analyze interrater reliability (IRR).

Results:

Average scores for relevance were 4.79 (ChatGPT-4o) and 4.86 (Gemini 1.5); accuracy: 4.59 and 4.64; clarity: 4.61 and 4.75; completeness: 4.64 and 4.71, respectively. No statistically significant differences were found between models across these dimensions. ICC values for ChatGPT-4o were low (0.009–0.036) and similarly low for Gemini 1.5 (0.024–0.034), indicating poor interrater agreement. These findings suggest high performance in content delivery but limitations in consistency among raters.

Conclusion:

AI applications like ChatGPT-4o and Gemini 1.5 show promise in patient education about pectus surgery. However, they cannot replace professional consultation, and patients should always seek confirmation from healthcare providers.

Keywords: Pectus Deformity, Artificial Intelligence, Surgical Consultation

Table 1: Inter-rater reliability (ICC) for ChatGPT-4o and Gemini 1.5

Model	Criterion	ICC	95% CI	p-Value
ChatGPT-4o	Relevance	0.024	-0.027–0.114	0.199
ChatGPT-4o	Accuracy	0.009	-0.023–0.067	0.308
ChatGPT-4o	Clarity	0.036	-0.010–0.118	0.071
ChatGPT-4o	Completeness	0.009	-0.033–0.036	0.669
Gemini 1.5	Relevance	0.034	-0.008–0.108	0.056
Gemini 1.5	Accuracy	0.027	-0.011–0.095	0.093
Gemini 1.5	Clarity	0.029	-0.008–0.096	0.069
Gemini 1.5	Completeness	0.024	-0.016–0.096	0.142

Psychosocial Determinants of Health-Related Quality of Life in Children with Chest Wall Deformities: A Mediation Analysis

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Background and Aim: Chest wall deformities can negatively affect pediatric patients through both cardiopulmonary compression and altered physical appearance, with persistent consequences throughout development. Patient-reported health-related quality of life (HRQOL) is a key indicator in evaluating disease burden. Existing studies on HRQOL in children with chest wall deformities primarily rely on various psychometric instruments, each emphasizing different psychosocial domains. To assess HRQOL in children with chest wall deformities and to explore the psychosocial and family-related risk factors that influence their quality of life.

Methods: This single-center cohort study included pediatric patients with chest wall deformities admitted to Beijing Children's Hospital between September 2024 and February 2025. Prior to treatment, HRQOL was assessed using the Pediatric Quality of Life Inventory (PedsQL). Additional evaluations included the Children's Self-Consciousness Scale, Child Behavior Checklist, Family Functioning Assessment, Children's Depression Inventory (CDI), and Social Anxiety Scale for Children. Demographic characteristics, clinical features, and psychological assessments were recorded. A parallel mediation model was constructed, using family functioning as the independent variable, HRQOL as the dependent variable, and depression and social anxiety as mediators. Gender, age, Haller index, and BMI were included as covariates.

Results: A total of 61 children were enrolled, with a mean age of 13.51 years; 80.3% were male. Among them, 57 had pectus excavatum and 4 had pectus carinatum. HRQOL scores were lower in the domains of academic functioning, activity opportunities, and physical competence. Family functioning showed a significant total effect on HRQOL ($\beta = -0.455$) and was identified as a key influencing factor. This effect was mediated primarily through depression, accounting for approximately 92% of the total effect. Social anxiety did not play a significant mediating role.

Conclusions: Patient-reported HRQOL is a critical consideration in the evaluation and treatment of pediatric chest wall deformities. Pre-treatment psychological assessment may inform clinical decision-making. Impaired family functioning has a significant negative impact on HRQOL, primarily mediated by depressive symptoms in affected children. Interventions aimed at improving family dynamics and addressing depression may enhance overall quality of life in this population.

Key word: Chest wall deformities, Health-related quality of life, Family functioning

Establishing a Regional Screening Program for Pectus Deformities in Primary School Students: Preliminary Results

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[1] Marmara University Department of Thoracic Surgery, [2] Marmara University Department of Family Medicine, [3] Turkish Pectus Society, [4] Marmara University Department of Pediatric Pulmonology [5] Marmara University Department of Pediatric Cardiology

Background and Aim: The real prevalence of pectus deformities (PD) are not well-documented up to date. The prevalence of pectus varied from 0.4% to 1.4%. This study aimed to present the preliminary results of establishing a screening program for PD in the Primary School students (PSS) in Pendik County, Istanbul.

Method: We implemented the Marmara Pectus Screening Program (PectoMar) into Family Medicine National Screening program in PSS in Pendik County. Children with suspected PD were referred to Marmara University Thoracic Surgery outpatient clinic. All patients were examined and referred to pediatric cardiology and pulmonology if needed.

Results: Out of 53242 primary school students, 10342 were screened between December 2024–June 2025. 224 (2.17%) PD were identified. The mean age was 8,6 ±3,13 (5 mo, 18 yo). 64 patients were female (28,5%) and 160 were male (71,4%). Among them; 200 (90%) were PE while 24 (10%) were PC. Among PE patients; vacuum bell treatment recommended for 143, follow-up for 50 and surgery for 7 patients. For PC patients; 19 patients (79.2%) were treated with compressive external bracing while 5 (20.8%) were followed-up according to pectus surveillance program. 22 patients (10 %) have a positive family history for PD. 14 patients (6.25%) have accompanying comorbidities. 15 (7%) patients were referred to pediatric pulmonology and no abnormality detected on PFTs. 14 (6%) patients were referred to pediatric cardiology and only one patient needed holter monitoring due to sinus tachycardia.

Conclusion: Although it is important to identify true prevalence of pectus deformities, establishment of a screening program is also crucial for raising awareness and detecting patients at early ages for nonsurgical treatment and better outcomes. It also provides a structured notion for the families in order to minimize negative impact of social and psychological burden of deformity on kids and their parents.
Keywords: Chest wall deformity, pectus excavatum, pectus carinatum, screening

Table 1 Patient Demographics and Characteristics

Number of children screened	10342
Number of patients	224 (2,17%)
Age (year)	8,6±3,13 (5 months, 18 years)
Sex	
Female	64 (28,5%)
Male	160 (71,4%)
Deformity type and recommended treatment	
Pectus Excavatum	200 (90%)
Follow-up	50 (25%)
Vacuum bell	143 (71%)
Surgery	7 (0,3%)
Pectus Carinatum	24 (10%)
Follow-up	5 (20,8%)
Compressive external bracing	19 (79,2%)
Presence of family history of chest wall deformity	22 (10%)
Accompanying comorbities (asthma, immune defficiency, aortic stenosis, aort coarctation, ADHD, epilepsy, omphalocele)	14 (%6,25)

Investigation of Thoracic Deformities Associated with Bifid Ribs in Pediatric Patients

Gunma children's Medical Center : Yoshie Sasaki , Kei Nakano , Akito Hamajima

Background and Aim:

Bifid ribs are a rare congenital rib anomaly, usually asymptomatic and incidentally detected. This study aimed to investigate the characteristics and treatment outcomes of thoracic deformities associated with bifid ribs.

Method:

A retrospective review was conducted on eight patients diagnosed with bifid ribs and thoracic deformity at our institution using chest X-ray and three-dimensional computed tomography (3D-CT). Patient demographics, rib morphology, deformity type, and treatment outcomes were analyzed.

Results:

Patients ranged in age from 2 to 14 years at initial visit; there were five boys and three girls. Bifid ribs occurred more frequently on the left side (5 cases) than the right (3 cases), with the fourth rib most commonly affected (4 cases), followed by the fifth (3 cases) and sixth (1 case). Thoracic protrusion was observed in five patients, and depression in three. Localized protrusion at the bifid rib site was noted in four cases. Global thoracic deformities included two cases of pectus carinatum and three cases of pectus excavatum. Management was based on severity: four cases with localized protrusion were observed without intervention; one pectus carinatum case received bracing; three pectus excavatum cases underwent the Nuss procedure at ages 13, 14, and 16, each with two titanium bars inserted. Postoperative outcomes were favorable without major complications. While chest X-rays detected rib bifurcation, cartilage morphology could not be assessed; 3D-CT provided detailed evaluation of both bone and cartilage branching. Among eight cases, three showed cartilage bifurcation directly attached to the sternum, while five showed fusion before sternal attachment.

Conclusion:

3D-CT is valuable for accurate diagnosis and surgical planning in bifid ribs with thoracic deformity. The Nuss procedure was effective and safe for pectus excavatum even in the presence of bifid ribs.

Keywords:

Bifid rib; Thoracic deformity; Pectus excavatum; 3D-CT; Nuss procedure

Analysis of clinical characteristics regarding Nuss procedure after congenital heart surgery with median sternotomy

Background:
Median sternotomy (MS) with congenital heart surgery (CHS) in childfood occasionally tend to cause pectus excavatum (PE). Nuss procedure (Nuss) for these patents with PE is thought to be difficult, because of detachment between sternum and mediastinum. The aim of this study was to analyze the clinical characteristics and to demonstrate the feasibility and safety of Nuss after MS with CHS.
Methods:
From 2009 to 2024, forty-eight patients were underwent Nuss in our department. According to the electronic medical records, various clinical data were investigated retrospectively. Results:
We included five patients after MS with CHS in this study, from 8 to 21 years old, with four boys and one girl. CHS were classified in two ASD, two DORV and one HLHS cases. The number of MS were three times in one, twice in one and once in three patients. The period since last sternotomy were 3 to 21 years. Two patients had symptoms such as chest tightness. All were symmetric PE, and Haller Index were 3.84-10.73 (median 5.29). Thoracoscopic dissection of adhesions was performed in all cases, 2 patients were needed additional partial MS due to severe adhesion between sternum and anterior mediastinum. To improve the surgical field of vision, selective lung ventilation (all cases), elevation of rib or sternum (all cases), artificial pheumothorax (two cases) were performed. Operative time were 82-523 minutes (median 361 min), and blood loss were 3-130 ml (median 36 ml). Postoperative bar rotation in one case was required reoperation. Hospitalization period were 7-26 days (median 15 days). Postoperative thoracic morphology was achieved good in all, and preoperative symptoms were disappeared in the two cases.
Conclusions:
Conditons after MS with CHS is by no means a contraindication for Nuss. It could be performed safely with adequate preparation and appropriate approach depending on the adhesion.

Nuss procedure with retrosternal incision

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Background and Aim:
The Nuss procedure may not be sufficient to correct severe sternal depression in certain cases. To achieve better correction, we attempted to incise the dorsal side of the sternum from within the thoracic cavity.

Case:
A 13-year-old boy with pectus excavatum, who has a moderate right-sided depression measuring 15 x 14 x 2 cm, underwent the Nuss procedure. A 5 mm port was placed in the right fourth intercostal space along the anterior axillary line, and a thoracoscope was inserted under artificial pneumothorax. A small incision was made at the right fifth costal cartilage, which represented the most depressed point, and a hook was inserted to elevate the sternum. An oblique skin incision measuring 4.5 cm was made on both sides of the chest. Using electrocautery through the 5 mm ports placed in the lateral incisions, the anterior mediastinum was dissected, and the most protruding portions of the third to seventh costal cartilages on both sides were incised. An additional incision was made on the posterior aspect of the sternum at the level of the third costal cartilage. This retrosternal incision improved the curvature of the sternum. Bars were inserted into the fourth, fifth, and sixth intercostal spaces, and stabilizers were attached. The shape of the thorax was excellent following the surgery. A comparison of the preoperative and postoperative CT scans revealed that the sternal curvature at the retrosternal incision decreased from 7.5 degrees to 1 degree.

Conclusion:
Although further case accumulation and evaluation after bar removal are necessary, this retrosternal incision may be beneficial for correcting severe sternal depression, particularly in adolescents and adults with rigid rib cages.

Keywords:
Nuss procedure, retrosternal incision

Correction of Asymmetric Pectus Excavatum by the Nuss Procedure: Strong Initial Overcorrection May Be Required for Symmetry

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[1]Department of Plastic and Reconstructive Surgery, Sendai City Hospital..

Background and Aim:
In the correction of asymmetric pectus excavatum using the Nuss procedure, relapse of the initial correction occurs not only at the time of bar removal but also during the bar placement period. As a result, the final correction effect often declines to less than 70% of the initial improvement. To achieve satisfactory final symmetry, it is considered important to obtain sufficient overcorrection at the time of the initial surgery. This study aimed to explore how much overcorrection is needed during the initial operation to ensure adequate final correction.
Method:
We reviewed cases of right-deviated asymmetric pectus excavatum treated with the Nuss procedure using step-shaped bars and asymmetrical staggered placement. The Asymmetry Index (AI) was measured immediately after surgery and again at the time of bar removal to evaluate the degree of maintained correction.
Results:
In cases where the AI after bar removal was <0.95, the initial postoperative AI had been ≤1.05. In contrast, cases with a final AI ≥0.95 showed an initial AI of ≥1.1, indicating that stronger initial overcorrection was associated with better symmetry at the time of bar removal.
Conclusion:
To achieve effective correction of asymmetric pectus excavatum using the Nuss procedure, an initial AI of approximately ≥1.1 may be required. These findings highlight the clinical importance of strong initial overcorrection to compensate for the regression observed both during bar placement and at removal.
Keywords:
Asymmetric pectus excavatum, Nuss procedure(MIRPE)

A case of Marfan syndrome after liver transplantation in which infection control is difficult after the Nuss procedure

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Background
Surgical procedures performed in immunosuppressed patients require careful attention to the risk of postoperative infection. We report a case of a patient with Marfan syndrome and funnel chest after living donor liver transplantation who underwent the Nuss procedure before cardiac surgery but experienced difficulty with postoperative wound infection.
Case
A 9-year-old boy developed neonatal hemochromatosis after living donor liver transplantation at 30 days of age. The patient had severe mental retardation due to West syndrome as a comorbidity. Sternal depression gradually progressed from childhood, and echocardiography revealed enlargement of the ascending aorta and aortic regurgitation (AR).
A computed tomography scan revealed a severe funnel chest with a Haller index of 7.7, which compressed a transplanted liver. As the AR findings worsened over time, we discussed with the pediatric cardiologist the possibility of future cardiac surgery and the impact of the sternal depression in this case and decided to treat the funnel chest with the Nuss procedure first.
One month after surgery, the patient developed a wound infection, which was treated with antibiotics and negative pressure wound therapy with continuous irrigation (NPWTci).
The local findings improved for a time; however, the wound infection recurred 4 months after surgery. Despite continued antibiotic therapy and NPWTci, the wound infection did not heal, and one of the bars was eventually removed. After removal of the bar, the wound infection was treated with NPWTci.
Conclusion
We reported a difficult case of postoperative wound infection in a child with Marfan syndrome after liver transplantation who underwent the Nuss procedure. This case suggests that perioperative management, including antibiotic administration, should be carefully evaluated when performing surgical procedures requiring foreign body insertion, such as the Nuss procedure, in immunosuppressed patients.
Keywords: Marfan syndrome, Nuss procedure, Infection control, Negative pressure wound therapy

A Case of Pectus Carinatum Treated with a Combination of the Modified Nuss Procedure and Sterno-Costal Elevation

Author(s) and Affiliation(s):

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2 Department of Plastic, Reconstructive and Aesthetic Surgery, Fukuoka University Hospital

Background and Aim:

Since the introduction of the Nuss procedure for pectus excavatum, its application has been extended to the treatment of pectus carinatum. At our institution, we perform a modified Nuss procedure for pectus carinatum, which penetrates the chest wall four times, in accordance with the technique described by Kálmán (J Thorac Cardiovasc Surg, 2009). However, we have encountered cases in which simple sternal compression using a Nuss bar results in noticeable bilateral subcostal depressions. In the present case, we combined this modified Nuss procedure with sterno-costal elevation, as reported by Iida (Eur J Cardiothorac Surg, 2010), and achieved a favorable improvement in thoracic morphology. We report this case here.

Method:

The patient was a 14-year-old boy who had noticed a protrusion of the left anterior chest wall since approximately age 13. Preoperative simulation demonstrated that the protruding deformity could be sufficiently corrected by manual compression of the sternum. However, compression of the protruding area also caused posterior displacement of the costal cartilages attached to the lower end of the sternum, resulting in bilateral subcostal depressions. We performed the modified Nuss procedure, and inserted a metal bar under thoracoscopic guidance. Subsequently, sterno-costal elevation was performed for the depression, with resection and shortening of the deformed costal cartilages in the affected area.

Results:

Good morphology was achieved using the modified Nuss procedure and sterno-costal elevation. No re-deformation was observed at six months postoperatively.

Conclusion:

For cases of pectus carinatum with bilateral subcostal depressions, the combined use of the modified Nuss procedure and sterno-costal elevation appears particularly effective. To our knowledge, no previous case reports have described this combination, making this a valuable clinical experience.

Keywords: Pectus carinatum, The modified Nuss procedure, Sterno-costal elevation

Reconstruction of Chest Wall and Breast Deformities in Poland Sequence Using Latissimus Dorsi Flap and Free fat injection

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Background and Aim:

Poland sequence is a congenital condition characterized by hypoplasia or aplasia of the pectoralis major muscle, often accompanied by deformities of the chest wall, breast, and upper limb. The etiology is thought to involve subclavian artery hypoperfusion during early embryogenesis. In female patients, breast asymmetry and deformity are common and can lead to psychological distress and functional impairment.

When reconstruction using a silicone breast implant (SBI) is considered, the absence of the pectoralis major muscle presents a significant challenge. Without adequate muscular coverage, the implant is placed directly under the skin, increasing the risk of infection and long-term exposure.

We present three cases of female patients with Poland sequence who underwent staged reconstruction.

Method:

Initially, a tissue expander was used to promote skin expansion and improve the local soft tissue envelope. This was followed by reconstruction of the chest wall and breast using a latissimus dorsi (LD) musculocutaneous flap. To enhance volume and improve contour, free fat injection was performed either at the time of flap transfer or in a subsequent procedure.

Results and Conclusion:

This combined approach allowed for both functional and aesthetic restoration, with satisfactory outcomes and no major complications. Our experience suggests that LD flap reconstruction with adjunctive fat grafting offers a reliable and customizable strategy for managing complex thoracic and breast deformities in Poland sequence.

Keywords:

Poland Sequence, Latissimus Dorsi Flap, Free fat injection

Vacuum Bell Therapy for Pectus Excavatum -How to Maintain Motivation-

Background and aim: Pectus excavatum (PE) is the most common chest wall malformation and now is most frequently treated with Nuss procedure. Vacuum bell therapy (VBT) has been an acceptable alternative for PE patients who want to avoid surgical correction. Though surgical treatment demonstrates rapid correction, VBT may require a long-term time commitment to achieve good results. The aim of this study was to examine the effect of VBT and its influencing factors in PE patients.

Method: 129 patients, 90 males and 39 females, underwent VBT for over 12 months between August 2005 and April 2025. The age ranged from 1 to 29 years, 47 patients were ≧11 years, 50 between 10-6years, 32 ≦5 years. In order to maintain motivation of the patients to practice daily use of the vacuum bell, we took action as follows: making scheduled routine follow-ups at regular intervals, showing the patients their previous photos at the regular follow-ups and taking care promptly in case of physical troubles or instrumental accidents. In addition, we recommend them to apply physiotherapy and to keep a dairy. And once a year we have a meeting for patients and their families to establish a friendship with each other.

Results: The initial chest wall depth was 16.3±6.4mm(mean±SD) and the final depth 8.0±6.2 mm. An excellent correction was achieved in 50 patients, good in 24, fair in 32 and poor in 23, according to the Obermeyer's criteria. Initial chest wall depth≦15 mm, the age≦10 years and daily wearing of the vacuum bell showed better results.

Conclusion: VBT is an effective therapeutic modality for PE. Older patients and severe PE patients can also be treated with VBT. It is very important to maintain motivation for a long time.

Discrepancies in Bar Quantity Selection for the Nuss Procedure: A Single-Center Retrospective Analysis and Development of a Preoperative Assessment Model.

Author(s)and Affiliation(s): *YiTsun Chen[1],*Qi Zeng[1], Chenghao Chen[1], Jie Yu[1], Na Zhang[1], Ting Yang[1], Yujia Wu[1], Changqi Xu[1], Dingyi Liu[1], Qian Zhang[1] , Dong Yan[1] , Xu Zhang[1]

[1] Department of Thoracic Surgery, Beijing Children's Hospital, Capital Medical University, National Center for Children's Health, Beijing, China.

Background and Aim:

To retrospectively analyze the differences in the selection of single and double bars in the Nuss procedure, identify the factors influencing bar choice, and develop a preoperative evaluation model to optimize clinical decision-making.

Method:

A total of 289 patients with pectus excavatum who underwent the Nuss procedure from January to December 2019 were included. Patients were divided into single-bar and double-bar groups. Preoperative imaging data, surgical information, and postoperative outcomes were collected. Multivariate logistic regression was used to identify factors influencing bar selection, and a nomogram prediction model was constructed based on these factors.

Results:

Patients in the double-bar group had significantly higher age, height, weight, and Haller index compared to the single-bar group ($P<0.05$). Multivariate logistic regression identified age, Haller index, and pectus excavatum type as independent factors influencing bar selection. The nomogram prediction model showed an AUC of 0.905, indicating high predictive efficacy.

Conclusion:

The preoperative evaluation model developed in this study can effectively predict bar selection in the Nuss procedure, providing clinicians with a personalized treatment planning tool to improve postoperative outcomes and patient satisfaction.

Keywords:

Nuss procedure, Bar quantity selection, Preoperative assessment model, Pectus excavatum, Nomogram prediction model

AS5-2 CW250116

Establishing a clinical guideline for pectus bar sizing based on age and body habitus stratified data

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Background and Aim: Choosing the right pectus bar size is critical for achieving optimal outcomes in the MIRPE procedure. However, there is currently no widely accepted age-based guideline to support consistent and evidence-based bar selection. This study aimed to develop a practical, age and body habitus-based guideline for bar size selection from a large patient cohort.

Methods: This retrospective cohort study analyzed 3,011 patients aged 3 to 25 years who underwent minimally invasive repair of pectus excavatum or carinatum between 2012 and 2024. Patients were stratified into six age bands. Corresponding height and weight ranges were binned into six groups each, aligned with growth patterns. Statistical analysis was performed to evaluate the relationship between bar size and age, anthropometry, and sex. The data belonged to the Asian population.

Results: Bar size demonstrated strong correlation with height, weight (r = 0.93, 0.95), and age (r = 0.82). The distribution of bar size varied clearly across six age groups. While sex alone was not statistically significant (p = 0.10). When bar size is selected by age alone, the stratified guideline in Figure 1 can be reliably followed, particularly for Asian habitus. However, Figure 2, derived from the height-weight heatmap, provides a reference for geographically diverse populations. This dual-path guidance allows for standardized preoperative planning across diverse clinical contexts.

Conclusion: This analysis supports the development of an age and habitus-based bar size guideline, which would help surgeons make more consistent, evidence-based decisions in MIRPE & MIRPC procedures.

Keywords: Pectus bar, Bar size, MIRPE, MIRPC, Guidelines

Figure 1: Boxplot showing bar size distribution across age groups.

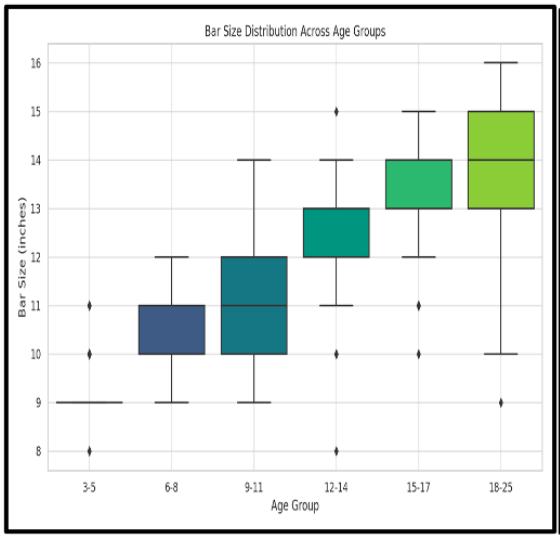
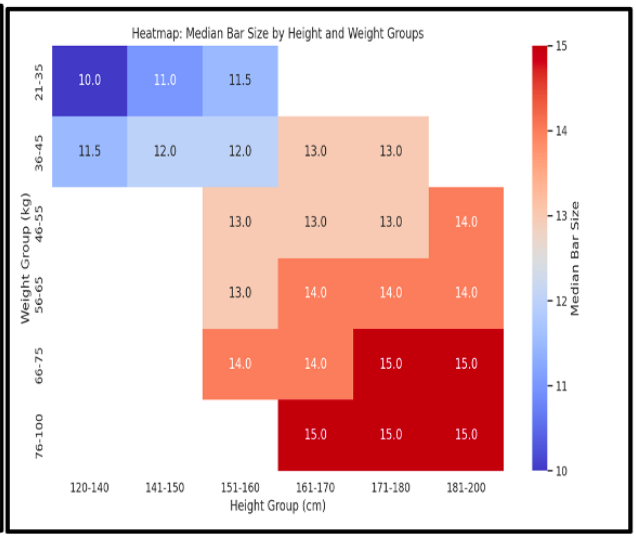


Figure 2: Heatmap showing median bar size by height and weight bins.



Application of Deep Neural Networks to Predict Surgical Outcomes and Optimize Nuss Bar Selection in Pectus Excavatum: Preliminary Study

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Background and Aim: This study aims to evaluate the feasibility of utilizing artificial intelligence–driven, data-centric models to predict surgical outcomes in pectus excavatum, with a focus on changes in key anatomical indices. Furthermore, it investigates the potential of these models to guide optimal Nuss bar configuration for achieving targeted chest wall correction.

Method: We developed two deep neural network (DNN) models with distinct objectives. The first model was designed to predict surgical outcomes by estimating postoperative values of key PE-related indices. The second model aimed to recommend optimal Nuss bar configurations to achieve the desired chest wall correction, as illustrated in Figure 1.

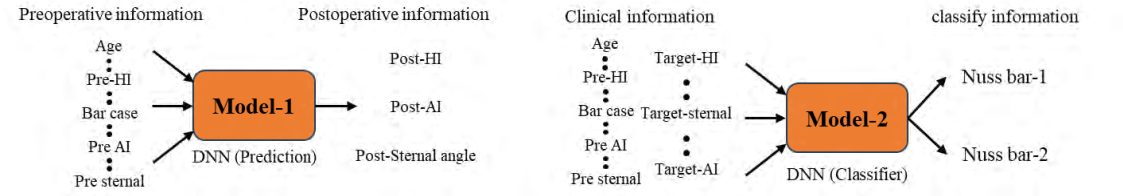
Clinical data were retrospectively collected from 136 patients who underwent the Nuss procedure at a single tertiary care center. Of these, 116 cases were used for model training and validation, while 20 cases were reserved for independent testing. The first model incorporated preoperative CT-derived indices and relevant clinical features as inputs, with predicted postoperative indices as outputs. The second model generated recommended bar configurations based on corresponding anatomical and surgical data.

Results: Trained models demonstrated strong predictive performance for postoperative Haller Index [RMSE=0.3976.MAE=0.3315], but relatively low prediction accuracy for other indices such as Asymmetry Index [RSME=3.0317, MAE=2.1994](Figure 2). Model 2 demonstrated satisfactory results in recommending optimal Nuss bar configurations, with 80% accuracy for single-bar and 70% for two-bar cases, suggesting potential for AI-assisted surgical planning in pectus excavatum correction (Figure 3).

Conclusion: This study demonstrates the potential of AI-assisted models in predicting surgical outcomes and optimizing Nuss bar configurations for patients with pectus excavatum. Despite the use of a limited dataset, the feasibility and clinical applicability of this data-driven approach were successfully explored. Future studies with larger cohorts may improve predictive accuracy and enable more personalized, objective surgical planning through broader integration of patient-specific factors.

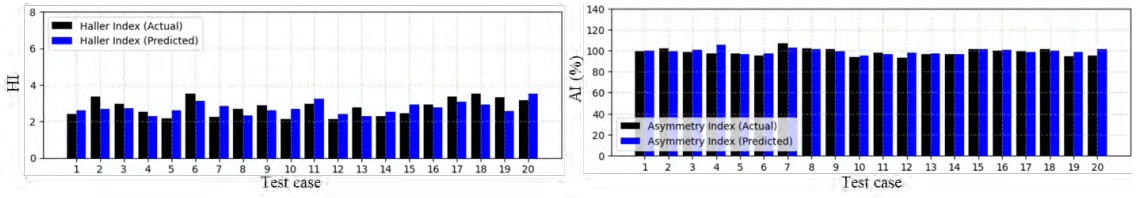
Keywords: Pectus Excavatum, Artificial Intelligence, Deep Neural Network, Haller Index, Nuss bar

Figure 1. Deep Neural Networks (DNN) of Model 1 and Model 2



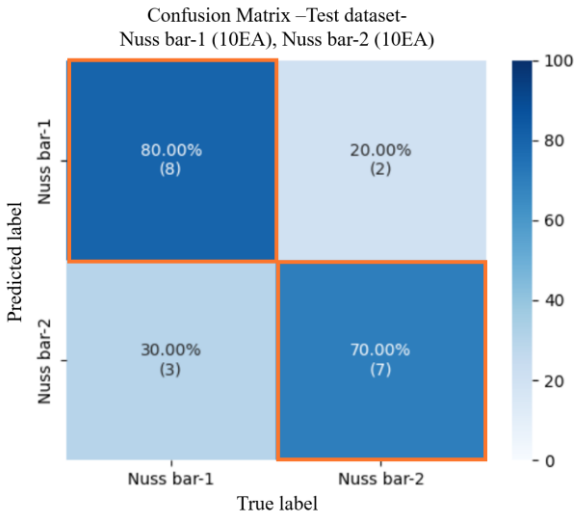
(A) Model 1: surgical outcome prediction **(B) Model2: optimal Nuss bar configuration suggestion**

Figure 2. Accuracy test for Model 1



(A) HI Prediction **(B) AI Prediction**

Figure 3. Appropriateness test for the Model 2



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EDUCATIONAL HISTORY

1985 Graduated from Matsumoto Fukashi High School (Nagano)

1992 M.D. Shiga University Medical School

2001 Ph.D. (Doctorate in Medical Science) Shinshu University School of Medicine

PROFESSIONAL BACKGROUND (EMPLOYMENT HISTORY)

May 1992	Passed the National Board Examination
May 1992 - March 1993	Resident in Shinshu University School of Medicine
April 1993 - March 1994	Resident in Department of Orthopaedic Surgery, Iida Municipal Hospital
April 1994 - March 1995	Resident in Department of Orthopaedic Surgery, Hokushin General Hospital
April 1995 - June 1996	Resident in Department of Orthopaedic Surgery, Kofu Municipal Hospital
July 1996 - June 1997	Resident in Department of Orthopaedic Surgery, Okaya Municipal Hospital
July 1997 - June 1998	Resident in Department of Orthopaedic Surgery, Yodakubo Hospital
July 1998 - March 2002	Medical Staff, Division of Spinal Surgery, Department of Orthopaedic Surgery, Shinshu University School of Medicine
April 2002-Dec 2006	Assistant Professor, Department of Orthopaedic Surgery, Shinshu University School of Medicine
April 2005 - Present	Chief, Division of Spinal Surgery, Department of Orthopaedic Surgery, Shinshu University School of Medicine
January 2007 - June 2008	Senior Assistant Professor (Lecturer), Department of Orthopaedic Surgery, Shinshu University School of Medicine
July 2008- December 2008	International Spinal Deformity Fellow, Pediatric Orthopedic & Scoliosis Center, Rady Children's Hospital San Diego (Dr. Peter O. Newton)
January 2009 -	Senior Assistant Professor (Lecturer), Department of Orthopaedic Surgery, Shinshu University School of Medicine
January 2017 -	Associate Professor, Department of Orthopaedic Surgery, Shinshu University School of Medicine

January 2020 - Professor, Department of Orthopaedic Surgery, Shinshu University School of Medicine

April 2023- Assistant to the Hospital Director, Shinshu University Hospital

LICENSES AND CERTIFICATIONS

1992 National Board of Medicine, Registration No. 351665

1999 Japanese Board of Orthopaedic Surgery, Certificate No. 113555

2003 Board-certified Spinal Surgeon approved by the Japanese Board of Spinal Surgery, Certificate No. 10333

MEMBERSHIPS

North American Spine Society (Member)

Scoliosis Research Society (Active Fellow)

Japanese Orthopaedic Association (Board Member)

Japan Spine Research Society (Board Member)

Japanese Scoliosis Society (President)

Japanese Spinal Instrumentation Society (Board Member)

The Japanese Society of Lumbar Spine Disorders (Board Member)

Central Japan Orthopaedic Surgery and Traumatology Society (Board Member)

Japanease Computer-assisted Orthopaedic Surgery Society (Board Member)

Japanese Society for Musculoskeletal Medicine (Board Member)

HONORS

2007 Shinshu University Orthopaedic Surgery Fellow Association Award

2008.3.19 Abroad study encouragement award

Japanese Society for Spine Surgery and Related Research Asia Traveling Fellowship 2010

2012 40th Annual Meeting of the Japanese Society for Spine Surgery and Related Research Best Paper Award

2014 43rd Annual Meeting of the Japanese Society for Spine Surgery and Related Research Best Paper Award

2019 132nd Annual meeting of Central Japan Association of Orthopaedic Surgery and Traumatology Best Paper Award

2019 133nd Annual meeting of Central Japan Association of Orthopaedic Surgery and Traumatology Best Paper Award

2020 135nd Annual meeting of Central Japan Association of Orthopaedic Surgery and Traumatology Best Paper Award

2021 APSS-APPOS 2021 Best Viewing Awards

The 35th The Japanese Society for Spine Surgery and Related Research Scholarship Award (Taisho Award), Clinical Division (February, 2023)

Surgical Approaches to Effectively Treating Pectus Excavatum Associated with Scoliosis

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Background and Aim: Patients with pectus excavatum have a higher prevalence of scoliosis compared to the general population. In severe scoliosis cases, bracing is recommended for curves exceeding 15 degrees, while surgery is indicated for curves greater than 40 degrees according to Cobb's method. Determining the right time for surgery can be challenging for patients with both pectus excavatum and scoliosis.

Method: In this study, we retrospectively evaluated records from our prospectively collected data in the *Chest Wall Deformities Clinical Database of the Thoracic Surgery Department*, covering the period from September 2018 to May 2025. Out of a total of 1,900 patients reviewed, we identified 63 patients (41 males and 22 females, mean age 18 years) who underwent minimally invasive repair of pectus excavatum and also had scoliosis. We recorded various data points, including the Cobb angle, age, gender, Haller index, and any associated anomalies.

Results: Out of 63 patients, 43 underwent vigorous physical therapy, 12 received bracing therapy, and 8 had surgery for scoliosis. Five patients with moderate sternal depression initially underwent surgical treatment for scoliosis, followed by correction of the excavatum deformity. Three patients experiencing severe exertional dyspnea due to significant sternal depression first underwent pectus repair before having their scoliosis corrected. The patients with excavatum received two (n=4) or three bars (n=4) to correct their pectus deformity. In one patient, during the scoliosis surgery, two of the bars had to be removed to allow for proper alignment of the spine.

Conclusion: Literature typically recommends that patients with severe pectus excavatum and scoliosis should first undergo repair for pectus excavatum, followed by correction of scoliosis. However, based on our experience, we believe that scoliosis surgery should be performed first. This is because the bars placed during pectus surgery may interfere with the proper alignment of the spine during the scoliosis operation.

Keywords: Pectus excavatum, scoliosis surgery, bracing

Impact of Nuss surgery on scoliosis: What Should Be Considered?

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Background and Aim: The association between chest wall deformities and scoliosis has been widely documented. On one hand, serious complications have been reported during surgical correction of scoliosis in patients with untreated severe pectus excavatum (PE). On the other hand, the impact of MIRPE on the progression of scoliosis remains unclear. The aim of this study was to assess whether the Nuss procedure may influence scoliosis progression.

Method: We conducted a retrospective study (2015–2024) of a cohort of patients who underwent PE correction using the Nuss procedure. The following variables were analyzed: demographic data, type and severity of PE (including asymmetry), degree of scoliosis, and the presence of connective tissue disorders. Scoliosis progression or improvement was defined as a change greater than 5°, and potential predisposing factors were evaluated.

Results: Of the 130 patients operated on during the study period, 31 (23.84%) had pre-existing scoliosis. Of these, 67.7% were male, with a mean age of 15.4 years (SD: 1.79). The chest wall deformity was symmetrical in 45% of cases, with a mean Haller index of 6.5 and a mean correction index of 43.1%.

Scoliosis was mild in 71% of patients, moderate in 25.8%, and severe in 3.2%. Following the Nuss procedure, scoliosis improved in 29% of patients and worsened in another 29%. Two patients (6.5%) required surgical correction of scoliosis, and five (16.1%) continued brace treatment, with one patient awaiting surgery.

Statistical analysis identified age under 14 years and moderate to severe scoliosis as significant risk factors for progression.

Conclusion: Pectus excavatum repair using the Nuss procedure can alter the scoliosis curve. Our findings suggest that younger age and greater baseline scoliosis severity may be risk factors for curve progression. In patients with moderate to severe scoliosis, close multidisciplinary monitoring with orthopedic specialists is essential, along with coordinated planning of the sequence of corrective surgeries.

Keywords: Pectus excavatum, scoliosis, MIRPE, sequence

Pectus Carinatum Bracing: Key Factors in Success and Dropout

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Background and aim:

Pectus carinatum (PC) is a common anterior chest wall deformity, often treated non-surgically with orthotic bracing. As orthosis treatment requires long-term patient compliance, identifying predictors of success and understanding the causes of dropout are essential for optimizing outcomes.

Methods:

We retrospectively analyzed 1,141 PC patients who presented to our clinic in Istanbul, Türkiye, between 2019 and May 2024. A total of 634 patients began orthosis treatment following joint decision-making. Force of correction (FOC), measured in kilograms, was recorded at baseline (1FOC) and during the first follow-up (2FOC). Success was defined as ≥50% reduction in last recorded FOC. Patients who did not return for follow-up were defined as dropouts and were contacted to explore their reasons for discontinuing treatment and to self-reported compliance levels.

Results:

The mean age of all patients was 13.5 ± 5.6 years, and 81.9% were male. Family history (father,mother, siblings) of pectus deformity was present in 12.7% of patients. Of the 634 patients who started orthosis treatment, 404 completed follow-up and were included in success analysis. More than half (51.5%) achieved successful outcomes. There was no significant difference in mean age or 1FOC between successful and unsuccessful groups; however, patients aged ≥18 had lower success rates. The ratio of 2FOC to 1FOC was correlated with success ($r = 0.53$). Dropout rate was 36.3% ($n = 230$), with discomfort and pain being the most influential factors. These patients also reported low self-reported treatment compliance.

Conclusions:

Orthotic bracing is an effective treatment for PC across various ages and deformity severities. Early improvement in FOC during follow-up appears to predict successful outcomes. Discomfort-related noncompliance is a key reason for treatment dropout, emphasizing the need for personalized support and close monitoring during the early phase of treatment.

Repair of Mixed Type Pectus Deformity Using The Sandwich Technique

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Background and Aim: Pectus carinatum (PC) is the second most common deformity of the anterior chest wall, with a prevalence of 0.3% to 0.7%. Although the Abramson technique is effective for repairing symmetric pectus carinatum, asymmetric pectus carinatum, as well as complex mixed deformities that involve both pectus carinatum and pectus excavatum, require a sandwich technique for repair.

Method: This retrospective study was conducted from September 2018 to May 2025 on patients with anterior chest wall deformities repaired using the sandwich technique. Data were collected on demographic characteristics, operation time, length of hospital stay, and postoperative complications.

Results: Our surgical cohort consisted of seventy-nine patients with pectus carinatum deformity, of which sixty-six patients underwent minimally invasive repair. Among these, twenty-four patients had a mixed-type deformity, and the repair was performed using the sandwich technique. The mean age of these mixed-type patients was 17.2 years, with a range from 14 to 28 years. All patients were male and had no significant medical history. Only one patient reported experiencing dyspnea on exertion. Twelve patients presented with an asymmetrical deformity. In the majority of cases, two bars (one for carinatum and one for excavatum) were sufficient to correct the deformity. However, three patients required three bars (two bars for excavatum and one bar for carinatum), and all three had a chest tube placed for potential drainage. The mean operation time was 118.4 minutes (±33.9 minutes), and the average length of hospital stay was 4.7 days. One patient required revision surgery for bar displacement 30 days after the initial operation.

Conclusion: The sandwich technique using an external and an internal bar is effecive in remodelling the chest wall in patients with complex mixed type pectus deformity and asymmetric pectus carinatum.

Keywords: asymmetric pectus carinatum, mixed pectus deformity, sandwich technique

Minimally Invasive Surgery for Pectus Carinatum Correction: A Retrospective Single-Center Study

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Background and Aim:

The surgical treatment of pectus carinatum has shifted from the traditional open Ravitch procedure to the widely used minimally invasive surgery. In this study we assessed our results with Abramson technique and sandwich technique in managing pectus carinatum (PC) patients.

Method:

This retrospective study analyzed 351 PC patients undergoing minimally invasive surgery between 2009-2019. The protocol involved preoperative sternal elasticity assessment and intraoperative pressure gauge measurement. Abramson Technique used single extrathoracic bar; Sandwich Technique combined extrathoracic and Nuss-type intrathoracic bars. Most bars were removed one to two years after surgery. Patients' characteristics, operation time, and complications have been recorded.

Results:

Among the 351 patients, 318 were male and 33 were female. The mean age was 13.57 year. 49% were symmetrical, and 51% were asymmetrical. 211 cases adopted the Abramson technique and 140 cases adopted the sandwich technique. The sandwich group demonstrated superior orthopedic outcomes (98.00% vs. 96.22% excellent/good results) despite longer operative durations (median: 55 vs. 51.5 min, $p<0.05$). Imaging parameters improved postoperatively, and postoperative complications occurred in 14.53% of cases. No recurrence occurred during 2 years follow-up post-bar removal.

Conclusion:

Minimally invasive surgery of pectus carinatum preserves the integrity of the chest wall. The sandwich technique provides a safe, minimally invasive alternative for complex PC cases with

mixed protrusion-depression deformities.

Keywords:

pectus carinatum, minimally invasive surgery, sandwich technique, Abramson technique, Nuss procedure, orthopedic

INTERNATIONAL SURVEY ON THE MANAGEMENT OF PECTUS EXCAVATUM: IS THERE A CONSENSUS?

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Background and Aim: Pectus excavatum (PE) is the most common congenital chest wall deformity. While cosmetic concerns are the primary complaint, cardiopulmonary impairment may also occur. Despite widespread use of the minimally invasive Nuss procedure, diagnostic and therapeutic approaches vary globally. This study aimed to identify consensus areas and ongoing controversies in PE management among international experts.

Method: A 31-question web-based survey was distributed to Chest Wall International Group (CWIG) members between November 2024 and January 2025. The survey covered five domains: preoperative evaluation, surgical indications and timing, operative technique, and postoperative management. Responses from 100 surgeons were analyzed descriptively.

Results: The most commonly accepted surgical indications included severe deformity (88.9%), Haller index >3.25 (78.8%), psychosocial distress and symptoms (77.8%). Although cosmetic concerns were a common motivator, only 28% of surgeons considered cosmetic appearance alone as sufficient for surgery. Vacuum bell therapy was preferred for mild deformities (69.7%), young children under six (59.6%), and families declining surgery (55.6%). Preoperative rehabilitation was not implemented by 35% of surgeons; among those who did, posture training and breathing exercises were common. For complex deformities, double-bar placement was preferred (90.8%). Routine osteotomy was largely avoided, and sternal elevation was used by 55.4% to prevent cardiac injury. While thoracic CT was widely used preoperatively, postoperative CT was avoided. Most surgeons favored bar removal after 2–3 years (86.6%) and encouraged early ambulation. Pain management was primarily via oral analgesics and IV pumps. Early complications included pneumothorax and infection, while bar displacement was the most frequent late complication.

Conclusion: Although consensus exists regarding several aspects of PE surgery, significant variability remains in surgical decision-making, preoperative workup, and postoperative care. These findings highlight the ongoing need for international standardization of treatment algorithms.

Keywords: Pectus Excavatum, Chest Wall Deformity, Minimally Invasive Surgery, Survey, Nuss Procedure

Impact of Age on Surgical Results for Symmetric Pectus Excavatum Patients: A Propensity Score Matched Comparative Study

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Background and Aim: Pectus excavatum (PE) is a common chest wall deformity, yet the optimal timing for surgical correction remains debated. This study aims to assess age-related surgical outcomes in male patients with symmetry-type PE and to evaluate favorable periods for intervention based on preoperative Haller Index (HI) matching.

Method: A retrospective review was conducted on 1,040 male patients diagnosed with symmetric-type pectus excavatum. Patients were categorized into four age groups: 2–9 years (A), 10–14 years (B), 15–19 years (C), and ≥20 years (D). To ensure comparability across age groups, propensity score matching (1:1) was performed based on preoperative Haller Index (HI) using the nearest neighbor method. Surgical outcomes assessed included postoperative HI (POHI), the difference between preoperative and postoperative HI, and complication rates.

Results: In matched cohorts, the 2–9 years group consistently showed superior outcomes. Compared to the 10–14 years group (n=76 each), the 2–9 group had a lower postoperative HI (2.3 ± 0.2 vs. 2.6 ± 0.3, $p<0.001$) and a greater HI reduction (1.9 ± 0.9 vs. 1.6 ± 0.8, $p=0.021$).

Similar trends were seen against the 15–19 years (n=77 each) and ≥20 years groups (n=112 each), with significantly better outcomes (all p<0.001). Although statistical significance in complication rates was achieved only compared to the ≥20 years group (4.5% vs. 17.0%, p=0.005), the 2–9 group consistently showed lower complication rates across all comparisons.

Conclusion: Early surgical correction for symmetric-type pectus excavatum in male patients, particularly between ages 2 and 9 years, is associated with improved morphological outcomes and a reduced risk of postoperative complications. These findings support considering earlier intervention to maximize surgical benefits in this specific patient group.

Keywords: Pectus excavatum, symmetry-type, surgical timing, Haller index, Complication

Table 1. Comparison of Surgical Outcomes by Age Groups

Characteristics	Group A (2–9 Y)	Group B (10–14 Y)	Group C (15–19 Y)	Group D (≥20 Y)	p-value	Significant Differences
Age, years	4.2 ± 1.4	12.9 ± 1.2	16.5 ± 1.5	24.6 ± 5.3	<0.01	A vs B, A vs C, A vs D
Preoperative Haller Index	4.2 ± 1.0	4.2 ± 1.0	4.2 ± 0.9	4.2 ± 0.8	0.999	None
Postoperative Haller Index	2.3 ± 0.2	2.6 ± 0.3	2.6 ± 0.3	2.7 ± 0.3	<0.01	A vs B, A vs C, A vs D
Difference of Haller Index	1.9 ± 0.9	1.6 ± 0.8	1.6 ± 0.8	1.5 ± 0.7	0.001	A vs B, A vs D
Complications (%)	4.5%	10.5%	9.1%	17.0%	0.007	A vs D

Exercise-induced ectopy and its relationship to cardiopulmonary fitness, cardiac function, and radiographic markers of severity in patients with pectus excavatum

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Victor F. Garcia, MD[1], Karla Foster, MS[1], Adam W. Powell, MD, MS[1]
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Background: Patients with pectus excavatum (PE) are at increased risk of cardiac derangements, including cardiac arrhythmias. Little is known about exercise-induced ectopy in pediatric patients with PE and how it relates to pulmonary function testing (PFT), cardiac magnetic resonance imaging (CMR), cardiopulmonary exercise testing (CPET), and PE anatomic indices.

Methods: This retrospective cohort study analyzed 661 patients with PE. Patient ECGs were categorized by frequency and presence of either atrial or ventricular ectopy. Patients were then split into complex/frequent ectopy (defined as frequent isolated ectopy or ≥4 beats of ventricular or atrial tachycardia) vs noncomplex/infrequent ectopy. Each group had PFT, CPET, CMR, and PE anatomic indices compared using a student's t-test. $P<0.05$ was considered significant.

Results: Mean cohort age was 15.4±3.6 years with 82% female. There were no differences in ectopy based on age, gender, body measurements, or CPET or PFT values. We observed ventricular ectopy in 34.9% of patients and atrial ectopy in 16.9%. Complex atrial ectopy was uncommon but occurred more in those with direct compression of the tricuspid valve. Those with a complex ventricular ectopy had significant differences in their Haller index (6.2±2.4 v 5.2±2.7; p=0.02), correction index (41.4±14.4 v 30.8±15.5%; p<0.0001), and depression index (0.77±0.05 v 0.58±0.01; p=0.0002). Patients with complex ventricular ectopy also had significantly lower left ejection fraction (56.8±3.0 v 58.5±4.0%; p=0.009). Ventricular tachycardia occurred in 2.6% of patients. Those with ventricular tachycardia had a lower peak oxygen consumption (75.5±13.2 v 87.3±16.9%; p=0.004) and left ventricular ejection fraction (55.6±2.2 v 58.5±4.0%; p=0.003).

Conclusions: Ventricular ectopy is common during exercise in pediatric patients with PE, and those with higher CMR markers of structural severity had more complex ventricular ectopy.

Keywords: pectus excavatum, atrial ectopy, ventricular ectopy, cardiopulmonary exercise testing (CPET), cardiac MRI, pulmonary function testing (PFT)

Exercise-Induced Right Ventricular Compression in Pectus Excavatum: Insights from an Exercise Cardiac CMR study

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Background and Aim: Pectus excavatum (PE) is the most common congenital chest wall deformity, defined by inward displacement of the sternum. Exercise intolerance is frequently reported by patients and may reflect cardiac limitations. Thoracic depression can mechanically compress the right ventricle (RV), impairing its filling. However, the impact of RV compression during exercise remains underexplored.

Method: Forty PE patients (38% female, age 27±11, BMI 22±3) who underwent exercise cardiac magnetic resonance (exCMR) imaging during preoperative workup between January 2022 and March 2023 were included. Images were acquired at rest and at 25%, 50%, and 66% of maximum workload, based on a prior exercise test. Peak exercise level was defined as the highest achieved workload. Patients were stratified into two groups using the median change in RV end-diastolic volume (ΔRVEDV: peak-rest) as the cut-off, expressed in mL.

Results: In the total cohort, the median of ΔRVEDV from rest to peak was -28 [IQR: -14 to -48] mL. RVEDV decreased significantly from rest to all exercise stages (all $p<0.001$), with the largest reduction between rest and 66% workload (ΔRVEDV: -28.4 mL). Patients with ΔRVEDV < -28 mL demonstrated lower left ventricular stroke volume (SV) at peak exercise (87 vs. 106 mL, $p=0.012$), a smaller increase in left ventricular cardiac output (CO) from rest to peak (+5.8 vs. +8.4L/min, $p=0.016$) and lower percentage predicted VO2max (78% vs 88%, $p=0.046$) compared to those with ΔRVEDV > -28 mL. No significant differences were observed between subgroups in baseline demographics, pulmonary function, or Haller Index.

Conclusion: ExCMR revealed a reduction in RVEDV during exercise in patients with PE. A great decrease in RVEDV from rest to peak was associated with reduced stroke volume, cardiac output, and aerobic capacity, suggesting that dynamic RV compression contributes to exercise limitations.

Keywords: pectus excavatum, exCMR, exercise

PECTUS IMPLANT STAINLESS-STEEL ABRASION IN THE PLEURAL CAVITY INDUCES SYSTEMIC METAL CONTAMINATION IN MICE

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Background and Aim: Patients undergoing minimally-invasive repair of pectus excavatum (MIRPE) typically receive stainless-steel bars and stabilizers as separate implants, that allow small metal-to-metal movements while breathing. In a previous study, we have detected elevated systemic nickel and chromium levels in these patients. To test the hypothesis that metal-to-metal friction is the key factor for metal contamination following MIRPE, we developed a mouse model to examine the effect of metal implants and abrasion in the pleural cavity.

Method: The study was approved by the Institutional Animal Care Committee (33.12-42502-04-16/2201). Mice were hold in metal-free cages and fed control diet C1000. Five experimental groups were established: groupA received stainless-steel particles intrapleurally, imitating metal-to-metal abrasion, groupB received small stainless-steel pieces intrapleurally, groupC received small stainless-steel pieces subcutaneously, groupD received small titanium pieces intrapleurally and the control group received alginate intrapleurally. Nickel and chromium levels were analyzed in urine two weeks post implantation and compared to baseline.

Results: Onehundredtwo mice were included. Implantation of stainless-steel particles into the pleural cavity resulted in a significant increase of mean nickel (25.8 to 72.74 µg/gCreatinine, *p<0.01*) and chromium levels (1.13 to 6.47 µg/gCreatinine, *p<0.001*) in urine after two weeks. No significant increase was observed in the other groups.

Conclusion: Stainless-steel abrasion in the pleural cavity induces systemic metal contamination in mice, while solid implants do not. After MIRPE in human, metal-to-metal friction between bars and stabilizers may produce abrasion, causing metal contamination.

Keywords: Metal contamination, stainless-steel abrasion, animal model

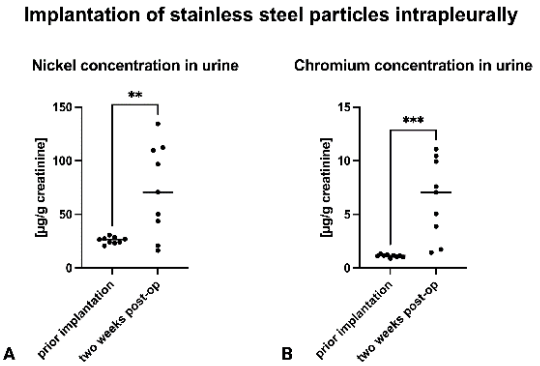

Figure 1 Nickel (A) and chromium (B) concentrations in urine of mice (mean levels and distribution) prior implantation of stainless steel particles intrapleurally and two weeks post-operatively, the difference was statistically significant for nickel (**$p<0.01$) and chromium (***$p<0.001$).

Surgical Considerations for Platythorax and Pectus Excavatum with Anterior-Posterior Insufficiency

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Words: 193/300

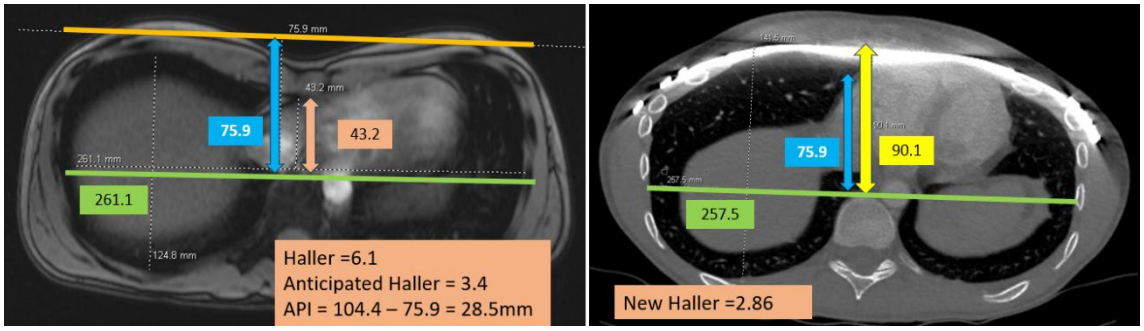
Background and Aim: To describe surgical modifications necessary to achieve successful results in patients with anterior-posterior insufficiency (API) of the chest.

Method: Descriptive study of modifications.

Results: The Nuss procedure uses the anterior ribs to support correction of sternal depressions. Often the extent of elevation is defined by the height of the anterior ribs when bars bridge the highest peaks. But pectus excavatum encompasses a wide variety of chest confirmations, including Platythorax with a narrow, flat chest as well as cases of Pectus Excavatum with (API). Both Platythorax and PE-API have inadequate chest space for optimal function of thoracic structures. Unfortunately, these patients often report disappointing results after standard Nuss procedure. We describe the importance of lateral bar entrance, support under the ribs, and use of multiple bars in achieving adequate repair of these variants. The lateral entrance also puts extensive pressure on the interspaces, which may require re-enforcement to prevent loss of correction or bar migration.

Conclusion: Modifications to the original Nuss procedure are required to achieve adequate repair in cases of Platythorax Pectus and Pectus Excavatum with Anterior-Posterior Insufficiency.

Keywords: Platythorax, Inadequate Anterior-Posterior Diameter of the Chest, Pectus excavatum; pericardial effusion; Nuss procedure



The Flarebuster: A Critical Adjunct for Inferior Chest Wall Remodeling in Pectus Excavatum Repair

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Background and Aim: Costal flare, defined by protrusion of the lower costal margins, commonly accompanies pectus excavatum (PE) and is often uncorrected by conventional repair. To address this, the Flarebuster technique was developed using heavy string compression. This study aimed to assess its safety and efficacy during PE repair.

Methods: A retrospective review was conducted of 114 patients who underwent pectus excavatum (PE) repair between January and December 2013. Patients were divided into two groups: conventional repair without Flarebuster (Group N, n = 50) and Flarebuster-assisted repair (Group F, n = 64). Flare volume changes were measured using SYNAPSE 3D imaging software (FUJIFILM Corporation, Tokyo, Japan) (Fig. 1), and flare angles were assessed via three-dimensional computed tomography (Fig. 2). Postoperative complications were also evaluated.

Results: The Flarebuster group showed significantly greater reductions in flare volume (314.25 ± 181.56 mL vs. 158.26 ± 130.28 mL, $p < 0.01$) and flare angle (15.04 ± 4.44° vs. 5.09 ± 5.69°, $p < 0.01$) compared to the conventional group. No significant differences were observed between groups in wound infection, pneumothorax, pleural effusion, or hospital stay.

Conclusion: The Flarebuster technique allows effective correction of costal flare deformities without increasing perioperative risk. Its routine integration into pectus excavatum repair may enhance anatomical restoration and lead to improved structural and aesthetic outcomes.

Keywords: Pectus excavatum, Flarebuster, volumetric change, costal angle

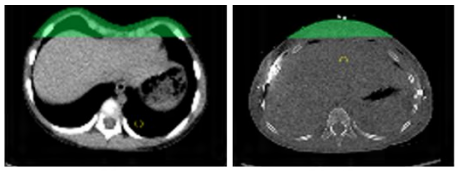

Fig. 1. Measurement of costal flare volume using SYNAPSE 3D imaging software (green area)

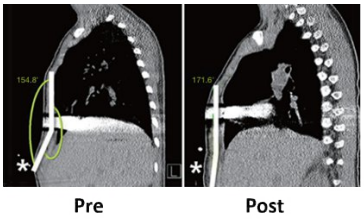

Fig. 2. Measurement of costal flare angle (* flare, green lines: flare angles)

Modified Nuss Procedure: Auxillary Subxiphoid Incision

Haktan Uygar Onen[1], Aleyna Gültekin Aridas[1], Nezih Onur Ermerak[1], Tunc Lacin[1] , Mustafa Yuksel[2]

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Background and Aim: Since the first description of the Nuss repair for pectus excavatum, many technical variations have been described. Retrosternal adhesions due to previous median sternotomy or pectus surgery increases the risk of cardiac injury during Nuss Procedure. An auxiliary subxiphoid incision was utilised to facilitate pectus bar placement and minimize operative risk in such complex patients. We hereby report our results in patients who underwent Nuss procedure with subxiphoid incision.

Method: 39 patients who were treated with MIRPE with subxiphoid incision between 2017-2025 were reviewed from a database.

Results: Among 39 patients; 34 (87%) were male and 5 were female (13%). Median age was 20 (7-35). Median Haller Index was 3.8 (2.6-4.4). 15 (38.4%) had a history of previous MIRPE, 14 patients (35.8%) had a history of Ravitch surgery, 4 (10.2%) had severe adhesions without any specific cause, 3 (7.7%) had severe deformity and 3 (7.7%) patients had sternotomy due to MVR. Although 1 bar is used in 27 (69 %) patients, 2 bars in 10 (25.6%) patients and 3 bars in 2 (5.12%) patients. Wound infection (4 patients – 10.2%), and nickel allergy (1 patient –2.5%) were the leading complications. Up to date, bars of 30 (77%) patients had been removed as planned. Median time interval between MIRPE and bar removal was 35 months (9 -50).

Conclusion: An auxillary subxiphoid incision is a safe, simple modification of the Nuss procedure for patients with severe retrosternal adhesions. This procedure prevents cardiac perforation by enabling dissection under direct visualization.

Keywords: Nuss procedure, subxiphoid incision, pectus excavatum, retrosternal adhesions

Minimally Invasive Repair of Pectus Patients who Require Re-Correction

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Background and Aim: The recurrence of pectus excavatum after primary repair, whether performed via the Ravitch technique or minimally invasive surgery, is a rare occurrence. The choice to pursue a revisional surgery is often complex. This study focuses on patients who have undergone minimally invasive repair for the redo treatment of pectus excavatum.

Method: A retrospective review was performed between September 2018 and May 2025 on patients with recurrence. Data regarding demographic characteristics, primary surgery, operation time, length of hospital stay, postoperative complications and early outcomes were recorded. Patients were categorized into two groups based on the primary surgery they underwent.

Results: Our surgical cohort consisted of twenty-three patients with recurrence.Primary surgery was Ravitch in 6 patients and minimally invasive repair in 17 patients. All patients underwent minimally invasive repair for correction. Table 1 shows the patient demographics and results of redo surgery. One patient in Group 1 developed a carinatum 3 months after the minimally invasive repair and he underwent an open surgery to correct the carinatum deformity using titanium plates to secure the sternum while keeping the excavatum bar in place. Three patients in Group 1 received 2 bars, two patients received 3 bars (XI technique). 10 patients in Group 2 received two bars (cross bars in 4 patients), 1 patient received 3 bars (XI technique). 66.6% of the cases in Group 1 had a chest tube placement during the correction surgery. Length of operation time and length of hospital stay was longer in Group 1.

Conclusion: The minimally invasive repair can be performed effectively and safely in patients with recurrent pectus excavatum. The team should be ready to apply more than one bar as the correction has become a complicated one. Meticulous mediastinal dissection and the presence of pleural adhesions due to primary surgery raise the need for chest tube placement.

Keywords: recurrent pectus excavatum, Ravitch surgery, minimally invasive surgery

	GROUP 1 (Primary surgery is open/RAVITCH)		GROUP 2 (Primary surgery is MIRPE)	
Age (median, years)	26		20	
Sex	2 Female	4 Male	3 Female	14 Male
Average length of hospital stay	7.5 days		3.5 days	
Chest Tube Insertion	4/6 cases		5/17 cases	
Average Length of Operation Time	117 mins		97 mins	

MIRPE: minimally invasive repair of pectus excavatum

Lipofilling in Chest Wall anomalies.

Maria Victoria Romanini, Michele Torre.

Istituto Giannina Gaslini

Background and Aim: Autologous fat grafting (AFG) is an emerging technique for cosmetics and functional treatments, not only for increase the volume of the tissue but also for its regenerative and skin texture improvement. However, the experience in pediatric patients is still limited. This study aims to evaluate indications, procedure, outcome, and complications of AFG in Chest wall anomalies in a cohort of pediatric patients.

Method: A retrospective analysis of AFG procedures in pediatric patients at our center from 2011 to December 2024 was conducted. Results were evaluated during outpatient appointments and scheduled periodic re-evaluations with a 3D analysis pictures and Posas scar scale.

Results: In 100 patients (8-18 year-old), 150 procedures were performed, and a mean volume injected of 142 ml per procedure. Most frequent indications were Poland Syndrome, Pectus Excavatum, Currarino Silverman. Mean follow-up was 42 months. In all cases, we observed an improvement of the thoracic condition, chest symmetry, and of the quality of the skin scar demonstrated with the scar scale evaluation POSAS. As complication, we observed one case of abdominal hematoma at the donor site (which required drainage).

Conclusion: Despite the challenge of limited fat tissue availability in children, our study demonstrates the safety and efficacy of AFG for pediatric conditions. The documented volume-restoring and tissue-regenerating potential suggest a need for further exploration to expand indications and establish best-practice guidelines for pediatric patients.

Keywords: Fat grafting, autologous fat grafting, chest wall anomalies, Pectus excavatum, Poland Syndrome, pediatrics, lipofilling.

Template and Instructions for Abstract - CWIG2025

"Free Sandwich" Technique: A Novel Personalized Surgical Approach for Asymmetric Pectus Excavatum in Children

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Background and Aim: Asymmetric pectus excavatum presents unique surgical challenges due to uneven sternal depression, often leading to suboptimal correction with traditional parallel bar placement. We innovatively developed the "Free Sandwich" technique, utilizing an angled fixation strategy between bars to achieve three-dimensional correction of asymmetric deformities, optimizing stress distribution through personalized angular adjustment.

Method: Placement of the first bar following standard NUSS principles (Figure 1A). Intraoperative real-time assessment for personalized placement of the second bar (10°-40° angulation relative to the first bar), creating a non-parallel "sandwich" construct (Figure 1B). Six consecutive severe asymmetric cases (2024-2025) with Haller index >4.5 and asymmetry index >1.8

Results: All patients achieved anterior chest wall morphological correction, with adjusted asymmetry indices through personalized bar placement (Figure1C、D). No intraoperative complications (cardiac injury, pneumothorax, or bar displacement).

Conclusion: The "Free Sandwich" technique provides a safe, real-time personalized solution for asymmetric pectus excavatum. Angled bar placement improves thoracic contour without requiring pre-contoured implants, though larger studies are needed to validate long-term stability. This technique shows promise for better chest wall appearance and significantly reducing reoperation rates in asymmetric cases.

Keywords: Pectus excavatum, Asymmetric chest wall deformity, Personalized surgery, Bar fixation, Chest wall biomechanics

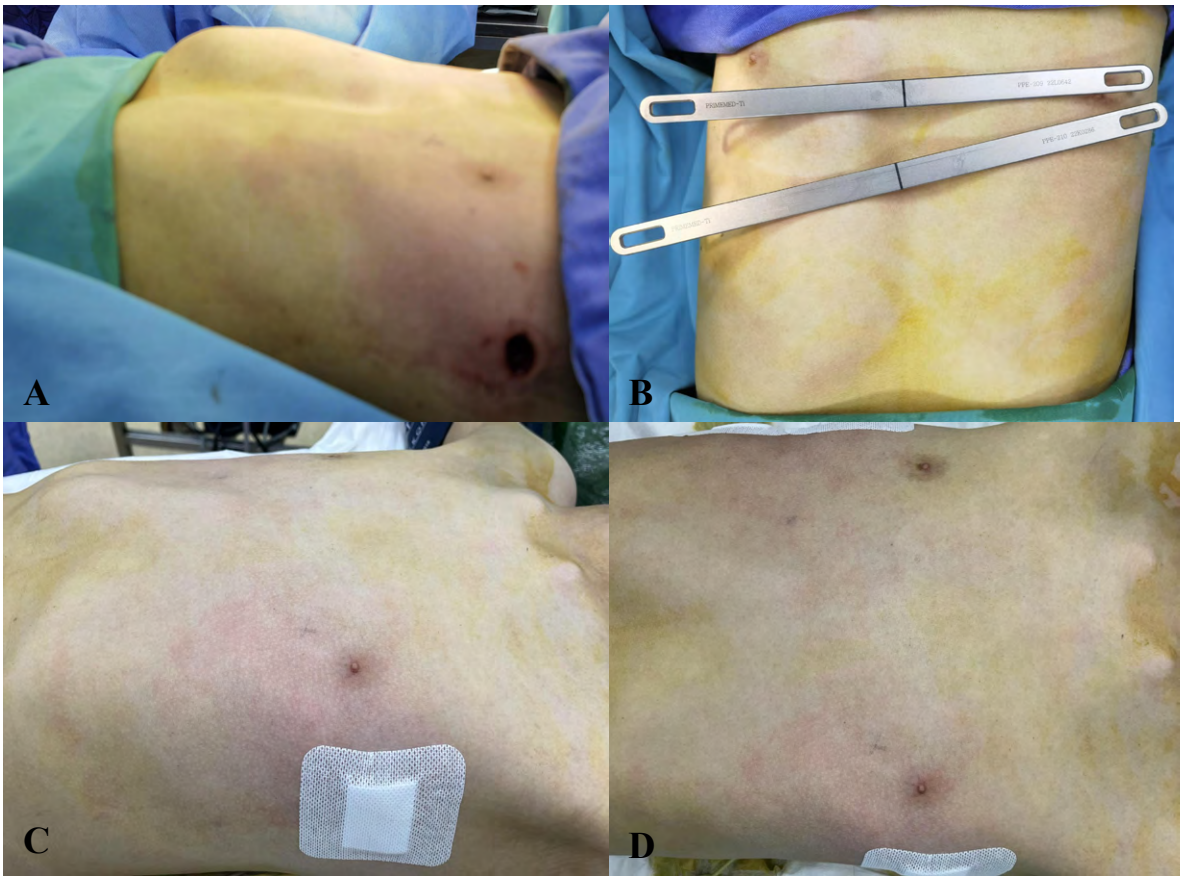

Figure 1. A First bar placement with standard NUSS technique. B Intraoperative planned bar placement angle.C、D Postoperative Immediate Outcomes

Evaluation of the Content and Quality of YouTube Videos Discussing MIRPE: Do We Need Peer Review for Better Quality?

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Background and Aim: Various online platforms, such as YouTube, are used for surgical education. MIRPE is sophisticated and surgical videos may help reducing learning curve for the surgeons. There is no clear consensus regarding the quality and reliability of MIRPE videos on YouTube. We aimed to evaluate MIRPE videos published on YouTube in terms of quality and reliability.

Method: The keywords "pectus excavatum" and "surgery" were both searched on YouTube. Only 20 videos were included in the analysis in the first 150 videos that came up. The quality and reliability of the videos were determined modifying scoring systems developed by the authors for other surgical procedures and the video power index. (MIRPE scoring system – MSS)

Results: A total of 20 videos were reviewed. Although 9 videos were < %50 category, while 11 videos were >%50 category according to MSS. The videos were analyzed as per the source of the upload: academic (%60), industry-sponsored (%10), or individual (%30). When the scores were compared by the origin of the videos, industry-sponsored videos scored significantly higher than the videos produced by individuals and academic centers. While the MSS, video power index score and and video length.

Conclusion: Conducting a professional evaluation of videos before they are published on YouTube may enhance video quality. Moreover, valuable videos of better quality can be produced by improving the MIRPE scoring system and by assessing more videos.

Keywords: MIRPE, Pectus Excavatum, YouTube, surgical training

Table 1. *MIRPE scoring system for YouTube Videos.*

Content		Score
Videos resolution	High Resolution (≥ 1280x720 pixels)	1
Preoperative evaluation	Age, gender, Haller Index (at least one) Preoperative picture Preoperative chest x-ray or CT scan Detailed correction method	1 1 1 1
Procedure description	Subtitle or voice comment	1
Surgery	Positioning Landmarks Incisions Bar Bending Placing Stabilizer VATS video recording Described in standardized steps	1 1 1 1 1 1 1
After Surgery	Surgical outcome Postoperative imaging	1 1

Table 2: *Features of videos*

	Year	Views	Comments	Likes	Duration	Source Of The Upload	MSS Compliance Scores
1	2011	738.815K	0	2.1K	5min	İndividual	10/15 (%66)
2	2024	5.8K	3	157	1h21min	Industry sponsored	11/15(%73)
3	2013	30K	32	154	3min	Academic	8/15(%53)
4	2015	10K	10	82	7min	Academic	8/15(%53)
5	2019	404k	1118	4.1K	2min	Academic	9/15(%60)
6	2020	853K	1088	7.3K	5min	Academic	4/15(%26)
7	2015	92K	112	375	2min	Academic	11/15(%73)
8	2025	1K	1	33	30min	İndividual	11/15(%73)
9	2022	192	2	4	21min	Academic	8/15(%53)
10	2016	420K	422	2.3K	2 min	Academic	3/15(%20)
11	2018	26K	220	83	3min	İndividual	6/15(%40)
12	2010	108K	0	385	9 min	Academic	5/15(%33)
13	2014	163K	0	913	5 min	Academic	8/15(%53)
14	2025	687	7	5	2min	İndividual	4/15(%26)
15	2023	3.3K	0	28	13min	Academic	2/15(%13)
16	2019	77K	245	613	4min	Academic	8/15(%53)
17	2015	192K	612	1.5K	16min	Industry sponsored	13/15(%86)
18	2021	11K	53	154	6min	Academic	7/15(%46)
19	2023	334	2	4	38min	İndividual	5/15(%33)
20	2013	842	0	3	3 min	İndividual	4/15(%26)

Table 3 : *Youtube videos compliance score's according to MIRPE scoring system(MSS) on Table 1 and video power index(VPI)**
**: VPI :[(like count/dislike count+ like count)x100]x[(number of views/days)x100]*

	MSS Compliance Scores	VPI
1	10/15 (%66)	3.135.170.509,7085
2	11/15(%73)	29.855.737,704882
3	8/15(%53)	10.382.022,471898
4	8/15(%53)	2.041.832,669292
5	9/15(%60)	7.198.609.300,3048
6	4/15(%26)	28.989.292.364,993
7	11/15(%73)	87.408.158,09475
8	11/15(%73)	2.408.759,12409
9	8/15(%53)	6.660,884648

10	3/15(%20)	2.907.011.736,3829
11	6/15(%40)	7.454.231,433493
12	5/15(%33)	75.027.066,041235
13	8/15(%53)	359.813.829,78742
14	4/15(%26)	15.866,05081
15	2/15(%13)	1.084.507,042248
16	8/15(%53)	209.782.222,22209
17	13/15(%86)	719.460.404,697
18	7/15(%46)	9.333.333,333324
19	5/15(%33)	13.716,632444
20	4/15(%26)	5.668,761222

Surgical Repair of Pectus Excavatum in Patients with Previous Intrathoracic Operations

Naoko Uga[1], Koichi Deguchi[1], Tasuku Kodama[1], Kengo Nakahata[1], Motonari Nomura[1], Takehisa Ueno[1], Miho Watanabe[1], Hiroomi Okuyama[2]

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Background and Aim: A history of previous intrathoracic operations such as congenital pulmonary airway malformation (CPAM) or congenital diaphragmatic hernia (CDH), is considered a risk factor for severe or asymmetric pectus excavatum (PE). At our institution, we choose either Nuss procedure or a modified Ravitch procedure depending on the severity. This study examined deformity characteristics and outcomes in patients with or without previous intrathoracic surgery.

Method: We retrospectively reviewed 84 patients who underwent PE repair between 2008 and 2024. Patients were divided into two groups: the associated group (AG, n=9) and the non-associated group (NAG, n=75), and their clinical characteristics and outcomes were compared. The AG included 4 patients with CDH and 5 with CPAM.

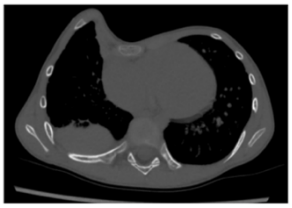
Results:

Among NAG, all 75 underwent the Nuss procedure as the primary surgery. In AG, 7 underwent the Nuss procedure initially. One of them had a recurrence and required reoperation with the modified Ravitch procedure. The remaining 2 patients in AG underwent the modified Ravitch procedure as the primary surgery.

The CT index was 4.2 in NAG and 5.0 in AG ($p = 0.12$). The asymmetric index was 1.05 in the NAG and 1.11 in AG ($p = 0.13$). In modified Ravitch cases, patients had more marked asymmetry, with an average ratio of 1.13 (Figure).

All patients with CPAM who underwent the Nuss procedure required adhesiolysis, with one case requiring reoperation due to postoperative air leak. Postoperative CT index improved to 3.1 in NAG. In AG, the index was 3.0 after the Nuss procedure, with recurrence in two cases and persistent asymmetry in one. In modified Ravitch cases, the postoperative index was 2.7 without complications.

Conclusion: PE patients with previous intrathoracic surgery had more severe and asymmetric deformities. The modified Ravitch procedures may offer favorable outcomes in such complex PE cases.



Preoperative CT of right CDH case

Keywords: Pectus Excavatum, Nuss procedure, modified Ravitch, procedure

Is open repair for chest deformities outdated or state of the art?

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Background and Aim:
Nuss procedure is widely performed for chest deformity. However, complications associated with foreign body, such as bar migration, infection, metal allergy, and residual pain have been reported. We are implementing the sterno-costal elevation method (SCE), which does not involve the placement of a foreign body.

Method:
From 1993 to 2024, 922 patients of chest deformity underwent surgical repair, 3-56 (16.5+/-10.0) years old, male:female 733:189, 868 pectus excavatum and 54 pectus carinatum.
Until 2006, 11 adults with severe deformity underwent sternal turnover, while 911 others underwent SCE. Through a mid-sternal skin incision, a portion of the third or fourth to seventh rib cartilages and the lower tip of the sternum were resected, and all of the stumps were pulled and re-stitched with braided polyester thread. The elasticity of the chest wall corrects the deformity. The same technique was used for pectus carinatum.

Results:
Mechanical ventilation was not needed after surgery, and no patients required blood transfusions. The wound was 6.7+/-1.9 cm in adults. There was one case of wound infection. None of them developed pneumonia, deep wound infection, and any life-threatening complications. No patient reported residual pain. Two patients required refixation. All but one patient satisfied with the result. Patients resumed daily activities of all types within three months after surgery.

Conclusion:
In SCE, moderate tension immobilizes the ribs and does not interfere with breathing. Because the morphology and malleability of the thorax varies, experience is required to the procedure. SCE provided satisfactory results by single surgery without leaving foreign body. We believe that SCE represent a less invasive and alternative procedure for the repair of chest deformities.

Keywords:
Open surgical repair, Pectus excavatum, Pectus carinatum

Impact of Different Bar Placement Techniques in Minimally Invasive Repair of Pectus Excavatum on Thoracic Morphology: A Retrospective Cohort Study

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Background and Aim:

Pectus excavatum (PE), the most common congenital chest wall deformity, is increasingly treated via minimally invasive repair (MIRPE) due to its reduced trauma and faster recovery.However, evidence-based guidelines for optimal bar placement strategies remain limited.This study evaluates the segmental effects of placement techniques on thoracic morphology and examines age-dependent outcomes to inform surgical decision-making.

Method:

We conducted a retrospective analysis of 80 pediatric patients who underwent MIRPE with subsequent bar removal at Beijing Children's Hospital (2019–2021). Patients were stratified by placement technique: single parallel bar, single oblique bar, double parallel bars, or double crossed bars.Preoperative and post-removal Haller Index (HI) and Correction Index (CI) were analyzed across thoracic segments (T4–T12). Age-stratified subgroup analyses were performed.

Results:

All four bar placement techniques demonstrated significant corrective effects, with single parallel bars improving both Haller Index (HI) and Correction Index (CI) across T4-T12 ($P<0.05$), single oblique bars at T5-T12, and double parallel bars showing HI improvement at T7-T12 and CI reduction throughout T4-T12. Double crossed bars exhibited the greatest change rates at T7-T12, though this did not reach statistical significance due to sample size limitations. While double-bar techniques required longer operative times and greater blood loss ($P<0.001$), they maintained comparable safety profiles. Age-stratified analysis revealed superior T12-level correction with double bars (particularly crossed configuration) in patients ≥10 years ($P=0.014$), whereas single parallel bars achieved better outcomes at T5/T6/T12 segments (ΔCI, $P<0.05$) in younger patients (<10 years).

Conclusion:

All four techniques effectively corrected pectus excavatum, with double-bar placement (both parallel and crossed configurations) demonstrating optimal correction of mid-lower thoracic segments (T7-T12), albeit with increased procedural complexity. Notably, crossed bars showed particular efficacy for lower-segment deformities. Age significantly influenced

outcomes, with double-bar strategies (especially crossed bars for lower-segment correction) being preferable for patients ≥10 years, while single parallel bars achieved superior results in younger patients (<10 years). These findings support an age-adapted, personalized approach to surgical planning in minimally invasive pectus excavatum repair (MIRPE).

Keywords:

Pectus excavatum, Nuss procedure, minimally invasive repair, thoracic remodeling.

Reinforcement of Thoracic Thickness Using the Cross-Bar Technique in Pectus Excavatum: A Comparative Study

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Background and Aim:

One of the advantages of the Nuss procedure for pectus excavatum is the improvement in anterior thoracic thickness, in addition to correction of the concave deformity. However, the anterior chest wall often recedes after bar removal, resulting in loss of thoracic projection. While the Haller Index is a widely used metric for evaluating pectus severity, it is affected by thoracic width, making it less suitable for assessing anterior–posterior thoracic depth.

To address this limitation, we previously proposed an original index based on sagittal CT images, evaluating thoracic thickness by measuring the angle between the sternum and the body axis. That study demonstrated a significant reduction in the sternal angle after bar removal, with the manubrium sterni showing the most notable change.

Anatomically, the lower costal cartilages are crucial in maintaining anterior projection of the sternum. The cross-bar technique, which enables bar placement in more caudal intercostal spaces, allows direct elevation of the lower costal margins and may provide enhanced support to the anterior thoracic wall. In this study, we retrospectively evaluated sternal angle changes using our index, comparing outcomes between the cross-bar and parallel-bar techniques.

Method (Fig.1)

We evaluated 58 patients using sagittal 3D CT images at three time points: before bar insertion, before removal, and six months after removal. Patients were divided into cross-bar (n=30) and parallel-bar (n=28) groups.

Results (Fig.2)

Both groups showed significant changes in sternal angle over time. The decrease after bar removal was significantly smaller in the cross-bar group (1.7° ±1.5°) than in the parallel-bar group (2.7° ±2.5° , $p<0.05$).

Conclusion:

The cross-bar technique may better maintain thoracic thickness postoperatively by enabling more effective elevation of the lower anterior chest wall.

Keywords:

Pectus excavatum, Cross-bar technique, Thoracic thickness

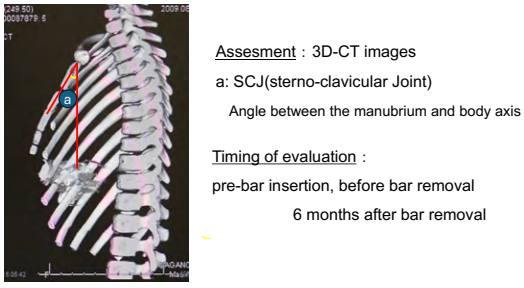

Fig.1 The assesment site

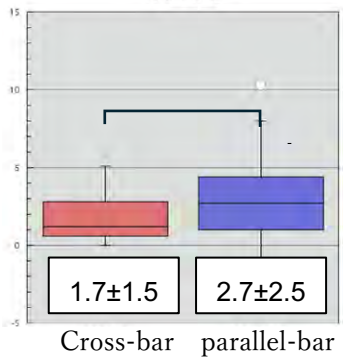

Fig.2 Compare the a mount of the variation of SCJ angle after bar removal.

Anterior chest wall response to Nuss bar removal in adolescents with pectus excavatum

Author(s)and Affiliation(s): Pavol Omanik[1], Eva Stefankova[2], Lenka Matejakova[3], Michaela Omanikova[2], Igor Beder[1], Jozef Babala[1]

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Background and Aim: Little information is available regarding long-term outcomes in patients with pectus excavatum after pectus bar removal. The presented study aims to identify the degree of anterior chest wall (ACW) retraction after bar removal in adolescents.

Method: A retrospective analysis of patients who underwent pectus bar removal in 2022-2024. Sagittal chest diameter as one of the anthropometrically used parameters was measured: before the Nuss procedure (S1), after the procedure (S2), and after pectus bar removal (S3). Based on these parameters, the extent of ACW elevation and the extent of ACW retraction were calculated. A correlation between the age of the patients and the degree of ACW retraction was analysed.

Results: 31 patients aged 13.7–18.9 years at the time of the Nuss procedure, and 17.2–22.6 years at the time of the bar extraction were included in the study. The bar in situ was 41.2±5.6 months on average. Follow-up after the bar removal was 7.9±4.7 months. The average S1 was 14.8±2.0 cm, S2 17.9±1.7 cm, and S3 17.4±2.3 cm. The average ACW elevation was 3.0±1.5 cm, and ACW retraction was 0.6±1.9 cm. The correlation coefficient between the patients' age and the extent of ACW retraction showed no correlation (p=0.77).

Conclusion: Based on the authors' experience, one must expect a certain degree of anterior chest wall retraction after pectus bar removal. The patients' age at the time of the initial operation or the bar removal does not affect the chest wall retraction value.

Keywords: pectus excavatum, adolescents, Nuss bar removal, anterior chest wall retraction, anthropometry

Tension-releasing procedures improve outcomes of Nuss procedure for PE in adult population. A computational study with clinical applicability.

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Background and Aim: The Nuss procedure is considered the gold standard treatment for pectus excavatum (PE) in pediatric population. However, its application in adults is associated with increased bar-related complications, insufficient correction and severe postoperative pain, all of wich are consequences of excessive chest wall rigidity. This study aimed to evaluate, both from an experimental and clinical point of view, the effects of incorporating minimally invasive tension-releasing techniques to the Nuss procedure in order to improve outcomes in adult PE population.

Methods: A finite element computational analysis was conducted on 3D thoracic models with varying degrees of deformity. Each model underwent simulations of sternal osteotomy and selective chondrotomies followed by sternal elevation. Required forces for elevation and resulting postoperative tension in the thoracic cage were calculated and values were compared with the corresponding ones of the standard Nuss procedure. At a clinical level both stress relieving techniques were succesfully applied to patients in a minimally invasive manner using instruments specifically designed for this purpose.

Results: Computational analysis revealed that greater HIs were associated with increased force requirements and mechanical tension during correction. Sternal osteotomy reduced corrective force by up to 54%, while costal chondrotomies resulted in force and rigidity reductions of up to 70%, independent of HI. In clinical practice, both tension-releasing procedures clearly decreased postoperative pain and improved correction results and were feasible through minimal aditional incisions.

Conclusion: Sternal osteotomy and costal chondrotomies significantly decrease thoracic rigidity and required corrective forces, offering effective, minimallynvasive adjuncts to the Nuss procedure for PE in adult patients.

Keywords: Pectus,Nuss procedure,chest wall rigidity, finite element analysis.

Predictors for Postoperative Pain in Pediatric Patients undergoing the Nuss Procedure for Pectus Excavatum

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[1] Department of Pediatric Surgery, The University of Osaka, [2] Department of Pediatric Surgery, Tottori University

Background and Aim:

The Nuss procedure offers a less invasive approach to pectus excavatum than conventional surgery, but nevertheless, patients undergoing the Nuss procedure often experience intolerable serious postoperative pain. Thus, optimizing postoperative pain management is crucial for promoting faster recovery and reducing chances of complications, including atelectasis. Careful evaluation of postoperative pain and identification of prognostic factors for severe pain are essential for improving pain management strategies.

The purpose of this study is to identify major predictors for postoperative pain among pediatric patients undergoing the Nuss procedure, for more effective pain management.

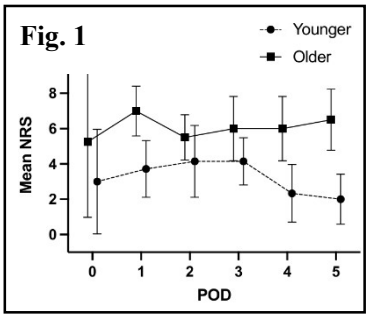
Method:

A retrospective study was conducted with 40 pediatric patients who underwent the Nuss procedure for pectus excavatum at The University of Osaka Hospital. Patient demographics, postoperative outcomes, postoperative numerical rating scale (NRS) pain scores, and usage of pain-relief medicine were reviewed. The association of these factors were statistically analyzed, especially focusing on differences due to sex and age.

Results:

The age at surgery was the only significant predictor for pain severity postoperative day of (POD) 5 (p=0.036). There were no significant differences due to sex, age and Haller index, in the postoperative outcomes, including complications and length of hospital stay. In contrast, pain severity as evaluated by NRS on POD 1 and 5 did not vary between females and males, however, older patients reported higher NRS score than younger patients on POD 1 (p=0.022) and 5 (p=0.018) (**Fig. 1**). The usage of pain-relief medicine was not significantly different by age or sex.

Fig. 1



Conclusion:

Older pediatric patients experienced more severe postoperative pain than younger patients following the Nuss procedure. On the other hand, there was no sex difference in severity of postoperative pain.

Keywords:

postoperative pain, Nuss procedure, pediatric, pectus excavatum

Current Practices in Perioperative Pain Management Following the Nuss Procedure; a CWIG-survey

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Background and Aim: The Nuss procedure for pectus excavatum correction is accompanied by severe postoperative pain. Several analgesic techniques have been researched, however a consensus pertaining the optimal strategy is yet to be reached. The lack of standardization has led to a variability in pain management. This survey aims to objectify the international variability in perioperative pain management following the Nuss procedure.

Method: A cross-sectional survey was designed using Qualtrics XM and distributed via the Chest Wall International Group. Medical specialists were included. Demographics and views on the use of various analgesic techniques, i.e., intercostal nerve cryoablation, thoracic epidural analgesia, locoregional blocks, patient-controlled intravenous analgesia and other, were collected. Data analysis was performed using IBM SPSS (v27.0). The index of qualitative variation (IQV) was calculated to quantify variability in responses.

Results: Analysis included 71 participants spread across Europe (46.5%), North America (28.2%), South America (12.7%), Asia (8.5%), Australia (2.8%) and Africa (1.4%). Of these participants, 70.4% had >10 years of experience treating patients undergoing the Nuss procedure. 63 participants reported the use of a standardized pain management protocol. Amongst which a high global variance in primary analgesic technique (IQV 0.86) was identified. A continental sub analysis showed a high variance within Europe and South America with an IQV of 0.93 and 0.86 respectively. Solely North America showed a low variance (IQV 0.14) with a preference towards intercostal nerve cryoablation (94%). Worldwide, most participants used additional analgesic techniques (89%) in their standardized protocol.

Conclusion: These findings revealed high international variability in pain management following the Nuss procedure. Nevertheless, results did suggest a global agreement on a multimodal approach. North American specialists showed a clear preference for intercostal nerve cryoablation as primary analgesic technique. Future research should focus on providing high quality evidence on the optimal technique, reducing variability in perioperative pain management.

Keywords: Pectus excavatum, pain management, cross-sectional survey

The Bridge Technique: Addressing Bar Rotation Challenges Amidst Enhanced Postoperative Mobility in the Cryoanalgesia Era

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Background and Aim: Enhanced and earlier mobility enabled by cryoanalgesia has been associated with high rates of bar displacement following minimally invasive repair of pectus excavatum (MIRPE). In the context of the use of bridging systems and cryoanalgesia as the default strategy in all patients undergoing MIRPE in our center since 2016 and 2018, respectively, we hypothesized that this stabilization method would mitigate displacement. Thus, we explored the impact of cryoanalgesia on the rates of bar displacement within a large cohort of patients undergoing MIRPE plus bridge systems.

Method: We analyzed a prospectively collected database of patients undergoing MIRPE by the same surgical team between January 2016 and May 2024. All patients had two or more implants, a requirement when employing lateral bridges. Patients were categorized into two groups depending on whether they received cryoanalgesia. Variables analyzed included demographics, implant displacement requiring reoperation, length of hospital stay, and opioid requirements.

Results: A total of 285 patients (91% male) with a mean age of 17.1±5.0 years were included, among whom 205 underwent cryoanalgesia and 80 underwent thoracic epidural analgesia (No Cryo). No patients required reoperation for implant displacement, including implant rotation, lateral displacement, or unilateral sinking. We didn't identify clinically relevant differences between groups regarding demographical characteristics except for duration of surgery [Cryo: 120 min (112.0; 145.0) vs. No Cryo: 100 min (80.0; 120.0), $p<0.001$] (Table 1). However, patients who underwent cryoanalgesia had significantly lower postoperative hospital stay [Cryo: 1.0 day (1.0; 2.0) vs. No Cryo: 3.0 days (3.0; 4.0), $p<0.001$]) and in-hospital opioid use [Cryo: 5.0 mg (0.0; 10.0) vs. No Cryo 29.5 mg (15.0; 46.0), $p<0.001$] compared to those without cryoanalgesia.

Conclusion: The placement of a bridging system is an effective approach to avoid bar displacement in patients undergoing MIRPE with 2 or more bars, irrespective of cryoanalgesia.

Keywords: Pectus; MIRPE; bridge; cryoanalgesia.

Disclosure Statement of COI: Marcelo Martinez-Ferro: Compensation: Pampamed SRL

Table 1: Comparison between patients with pectus excavatum undergoing the Nuss procedure with the bridge technique depending on whether they received cryoanalgesia.

	Cryoanalgesia	No cryoanalgesia	P value
N (285)	205	80	
Age (years)	15 (14.0; 17.0)	16 (14.8; 20.0)	0.025
Haller Index	4.7 (3.9; 6.0)	5.0 (4.2; 6.1)	0.39
Correction Index (%)	42.2 (34.0; 53.1)	36.0 (26.0; 49.5)	0.005
Titanic Index	81.9 (63.0; 87.2)	72.1 (48.0; 77.8)	0.095
N implants/patient	3 (2.0; 3.0)	3 (2.0; 3.0)	0.376
Bar displacement requiring revision (cases)	0	0	
In hospital opioid requirement (OME)	5.0 (0.0; 10.0)	29.5 (15.0; 46.0)	<0.001
Length of stay (days)	1.0 (1.0; 2.0)	3.0 (3.0; 4.0)	<0.001

Median (Interquartile range) was used for continuous variables and comparisons were made with the Mann Whitney U test. Abb.: OME: oral morphine equivalent.

Risk factors of Acute Postoperative Pain Following the Surgery of Pectus Excavatum

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[1] Department of Surgery, Division of Thoracic Surgery, Keio University School of Medicine, Tokyo, Japan [2] Department of Anesthesiology, Keio University School of Medicine, Tokyo, Japan

Background and Aim: Acute postoperative pain after the Nuss procedure for pectus excavatum is often intense because mechanical chest-wall elevation stresses intercostal nerves. Severe pain prolongs hospitalization, increases complications, and can progress to chronic pain, yet its determinants are not fully understood. We prospectively evaluated early postoperative pain and its clinical predictors.

Method: Consecutive patients undergoing the Nuss procedure at our institution from October 2023 to April 2025 were enrolled. Pre-operative health-related quality of life (EQ-5D-5L) and psychological status were surveyed. Pain intensity was recorded daily with an 11-point numeric rating scale on postoperative days 0–5. Patients with a mean score ≥ 4 were assigned to the Moderate-to-severe pain group, whereas those with a mean < 4 formed the Mild pain group. Demographics, operative details, and outcomes were compared.

Results: Among 139 consenting patients, 49 (35.2 %) were classified into the Moderate-to-severe pain group and 90 (64.8 %) into the Mild pain group. Age (median 24 vs 26 years, $p = 0.183$), pre-operative Haller index (4.20 vs 4.50, $p = 0.416$), and male proportion (79.6 % vs 78.6 %, $p = 1.00$) were comparable. Median patient-controlled analgesia duration (5 vs 4 days, $p = 0.009$) and postoperative hospital duration (8 vs 7 days, $p < 0.001$) were longer in the Moderate-to-severe pain group. This group also showed lower pre-operative EQ-5D scores (0.82 ± 0.15 vs 0.89 ± 0.11, $p = 0.002$), higher HADS-Anxiety scores (9.07 ± 4.19 vs 6.85 ± 4.54, $p = 0.005$) and Symptom Catastrophizing Scale (6.00 ± 3.13 vs 4.61 ± 2.75, $p = 0.009$).

Conclusion: Greater acute pain after the Nuss procedure is significantly associated with pre-operative anxiety and catastrophizing thoughts. Routine psychological assessment before surgery may facilitate individualized perioperative analgesia and help curb the transition to chronic pain; prospective validation is warranted. (298/300 words)

Keywords: acute postoperative pain, anxiety, numeric rating scale, Nuss procedure, pectus excavatum

Current Management of Skin Reactions and Infections After Nuss Procedure: A Survey Among CWIG Surgeons

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Background and Aim:
Skin reactions after minimally invasive pectus excavatum repair (MIRPE) are complex, often involving infection, allergy, or foreign body response. Management, including implant retention and bar removal, is controversial and depends on surgeon experience. This survey explored current practices among Chest Wall International Group (CWIG) members.

Method:
A web-based questionnaire consisting of 35 questions was distributed to CWIG members across 215 institutions. Seven questions focused on participant information, while 28 addressed the perioperative management of skin reactions following MIRPE.

Results:
Forty-seven institutions responded (21.9% response rate). Preoperative antiseptic showers were used by 82%, and 91% administered cefazolin prophylaxis. Antibiotics were given in all infection cases. Allergy testing was performed routinely by 15% of surgeons and selectively by 76%, based on patient history, covering 30–40% of patients. Infection rates were low, with 62% reporting fewer than five infections. Conservative management was used in 88% of complications, while 12% required bar removal, mainly for severe infection (9%) or bar exposure (3%). Antibiotic therapy, typically cefazolin or clindamycin, lasted 2–6 weeks. Cultures were routinely obtained, with debridement performed in 18% of infection cases and VAC therapy used in 7% of complicated cases. Risk factors included wide subcutaneous dissection (71%), unrecognized metal allergy (44%), and poor soft tissue coverage (38%). Although a 3-year bar retention period was standard, 59% of surgeons considered 12–24 months acceptable in complicated cases.

Conclusion:
Despite the use of similar preventive strategies, there was notable variability in the management of MIRPE-related skin and infectious complications. Only 12% of surgeons reported requiring bar removal due to complications. These findings emphasize the need for consensus guidelines from CWIG or prospective multicenter studies to standardize care and enhance outcomes.

Keywords:
MIRPE (Minimally invasive repair of pectus excavatum)/Nuss procedure, complications, bar infection, survey, CWIG

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Nuss Bar Infections: Surgical Risk Factors and Management Strategies

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Background and Aim: This study aims to evaluate the incidence and characteristics of Nuss bar infections, identify surgical risk factors, and proposes an optimized management strategy.

Method: We conducted a retrospective cohort study of all patients who underwent the Nuss procedure between 1999 and 2024 at the Amsterdam Pectus Center. Primary outcomes included the incidence and management of Nuss bar infections. Secondary outcomes included infection characteristics (early- versus late-onset, superficial versus deep), diagnostics, cultured bacteria, prognostic factors (sex, age, type of anesthesia, number of bars, bar dislocation, stabilizer position, use of sutures), impact on bar removal, and incidence of allergies and terra firma-forme dermatosis.

Results: Of 695 patients, 4.0% (n=28/695) developed Nuss bar infections, typically presenting six months postoperatively with erythema, pain and exudate. Over time, infections shifted from early- to late-onset (P=.03). Deep infections (71.4%, n=20/28) more often required surgery (P=.007) whereas superficial infections were managed with antibiotics alone, involving a wide range of regimens. Bar dislocations (5.6%, n=39/695) and stabilizer plate loosening (1.0%, n=7/695) required reoperation and were risk factors for infection (P=.001). Operative time for bar removal was longer in infected patients (52.0 (32.0–68.0) versus 35.0 (26.0–49.0), P=.03). One case of cobalt allergy was identified. Terra firma-forme dermatosis (0.4%, n=3/695) was successfully treated using alcohol wipes.

Conclusion: The incidence of Nuss bar infections remains low but requires structured, multidisciplinary management. Bar dislocation and plate loosening are key risk factors. Our protocol emphasizes precise diagnostics, consistent and tailored antibiotic therapy, and awareness of alternative diagnoses in atypical presentations.

Keywords: Nuss procedure, infection, cutibacterium acnes, bar dislocation, terra firma-forme dermatosis

Surgical Site Infections in Adult Pectus Repair

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Background and Aim: Infections after pectus repair are uncommon but pose serious risks due to implanted hardware. Data on surgical site infections (SSIs) for adult pectus repair are limited. This study evaluates the incidence, risk factors, and management of SSIs in adults undergoing pectus repair.

Method: A retrospective analysis was performed on all patients who underwent pectus repair by a single surgeon at Mayo Clinic Arizona between January 1, 2010, and March 31, 2024. Patients were stratified by surgical approach: primary minimally invasive repair (MIRPE), hybrid MIRPE, revision procedures, and complex reconstructions. Patients with breast or pectoral implants were analyzed separately. SSIs were categorized as superficial or deep/organ-space per IDSA criteria. Comparative analysis was conducted.

Results: A total of 1,253 adults underwent repair during the study period (median age 29.7 years; 66.4% male; median Haller index 4.6). Superficial SSIs occurred in 1.1% and were managed with antibiotics. Deep/organ-space infections occurred in 1.0%, primarily treated with incision and drainage, IV antibiotics, and suppressive oral therapy. Bar removal was performed in 85% of the infected cases at a median time of 3.3 years with only 13.0% requiring early bar removal (<2.5 years). Women with breast implants represented 7.9% of the repairs and significantly higher infection rates was associated with having implants present at the time of pectus repair (9.0% vs. 2.0%, $p<0.001$). Other risk factors included longer operative duration (median 250 vs. 146 minutes, $p<0.001$) and greater surgical complexity. Hybrid MIRPE did not significantly increase infection risk compared to primary MIRPE. Female sex was associated with higher infection rates, likely due to breast implants.

Conclusion: Surgical site infections following adult pectus excavatum repair are rare but more common in complex or prolonged procedures and in patients with breast implants. Identification of high-risk patients and tailored perioperative strategies are essential to minimizing infection-related complications.

Keywords: Pectus excavatum, surgical site infection, MIRPE

Pectus Hardware Salvage Following Infection At A Single Institution

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Background and aim:
Hardware infection is a rare but serious complication of pectus excavatum repair with the potential need for bar removal. Here, we evaluate our institutional experience with pectus infections and ability to preserve hardware and salvage our chest wall repairs with an aggressive treatment strategy.

Methods:
We present a single-institution retrospective review of patients who underwent Nuss procedure from 7/1/2013-1/1/2025 to treat pectus excavatum. Outcomes including demographics, antibiotics, infection, management, and bar preservation were evaluated.

Results:
A total of 863 pectus patients were included. Mean age was 14.7. Infection rate within 90 days was 1.39% (12/863) with 33% (6/18) occurring after the 90-day definition of a postoperative surgical wound infection resulting in an overall infection rate of 2.09% (18/863). Of those with a post operative infection, 1/3 were superficial and 2/3 were deep. Management of infections included antibiotic therapy only (44.4%, 8/18), operative washout (16.6%, 3/18), FiberWire removal (16.6%, 3/18), and wound vac (16.6%, 3/18). One bar was removed beyond the standard 2-year period (0.06%, 1/18). All bars were preserved.
Conclusion:
Treatment of superficial and deep postoperative hardware infections using antibiotics, operative washout, debridement, removal of FiberWire, and/or wound VAC therapy and suppressive antibiotics may avoid the need for pectus hardware removal following Nuss procedure. Deep bar infections may present beyond the 90-day definition of a postoperative hardware infection.

Keywords:
Pectus excavatum, Nuss procedure, infection, pectus bar, preservation

Prospective randomized trial of efficacy and safety of erector spinae catheter and intercostal cryoablation protocols after pectus surgery: Interim analysis

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Background and Aim: Cryoablation of the intercostal nerves (INC), is a newer modality of pain control used in adolescent patients for Nuss procedures. This study aimed to compare a) the time to achieve short-term physical therapy (PT) goals b) immediate postoperative opioid consumption and pain outcomes c) S-LANSS at 6 weeks, 2-3 months, and 4-6 months in patients undergoing INC and multimodal ES catheter protocols for pain control after pectus surgery repair.

Method: A prospective randomized clinical study of 12- to 21-year-old patients scheduled for the Nuss procedure were grouped into erector spinae catheters (ESC) (N=15) and thoracoscopic guided intercostal cryoablation and intercostal nerve blocks (INC) (N=16).

Results: The cohort had a mean age of 15.4 years (SD 1.69). Both groups were comparable on age, ASA status, comorbidities, Haller index, BMI, preop pain scores. Both groups met short-term PT goals of stair-climbing and walking in halls by POD 2, but significantly more INC patients met stair-climbing goals on POD 1 (p = 0.0136). Group INC had lower opioid consumption and better pain control during the hospital stay. (Table 1). Higher trends for postoperative S-LANSS scores were noted in the INC group. The positive responses were recorded for pins and needles sensations, abnormal sensitivity to touch, sudden shock-like sensations, and numbness to touch. No patients required medical treatment for these symptoms.

Conclusion: Acute pain and opioid use are significantly lower in patients who receive INC (vs. ES), while time to achieve short term PT goals is similar. Patients who received intercostal nerve cryoablation may continue to have symptoms suggestive of neuropathic pain at six months postoperatively. Patients who receive cryoablation for postoperative pain relief will need long-term follow-up to ensure complete neurological recovery.

TABLE 1	ESC (N=15)	INC (N=16)	P value
SLANSS week 4-6	0 (0, 2)	3 (0, 10)	0.1039
SLANSS month 2-3	0 (0, 1)	1.5 (0, 3)	0.1217
SLANSS month 4-6	0 (0, 3)	7 (2, 16)	0.0278
Total Opioid (MME)	2.12(1.29, 2.61)	0.99 (0.57, 1.54)	0.0014
Integrative pain score	115.41 (177.58)	-66.31 (212.10)	0.0413

Keywords: Nuss procedure, pectus excavatum, erector spinae catheters, cryoablation

Impact of 2-site cryoablation on pain control after the Nuss procedure

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Please structure your abstract within a single page, following the format below. The abstract should not exceed 300 words. You may include images and charts as long as they fit within a single page.

Background: Intercostal nerve cryoablation (CRYO) has reduced opioid use and hospital length of stay (LOS) following the Nuss procedure. Traditionally, only the main branch of the intercostal nerve (ICN) has been targeted with cryoablation. However, a recent study suggested the collateral branch of the ICN may also be important for pain control.

Methods: We retrospectively analyzed patients ≤21 years of age who underwent the Nuss procedure with the Park System from 1/2023 to 03/2025. Group 1 underwent standard CRYO inferior to the ribs, freezing the main ICN (1-site CRYO). In Group 2, an additional CRYO site was added by also freezing the superior aspect of the rib below, thus freezing both the main ICN and the collateral ICN branch for each interspace (2-site CRYO). Postoperative pain and opioid requirements were compared.

Results: 39 patients (60.9%) received 1-site CRYO and 25 (39.1%) had 2-site CRYO. Patients had a mean Haller Index of 5.0 and 4.6 respectively, a median of 2 bars/patient, and similar demographics. Average pain scores were significantly improved for the 2-site CRYO group (2.9 ± 1.7 vs. 1.8 ± 1.1, p=0.003). A significant reduction in postoperative IV opioid usage was also seen (22.4 ± 37.9 vs 8.9 ± 10.1 oral morphine equivalents [OME], p=0.039). There was no impact on LOS.

Conclusions: Targeting the collateral branches of the ICNs with 2-site CRYO reduces postoperative pain and opioid use compared to 1-site CRYO. Further follow-up is warranted to determine impact on sensory recovery.

Keywords: pectus excavatum, cryoablation, cryoanalgesia, pain management, collateral intercostal nerve branch, opioid.

Non-Inferiority of 1-Minute Versus 2-Minute Cryoanalgesia Cycles During Minimally Invasive Repair of Pectus Excavatum (MIRPE): A Propensity Score-Matched Analysis

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Background and Aim: Since September 2018, 268 patients underwent MIRPE (minimally invasive repair of pectus excavatum) with 2-minute cryoanalgesia cycles at our center, resulting in reduced postoperative opioid requirements and length of stay compared to standard analgesia. Since the optimal duration of cryoanalgesia cycles remains undefined, our protocol was modified in January 2025 to adopt 1-minute cryoanalgesia cycles. Thus, the aim was to compare postoperative opioid consumption and length of stay between patients undergoing MIRPE with 1-minute versus 2-minute cryoanalgesia cycles.

Method: Patients treated with 1-minute cryoanalgesia cycles were matched to controls from the 2-minute group using Propensity Score Matching (nearest-neighbor method) to improve the reliability of the comparison. Thirty-four patients with comparable age, sex, weight, Haller Index, Correction Index, number of bars, and bar crossing were matched. Opioid requirement expressed as OME (oral morphine equivalents) and length of stay were compared between groups using the Wilcoxon test and a non-inferiority analysis, with predefined thresholds of 10 mg OME and 0.5 days for length of stay.

Results: Seventeen matched pairs were analyzed. No significant differences were observed in median length of stay (1-minute: 0 days [IQR: 1; 2] vs 2-minute: 0 days [IQR: 1; 1], p=0.25) or in OME (1-minute: 10 mg [IQR: 0; 20] vs 2-minute: 2.5 mg [IQR: 0; 5], p=0.21). Differences in median opioid requirements (7.5 mg OME) and hospital stay duration (0 days) were below the predefined non-inferiority thresholds, showing that the 1-minute group demonstrated non-inferiority to the 2-minute group for both outcomes.

Conclusion: One-minute cryoanalgesia cycles during MIRPE appear to be non-inferior to two-minute cycles regarding opioid use and hospital stay. A shorter cryoanalgesia duration may offer a safe and efficient alternative in selected patients.

Keywords: MIRPE, pectus excavatum, cryoanalgesia, opioid requirement

Antibiotic treatment for chronic pain following minimal invasive repair of pectus excavatum.

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Background and Aim:
Chronic pain following MIRPE is an under investigated problem. Following the idea that a low-grade infection caused by the Cutibacterium acnes might be the cause of this chronic pain, antibiotic treatment might be the new analgesia in these patients.

Method:
Patients were included after MIRPE, with a subsequent removal of the bars and of whom cultures were taken peroperative during bar removal. Patients were selected based on a retrospective suspicion of low-grade infection. The patient characteristics as well as the follow up course after bar implantation and removal, and the culture results were compared between patients with and without antibiotic use.

Results:
A total of 62 patients were included and 29 (46.8%) of these patients received antibiotic treatment. During treatment 14 patients experienced full complaint reduction, seven experiences complaint reduction to a bearable level without the need of analgesic medication, four experienced complaint reduction but were still in need of analgesic medication, and only four patients did not experience any pain reduction. The Cutibacterium acnes was cultured in 16 patients (55.2%) receiving antibiotic treatment compared to 24 patients (82.8%) not receiving antibiotic treatment (difference 29.6%, p =0.01).

Conclusion:
Antibiotic treatment shows potential as a treatment for chronic pain after MIRPE when a low-grade infection is suspected and other possible causes are excluded. This might prevent prolonged periods of pain and analgesic medication use. We propose a stepped approach to adequately identify and treat these patients.

Keywords:
Nuss-bar procedure, MIRPE, pectus excavatum, low-grade infection, chronic pain, antibiotics

Another source of near-fatal bleeding - late-onset hemothorax six weeks after uneventful minimal invasive repair of pectus excavatum

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Objective
The minimal invasive repair of pectus excavatum (MIRPE) and its' modifications represent the gold standard for surgical repair of chest wall deformities. Severe complications during and/or after MIRPE are rare but also underreported in the literature.

Results
We report on a 14-year-old adolescent who underwent an uneventful repair of his asymmetric funnel chest. 6 weeks postoperatively the patient presented with shortness of breath and dizziness. Clinical examination and imaging showed a spontaneous massive right-sided hemothorax. After chest tube placement and initial drainage of 600ml bloody pleural effusion, Angio-CT imaging was performed without evidence of active bleeding, but suspicion of a lesion to the right-sided internal mammary artery. After evacuation of 1600ml bloody effusion with the patient still in stable condition, the chest tube was removed within 24 hours. The further clinical course was uneventful.

Discussion
Accidental lesion of the internal mammary or intercostal vessels during pectus surgery represent a rare but potentially serious complication. Only a few cases with delayed and near-fatal bleeding as a complication after MIRPE are reported in the literature, many of them never demonstrated a clear source of bleeding.

Conclusion
Watchful waiting was finally successful in our case. However, immediate intervention (IMA coiling by interventional radiologist or thoracoscopic surgical repair) is mandatory in case of persistent bleeding. Pectus surgeons have to be aware of this possible risk and therefore we stress the need to report on such rare complications.

Costo-clavicular Space: A Risk Zone for Brachial Plexus Injury in Pectus Repair?

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Background and Aim: Brachial plexus injury is a rare but serious complication following pectus excavatum (PE) repair. Among various anatomical factors, narrowing of the costoclavicular space (CCS) may play a critical role by creating a channel for neurovascular compression. This narrowing can result from rib cage elevation, which alters the geometry of the thoracic outlet.

Methods: Pre- and postoperative CT scans of 100 recent patients who underwent the XI bar technique were analyzed. The costoclavicular space was measured as the shortest vertical distance between the clavicle and the first rib on sagittal projections (Figure 1). Changes in this gap were assessed to help define a safety margin for chest wall elevation.

Results: Among 2,217 patients who underwent PE repair using pectus bars between 2011 and 2025, 7 patients (0.003%) developed brachial plexopathy. In three cases, the upper bar was removed immediately after the initial operation due to severe motor paralysis of the right upper extremity. Neurological symptoms completely resolved in all patients in 4 to 6 weeks, with no permanent deficits observed. The measurements of CCS are summarized in Tables 1 and 2.

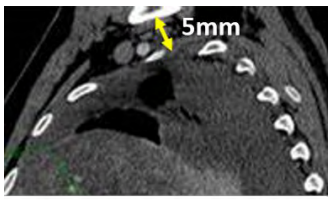

Fig. 1. Measurement of Costoclavicular Space between First Rib and Clavicle

Region	Distance Range (Mean, mm)	≥5mm n (%)
Pre R	2.43–12.37 (5.04)	42 (42%)
Pre L	1.52–12.83 (4.92)	40 (40%)
Post R	2.00–11.99 (4.06)	17 (17%)
Post L	2.00–8.72 (4.26)	28 (28%)

Table 1. Measurement of Costoclavicular Space
Pre: preoperative, Post: postoperative, R: right, L: left

Pair	Mean Difference	SEM	95% CI	p-value
PR – POR	0.98	0.21	0.56 – 1.40	< .001
PL – POL	0.66	0.20	0.27 – 1.05	.001

Table 2. Comparison of Costoclavicular Space Changes
PR: preoperative right, PL: preoperative left,
POR: postoperative right, POL: postoperative left

Conclusion: In the majority of our patients, the costoclavicular space was narrower than the estimated normal value of 10 mm and further decreased after PE repair, indicating a potential risk for brachial plexus compression. A 5 mm threshold has been adopted in our practice as a precautionary guideline to identify high-risk cases and support safer surgical planning, particularly when upper bar placement is required.

Keywords: pectus excavatum, brachial plexus, costoclavicular space, thoracic outlet

Pleural Effusion After MIRPE: Steroids Fail to Show Benefit in a 446-Patient Retrospective Study

Background and Aim: Pleural effusion is a frequent but understudied complication following minimally invasive repair of pectus excavatum (MIRPE), with reported incidences ranging from 3% to 17%. Despite its clinical relevance, little is known about preventive strategies, and the potential role of corticosteroids remains unclear. Our aim was to evaluate whether early postoperative steroid administration reduces the incidence, timing, or severity of pleural effusion following MIRPE in a large single-center cohort.

Methods: We retrospectively analyzed 446 patients (mean age 17.5±5.4 years; 89.3% male) who underwent MIRPE between 2013 and 2025 at a tertiary referral center. Patients were grouped based on whether they received corticosteroids within the first 72 hours postoperatively. The primary outcome was incidence of pleural effusion; secondary outcomes included timing and need for surgical drainage.

Results: Pleural effusion occurred in 11.0% of patients, with a mean onset of 12.3±8.2 days post-op; half required surgical intervention. No significant differences were observed between steroid (S) (n=296) and non-steroid (NS) (n=151) groups in incidence (S: 10.5% vs NS: 11.9%, p=0.643), timing (S: 12.7±9.2 vs NS: 11.6±6.1 days, p=0.680), or videoassisted thoracoscopic pleural toilette rates (S: 4.1% vs NS:7.9%, p=0.084).

Conclusion: Early postoperative steroid administration does not reduce the risk or severity of pleural effusion following MIRPE. These findings suggest the need to explore alternative prophylactic strategies for this common complication.

Evaluating the Cumulative Complication Risk during the Surgical Treatment Course of Pectus Excavatum; a Single-Center Analysis.

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Background and Aim: The Nuss procedure for correction of pectus excavtum is associated with complication rates ranging from 2-27% for bar insertion and 3-4% for bar removal surgery. However, a cumulative complication risk throughout the entire treatment course remains unknown. Understanding this cumulative risk is essential for both patients and healthcare providers to make an informed decision for surgery. Thus, this study aims to objectify the cumulative complication rate as well as contributing risk factors.

Method: This single-center retrospective cohort included patients who underwent the full treatment course for the Nuss procedure and completed follow-up until 12 months after bar removal. Data extracted included patient characteristics, surgical details and complications. Complications were graded using the Clavien-Dindo classification and analyzed as primary outcome. Statistical analyses included Kaplan-Meier time-to-event analysis and logistic regression to identify predictors of complications.

Results: Out of 434 included patients, 19% (n=81) experienced at least one complication during the treatment course. Most complications occurred after bar insertion (81%) and were classified as minor (57%). Patients with complications were older at the time of bar insertion (median 18.0 years vs. 16.9 years, p = .002) and multivariate regression analysis identified age at insertion as the sole significant predictor of complications (OR 1.059, 95% CI 1.021–1.100, p = .002). Kaplan-Meier analysis demonstrated a significant decrease in complication-free survival among patients older than 24 years at insertion (p = .004).

Conclusion: 81% of patients undergoing the Nuss procedure experience a complication-free treatment course. Age at bar insertion was identified as a significant predictor of complications, with higher risks observed in patients older than 24 years. These findings support timely bar insertion which should be considered during the shared decision-making process for surgical correction.

Keywords: Pectus excavatum, Nuss procedure, complication risk

Patient-Specific 3D Surgical Guide-Assisted Wedge Osteotomy for Pectus Arcuatum: A Novel Tabula-Sparing Technique

Purpose

Pectus arcuatum is a rare anterior chest wall deformity characterized by both protrusion and angular deformity of the sternum. Surgical correction poses significant technical challenges due to the need for precise osteotomy without compromising the posterior sternal table. We present a novel case utilizing a custom-designed 3D surgical cutting guide with integrated suction channels to perform a precise, bloodless, and tabula-preserving wedge osteotomy.

Methods

A 35-year-old male presented with anterior chest wall protrusion. Computed tomography (CT) revealed a narrowed sternal apex angle consistent with pectus arcuatum. A patient-specific cutting guide was developed using CT-derived 3D reconstruction and angle planning (22.7° wedge), ensuring 1/3 posterior table preservation. The guide design prevents the oscillating saw from exceeding 2/3 of the sternal depth, thereby protecting the posterior cortex. Moreover, the internal geometry of the guide strictly constrains the blade to follow the pre-calculated wedge angle, eliminating both under- and overcorrection risks. This prevents inadequate correction as well as excessive gaps that may compromise fixation stability or lead to delayed healing or infection. The guide also included a built-in suction port to remove medullary debris during osteotomy, improving visibility.

Results

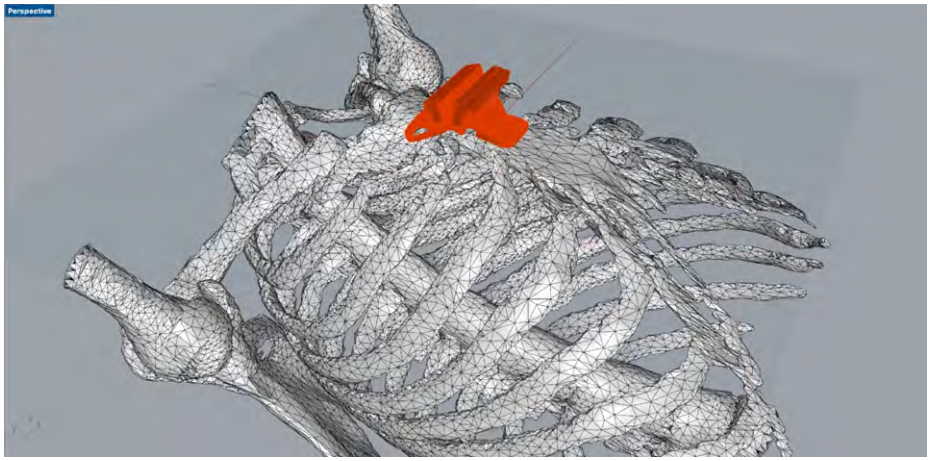
The guide was successfully affixed to the sternum. Oscillating saw osteotomy was performed within the guide channels, achieving a clean and symmetrical wedge resection. Subperichondrial bilateral resection of the 2nd–4th costal cartilages was also performed. The planned wedge angle was successfully reproduced intraoperatively thanks to the guide's precise geometry, which physically restricted the saw blade to the intended depth and orientation. No posterior table breach occurred. The resulting osteotomy line was smooth and symmetric, facilitating accurate sternal repositioning and screw fixation with minimal residual gap. The patient was discharged on postoperative day 2. At 7 months, both clinical and radiologic evaluations confirmed successful anatomical correction without recurrence or hardware complications.

Conclusion

This is the first reported case of wedge osteotomy for pectus arcuatum utilizing a patient-specific 3D cutting guide with integrated suction channels. This technique enables precise, bloodless correction while preserving the posterior sternal table. The method represents a novel and reproducible strategy for complex anterior chest wall deformities.

[Disclosure Statement of COI]

We have no conflicts of interest to declare.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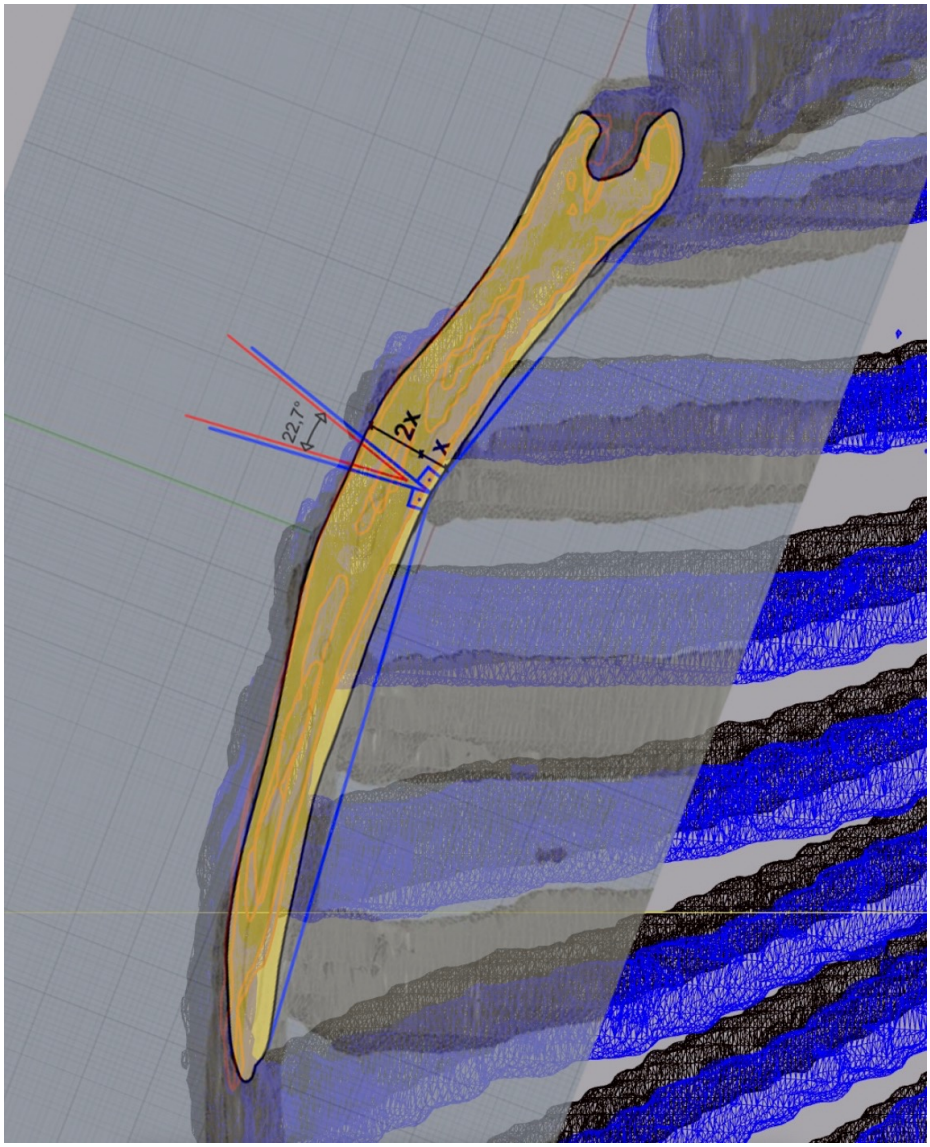
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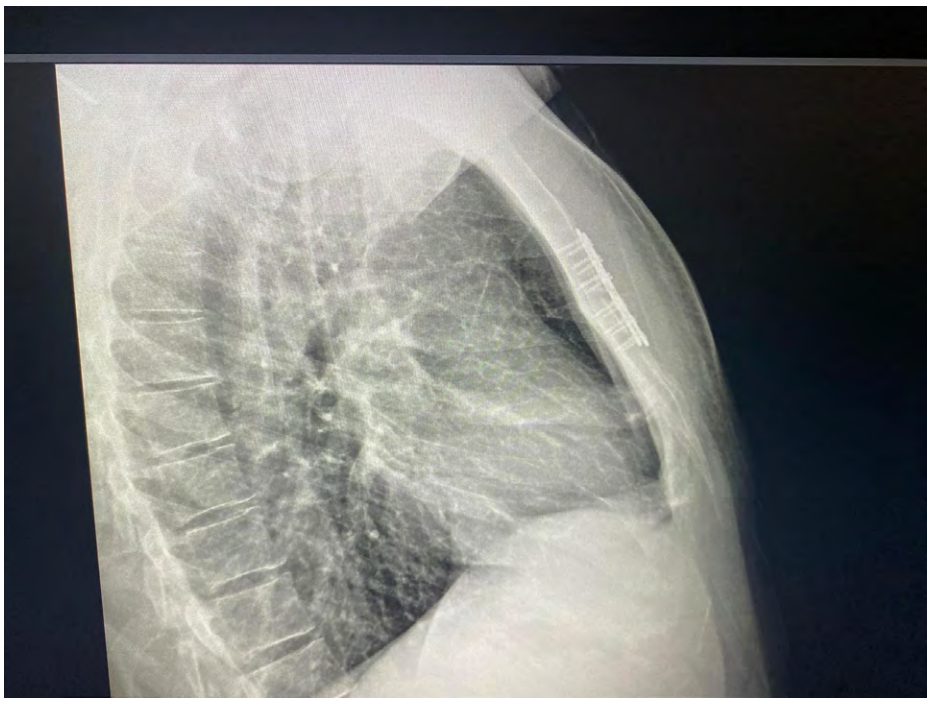

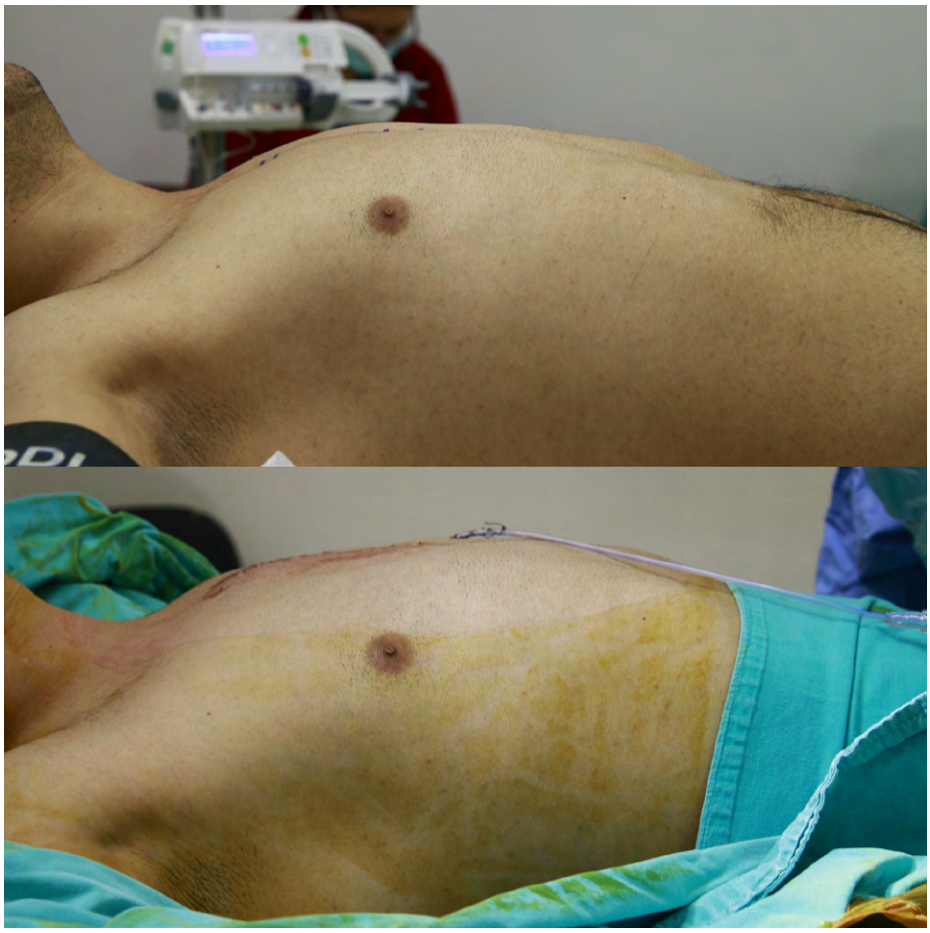

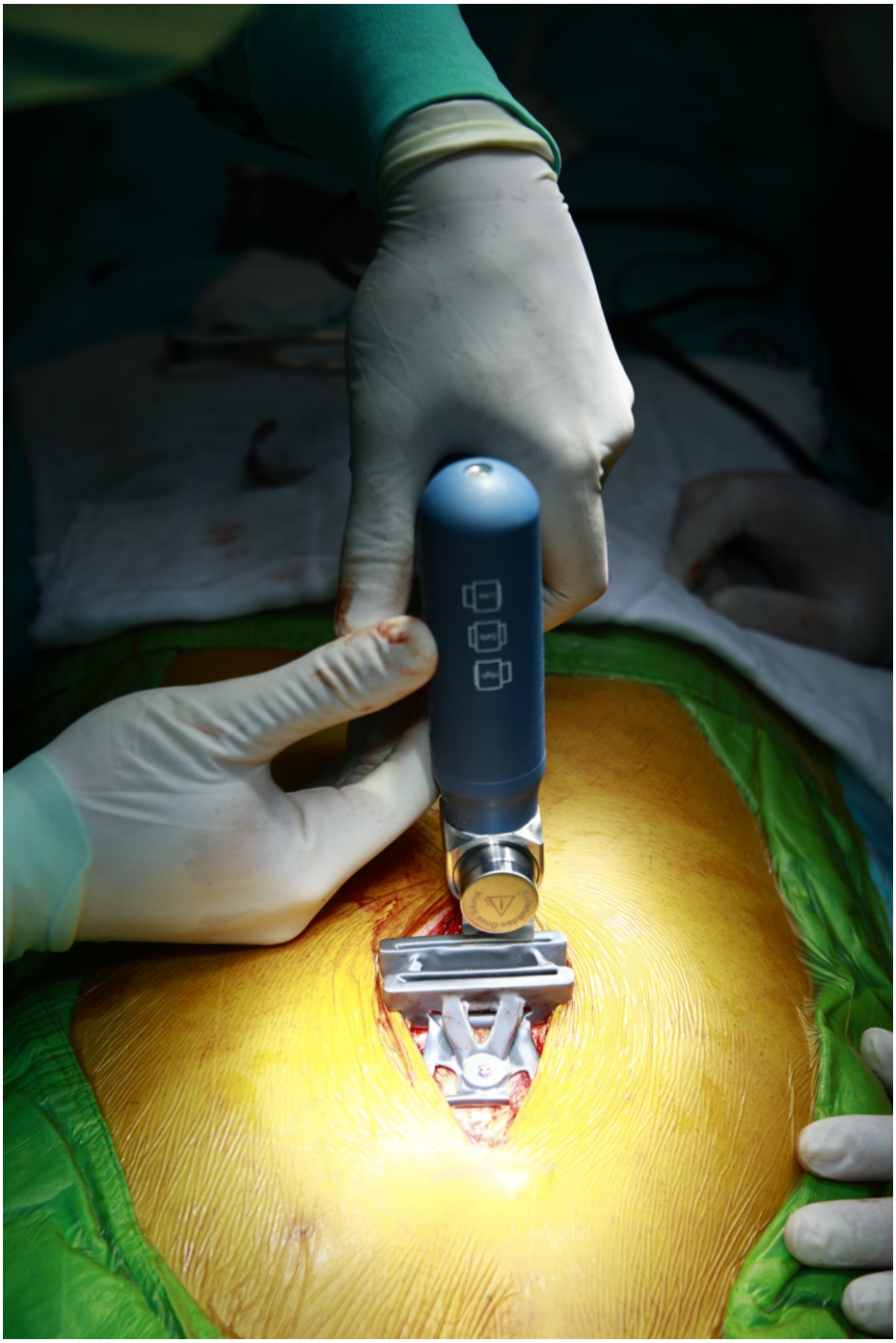

Pectus Arcuatum Repair: A Novel Minimally Invasive Technique

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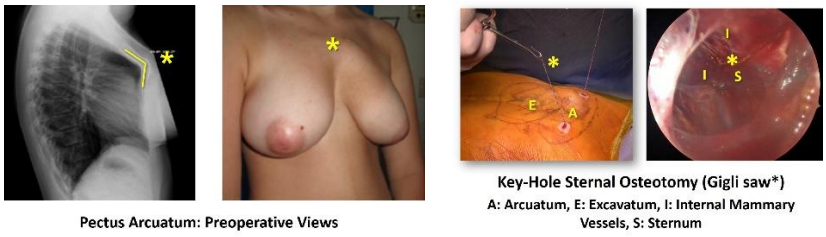
Background and Aim: Pectus arcuatum is a complex chest wall deformity traditionally treated with open sternal osteotomy and extensive cartilage resection. We present a novel technique of minimally invasive repair of pectus arcuatum (MIRPA), termed the "Hybrid Sandwich Technique," which combines closed sternal osteotomy and a pectus bar sandwich approach.

Methods: Two male patients (ages 8, 18) and a female (age 16) underwent the procedure. The closed osteotomy using a Gigli saw and the sandwich bar press-molding to correct both manubrio-sternal protrusion and sternal body depression was performed. Internal and external sandwich bars were connected to bridge plates for secure fixation. Osteotomy was performed blindly in the first two cases and under thoracoscopic guidance in the third.

Results: All three patients achieved satisfactory correction without significant perioperative complications. The first patient underwent bar removal at one year and maintained stable results. The remaining two are under follow-up, with bar removal scheduled at 2–3 years.

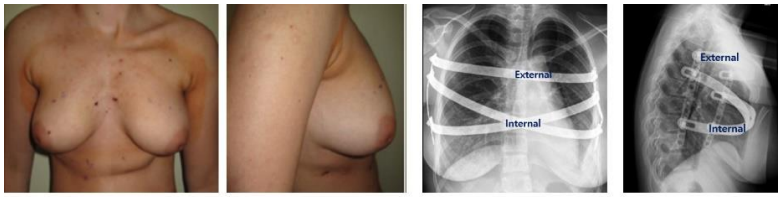
Conclusion: The Hybrid Sandwich Technique offers a safe and effective minimally invasive solution for pectus arcuatum correction. This approach allows simultaneous correction of both protrusive and depressive components of the deformity while avoiding large incisions and radical cartilage resections.

Keywords: pectus arcuatum, minimally invasive repair (MIRPA), Gigli saw, sternal osteotomy, Hybrid Sandwich Technique



Pectus Arcuatum: Preoperative Views

Key-Hole Sternal Osteotomy (Gigli saw*)
A: Arcuatum, E: Excavatum, I: Internal Mammary Vessels, S: Sternum

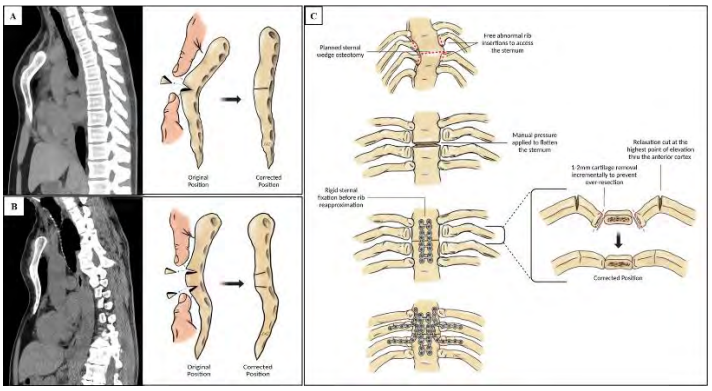


Postoperative Views: Hybrid Sandwich Technique

Pectus Arcuatum: Over 15 Years of Experience at a Reference Center

Authors: Rawan M. Zeineddine[1] MD, Juan M. Farina[1] MD, Cecilia Villa Etchegoyen[1] MD, PhD, Nour B. Odeh[1] MBBS, Ahmed E. Khedr[1] MBBS, Abdulrahman Senjab[1] MBBS, Dawn E Jaroszewski[1] MD.

[1]Department of Cardiovascular and Thoracic Surgery, Mayo Clinic, Phoenix, Arizona



Background and Aim: Pectus arcuatum is a rare and often misdiagnosed variant of pectus deformities that requires unique clinical and surgical considerations. This study aims to provide a comprehensive evaluation of a single-center cohort of pectus arcuatum, including surgical technique and outcomes.

Methods: A retrospective review of all patients undergoing surgical treatment of pectus arcuatum at a Mayo Clinic Arizona between January 1, 2010, and June 13, 2025 was performed. Descriptive statistics, surgical techniques and outcomes are presented.

Results: Twenty-two patients underwent pectus arcuatum repair during the study period (median age 22.9 years; 50% male; median Haller index 2.8 [IQR 1.4]). All were symptomatic with the most common symptoms being exercise intolerance, dyspnea, and chest pain (each 90.9%). Cosmetic concerns also predominated (100%). Cardiopulmonary exercise testing noted a low peak VO2 (67% of predicted) in 8 of the 9 patients tested preoperatively. A hybrid approach combining sternal osteotomy and minimally invasive pectus excavatum repair was used in 21 patients (figure 1A-C); one underwent osteotomy alone. Single wedge osteotomy was sufficient in 72.7% of cases. Median operative time was 3.5 (1.1) hours. The adoption of cryoablation in 2018 significantly reduced hospital stay from 5.0 (1.5) to 3.0 (3) days (p<0.001). At follow-up, all patients reported cosmetic satisfaction and most noted symptom improvement.

Conclusion: Pectus arcuatum can be successfully repaired with a hybrid surgical approach involving sternal osteotomy and Nuss bar placement. Surgery should be considered in symptomatic patients, with expected cosmetic and functional improvement.

Keywords: Pectus arcuatum, Currarino Silverman syndrome, Pouter Pigeon breast deformity, Type II pectus carinatum, Chondromanubrial deformity, Horns of Steer deformity, Hybrid MIRPE

Taulinoplasty and MIRPE: comparison of two different approaches for pectus excavatum repair

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Background and Aim: Taulinoplasty and MIRPE are different options for pectus excavatum repair. These techniques have never been compared so far, to our knowledge.

Method: A retrospective study was conducted on patients operated for pectus excavatum in two referral centers, one adopting taulinoplasty (group A) and the other MIRPE (group B). Pre-; intra-; and post-operative data; early and late complications were analyzed.

Results: Since 2022 to 2024, 43 patients underwent taulinoplasty (group A) and 108 patients underwent MIRPE (group B). In both groups, average age was 15 years; male were more represented in group A (98% versus 85%). Pre-operative protocols differed substantially: in both Centers lung tests were performed, but patients of group A underwent thoracic radiograph or CT scan and metal allergy test, while group B patients underwent echocardiography, MRI and/or CT scan.
Taulinoplasty procedure lasted less than MIRPE (65 versus 78 minutes). No intraoperative complications were observed in either group. Group B had more number of implants; hospital stay was shorter in group A (2.95 versus 4.17 days). Despite different analgesic protocols, no differences were observed in pain score at first post-operative day, but group A patients had higher pain score at discharge. Taulinoplasty resulted more expensive than MIRPE (3841 versus 3415 euros) Patients of group A experienced more subcutaneous collections (12%) and more late complications (14% versus 5.5%), with more reoperations needed (14% versus 3%). We avoided comparing the cosmetical results: all patients still having implants on, this would have biased the results, as the struts are visible under the skin in patients after taulinoplasty.

Conclusion: Taulinoplasty is a faster procedure with a shorter hospital stay. However, it is more expensive, characterized by higher pain score at discharge and by more early and late complications than MIRPE. Further studies are warranted to evaluate functional and cosmetical results.

Keywords: pectus excavatum; MIRPE; taulinoplasty

“Sternochondroplasty with extrathoracic Pectus Up bar by intraoperative traction”: Taulinoplasty combined with a “mini-Ravitch” surgery for pectus excavatum correction.

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Background and Aim: Pectus excavatum (PE) is the most common congenital chest wall deformity. Traditional surgical techniques, including the Ravitch and Nuss procedures, have evolved over the years but come with significant invasiveness, postoperative pain, and complications. This study introduces an innovative surgical approach combining Taulinoplasty surgery (also known as “Pectus Up”) with a mini-Ravitch approach.

Method: Forty-three patients (39 males, 4 females) aged 14–38 years, with moderate to severe PE, underwent the modified Taulinoplasty procedure. Mini-Ravitch approach consisted of adding to the classical procedure an extra-perichondral fragmentation of malformed cartilages for approximately 1 cm, using the same incision. In more severe cases a sternal incision is also made.

Results: Median intraoperative time was 42 minutes, median hospitalization 4.7 days. The average pre-operative Haller index was 3.79. No major pre-operative and pos-operative complications were reported. Two minor post-operative complications occurred: one seroma and a screw displacement. Median time to bar removal was 15 months (range 8-18 months); no recurrences were observed.

Conclusion: The Pectus Up surgery, in combination with a mini-Ravitch approach, offers a minimally invasive, extra-thoracic alternative for PE correction. This technique minimizes risks such as organ injury, excessive bleeding, and postoperative pain.

Keywords: Pectus excavatum, chest-wall deformity, Pectus Up, Taulinoplasty, Ravitch surgery

Guidance in osteotomy for Ravitch procedure in chest wall deformities: optimised resection and reconstruction

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Background and Aim:

Despite advancements in minimally invasive corrective techniques, the Ravitch procedure still remains a valuable approach for correction of pectus deformities, particularly in cases of complex arcuatum, asymmetric deformities or redo surgery.

One of the major challenges in this procedure is accurate calculation of osteotomy width and corrective angle, as well as freehand transverse cutting of the sternum, possibly leading to shortening of the sternal bone, misalignment and eventual pseudarthrosis.

We present two cases of patients with chest wall deformity in whom preoperative CT planning on a virtual 3D model was used to calculate and optimize osteotomy planning.

Method:

A contrast-enhanced CT scan of the chest with 1 mm slice thickness was used to generate a preoperative 3D model, and was imported into dedicated surgical planning software (Surgicase, Materialise Inc, Leuven, BE). During one-hour online collaborative sessions between physicians and tech engineers, the ideal position of the corrected sternum was determined and subsequent osteotomies were defined. Custom cutting guides were developed based on the calculated saw angles in order to minimize the extent of the osteotomy. Additionally, the plate and screw osteosynthesis system was virtually adapted according to the innate shape of the sternal body.

Results:

In both cases, modified Ravitch procedure was started with resection of the deformed cartilage. Subsequently, the osteotomies were then executed according to the preoperative patient-specific surgical plan and cutting guides. Next, the osteosynthesis completed the reconstruction and ensured optimal bone contact at the level of the osteotomies.

Conclusion:

Preoperative 3D modeling allows unlimited exploration of the most critical aspects of the Ravitch procedure. By means of patient-specific osteotomy guides, the most optimal sternal reconstruction could be performed without sternal shortening and with optimal bone contact at the level of the saw cuts. This approach promotes optimal bony healing of the transverse osteotomy, ultimately leading to improved surgical outcomes.

Keywords:

Ravitch; 3D; custom cutting guide; preoperative planning

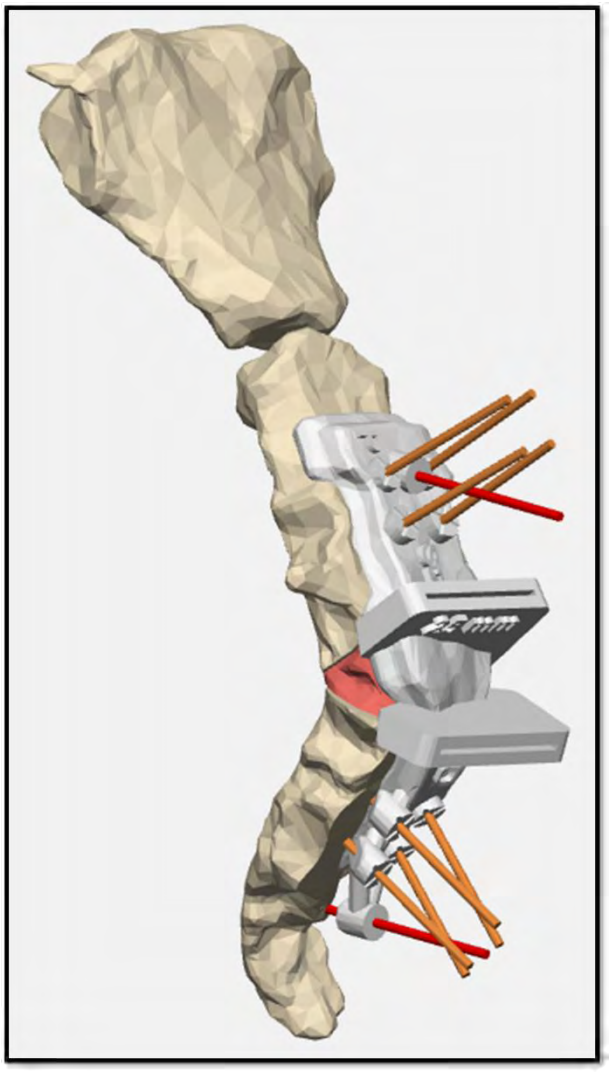

Figure 1 - custom cutting guides case 1 – recurrent excavatum

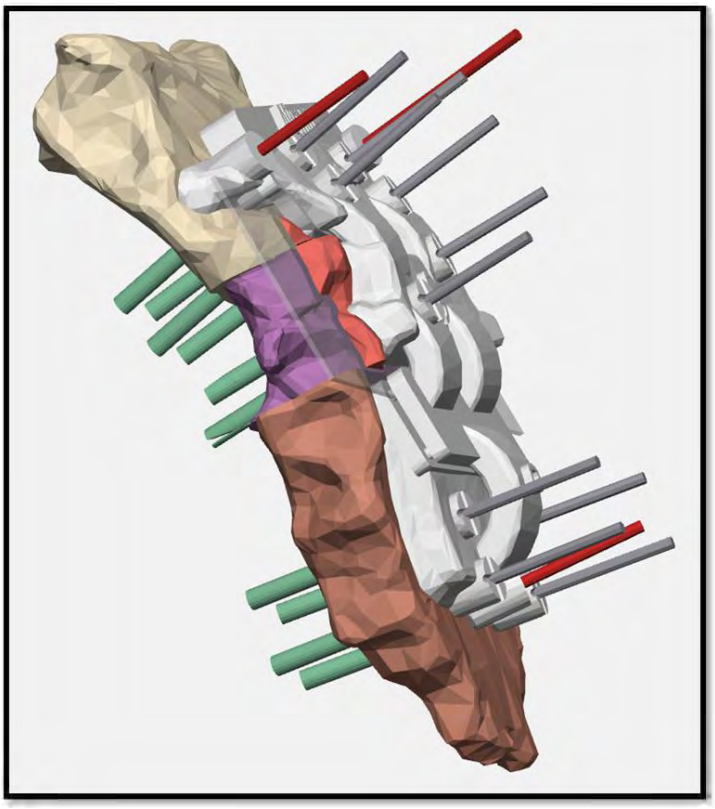

Figure 2 - custom cutting guides case 2 - arcuatum

The new IX-bar technique.

Viktor Markushin [1,3], Rustem Hayaliev[1,2], Sharif Rahimiy[1]

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[2]Republican Scientific-practical Center of Sport Medicine, Tashkent, Uzbekistan
[3]TS hospital, Krasnodar, Russia

Background and Aim: The pectus-bars installed using the X-bar technique are supported by a parallel bar (I) and securely attached to the skeleton of the chest (IX-bar is obtained) using steel ties and steel wire (standard surgical materials). The support of the crossbars (X) on the parallel bar (I) and fixation in this position ensures that the edges of the bars resting on the parallel bar will never slip off or migrate (fig 1). In addition, due to pressure at the center of each of the crossbars, the sternocostal complex tending inward, the supporting edges of the crossbars additionally press the parallel bar against the chest, thereby eliminating the displacement of the parallel bar. If you read into it, understand the biophysics of the current moments, it will be clear how beautiful it is this is an operation in every sense.
Results: In total, from 07.2023 to 05.2025, 364 patients with IX-bar plates in various modifications were operated on. Men: 288, women: 76. Number of complications: 1 case of pleurocutaneous fistula, and 5 patients with pleurisy - conservative treatment. 1 patient was diagnosed with hemothorax, and pleural cavity rehabilitation was required.
Conclusion: Conclusion: in any situation, you should determine the best method of eliminating the complication without panic and try to keep the installed bars.
Keywords: correction, pectus excavatum, the Nuss surgery, cross-bars.

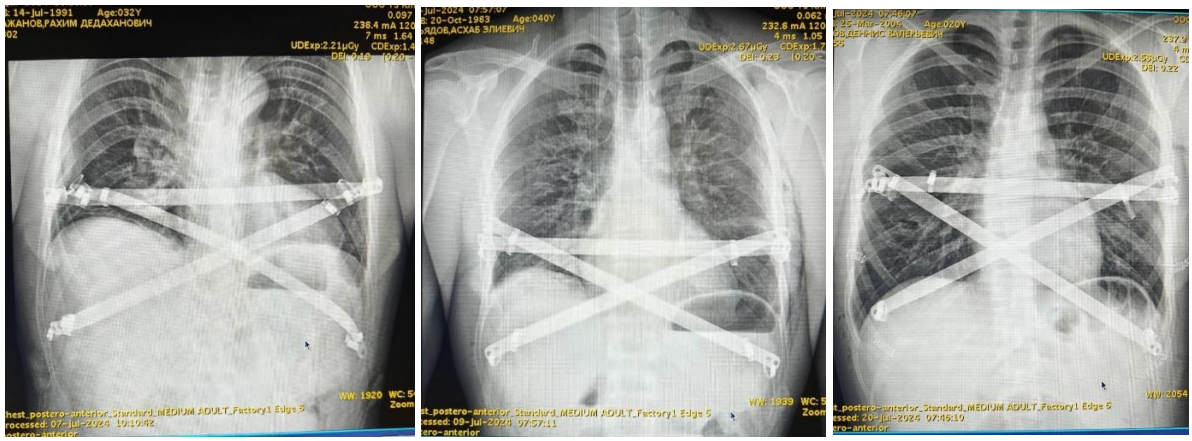


Fig. 1. X-ray images of various patients with attached IX-bars.

Understanding Chest Wall Movement Recovery Trajectories Following Pectus Surgery

Author(s)and Affiliation(s):*Kwanyong Hyun[1], Hyung Joo Park[2]
[1] St. Vincent's Hospital, College of Medicine, The Catholic University of Korea, [2] Cleveland Clinic Pectus and Chest Wall Institute

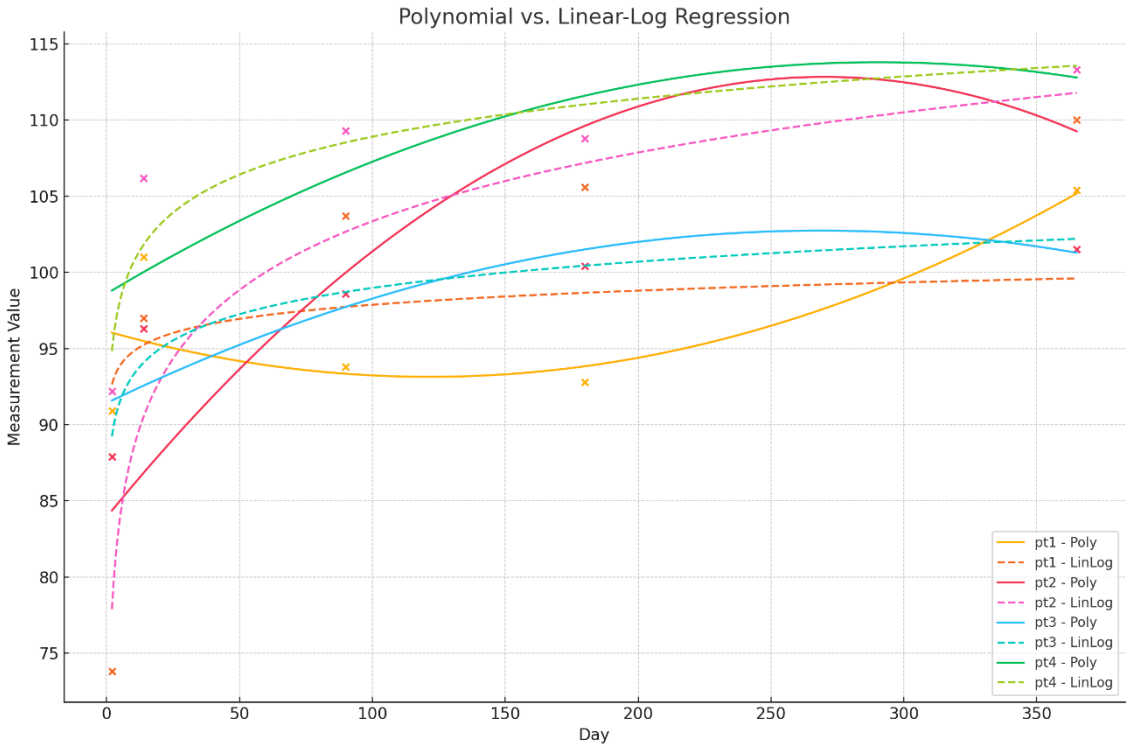
Background and Aim:
Assessment of chest wall movement recovery after pectus surgery remains a clinical challenge. The apex-to-diaphragm distance on chest radiographs provides a reproducible anatomical marker that reflects thoracic expansion and diaphragmatic excursion. This study proposes an imaging-based framework to define recovery by comparing preoperative and postoperative apex-to-diaphragm distances under different respiratory conditions, with consideration of mechanical constraints imposed by correction bars.

Method:
We propose using the preoperative apex-to-diaphragm distance measured on a standard chest PA radiograph—typically obtained under non-maximal inspiration—as the baseline. Postoperative full-inspiration chest PA images are acquired in a standardized manner. Recovery thresholds are stratified as follows:
(1) ≥100% of baseline indicates partial recovery,
(2) ≥105% suggests functional recovery during the bar-insertion period, and
(3) ≥110% reflects complete recovery after bar removal, representing full restoration of chest wall mobility.

Results:
Thoracic height is a reliable and easily measurable radiographic parameter. Full inspiration increases lung height by ~12–20% (3–5 cm) over non-maximal inspiration. However, in procedures such as the Nuss operation, insertion of a correction bar restricts chest wall mobility despite surgical success. Therefore, applying a uniform ≥120% criterion immediately postoperatively may not reflect true recovery. The proposed tiered criteria allow for a more realistic and clinically meaningful interpretation of functional progress.

Conclusion:
Apex-to-diaphragm distance offers a practical, standardized metric for tracking recovery after pectus surgery. Recognizing bar-related limitations, a stratified threshold approach (100–110%) enhances the clinical applicability of this metric and enables consistent evaluation of thoracic mobility in both early and long-term postoperative phases.

Keywords:
Pectus surgery, Chest wall movement, Apex-to-diaphragm distance, postoperative recovery



	Thoracic height at each postoperative day during full inspiration (% relative to preoperative chest PA)					Regression-Based Threshold Estimation		
	day 2	day 14	day 90	day 180	day 365	model	day.to.reach 100%	day.to.reach 105%
pt1	90.9	101.0	93.8	92.8	105.4	linear-log	490	20651.9
pt2	73.8	97.0	103.7	105.6	110.0	linear-log	59.7	129
pt3	87.9	96.3	98.6	100.4	101.5	linear-log	150.6	1124
pt4	92.2	106.2	109.3	108.8	113.3	linear-log	8.4	34
pt5	81.6	95.7	100.0	104.9		linear-log	65.1	182.7
pt6	92.3	103.3	102.3	104.2	106.8	linear-log	20.7	173.1
pt7	89.5	104.3	101.4	104.0	102.0	linear-log	39.4	401.9
pt8	90.0	92.2	100.4	98.0	96.2	linear-log	743.2	15618.3
pt9	97.1	103.6	103.2	103.8	104.2	linear-log	6	392.6
pt10	91.8	98.9	87.8	102.7	106.2	linear-log	160.2	2077.8
pt11	81.6	98.5	100.3	98.1		linear-log	112.9	NR
pt12	84.7	105.6	110.5	110.5		linear-log	15.7	38.1
pt13	83.8	101.3	98.3	106.8		linear-log	46.3	151.2
pt14	93.9	101.9	105.1	100.7		linear-log	20.8	329.8
pt15	93.7	95.8	100.7	101.1		linear-log	88.4	1477.8
pt16	99.9	103.5	109.2			linear-log	2.4	18.9
pt17	95.1	100.9	105.1			linear-log	11.8	79.3
pt18	92.5	100.9	101.9	102.6		linear-log	33.2	348
pt19	90.2	94.8	91.5	100.7		linear-log	NR	NR
pt20	91.9	99.2	99.6			linear-log	62.4	NR
pt21	92.1	106.5	107.7			linear-log	8.2	27.5
pt22	96.5	110.0	113.6			linear-log	3.1	9.3
pt23	90.4	92.9	96.6			linear-log	837.9	NR
pt24	88.7	93.4	117.6			linear-log	13.8	26.7
pt25	90.7	94.8	97.6	101.1		linear-log	164.6	NR
pt26	86.0	90.6	96.9			linear-log	298.8	NR

NR (not reached): 100% or 105% target not reached within observation window

Criterias to decide how many bars to place before pectus excavatum surgery

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Background. The decision on the number of bars to be placed in a patient with pectus excavatum depends on the surgeon's expertise.As patient satisfaction is the priority and the main complaint is cosmetic, it is crucial to determine the correct number of bar placements.This study aims to introduce a severity index that determines the ideal number of bars required for maximum satisfaction.

Method. The records of the *Chest Wall Deformities Clinical Database* between September 2018 and May 2025 include 397 patients who underwent minimally invasive repair of pectus excavatum. 107 out of 397 patients were enrolled in this study(90 Male,17 Female) and received preoperative chest computerized tomography.We divided the patients into three groups based on the number of bars they received.Group I received one (n=31),Group II had two(n=51),Group III had three or more bars(n=25).Haller index(HI),correction index(CI),asymmetry index(AI),costosternal angle,sternum slope ratio,length and density of sternal body were calculated.These values were correlated with the number of bars that were placed.A severity index is created to determine the number of bars to be placed.

Results. We found that there was an inverse relationship between the density of the sternal body and the number of bars.The density was found to be statistically significant between Group I and III($p=0.05$).Sternum slope ratio,costosternal angle,and CI were statistically significant between Groups I and III ($p<0.05$).Length of sternal body,HI, and AI did not show any significance.

Conclusion. Currently,HI,CI and AI are indices that are used to calculate the severity of the excavatum.This study is the preliminary report to address the use of new parameters to determine the appropriate number of bars needed during surgical correction.Utilizing these parameters can help avoid surgical complications,such as inadequate sternum elevation,bar rotation, and intercostal muscle tears caused by an insufficient number of bars.We have created www.barassistcalc.com for global use to determine the number of bars to be placed before the surgery.

Keywords: Pectus exacavatum, bar number, pectus indices

Development and Pre-Validation of Simulation Models for Minimally Invasive Repair of Pectus Excavatum

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2 Fundación Hospitalaria Mother and Child Medical Center, Buenos Aires, Argentina.

Background and Aim:
Advancements in minimally invasive repair of pectus excavatum (MIRPE), including sternal elevation, "Hammock" technique, and bridge use, have improved procedural safety and outcomes. Due to limited training availability, this study reports the development and pre-validation of three innovative simulation models designed to replicate these techniques.

Method:
Retrospective analysis of the development of three simulation models, pre-validated by surgeons during a training session in Córdoba, Argentina.
Participants rated realism, reproducibility, and educational impact using a 5-point Likert scale (1=lowest and 5=highest realism/effectiveness). Responses were compared based on participants' level of expertise in MIRPE (experts=more than 40 procedures performed).
Simulation models (Figure 1):

1. Sternal Elevation Model: A chest wall printed in polylactic acid (PLA) with a foldable steel bar for sternal attachment and three lifting devices.
2. Implant Bridge Model: A PLA chest wall with silicone layers mimicking muscle and skin for bridge fixation.
3. Hammock Model: A PLA chest wall covered with silicone, an endoscopic camera, and standard surgical tools for interspace reinforcement.

Results:
Of 37 participants, 24 (64.9%) responded. Median age was 44 years (IQR: 39.0; 50.0), 16 (66.7%) were male, 8 (33.3%) were experts, while 12 (50%) had performed < 10 MIRPE. All models received scores > 4 for structural realism and technique replication, and 5 for accelerating the learning curve. No significant differences were found between experts and less experienced participants.

Conclusions:
This is the first report on the development and pre-validation of simulation models for sternal elevation, bridge placement, and hammock technique. All models were perceived as highly realistic and effective, regardless of MIRPE experience.

Keywords:
Simulation, MIRPE, pectus excavatum

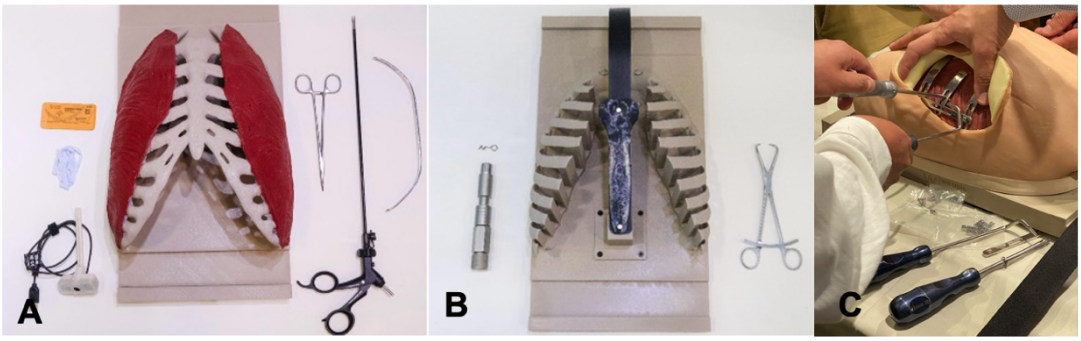

Figure 1. A. Hammock technique model. **B.** Sternal Elevation and grip model. **C.** Implant fixation bridge placement model.

Stabilizer Fixation versus Pericostal Suture Fixation in the Nuss Procedure

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Background and Aim: In the Nuss procedure for pectus excavatum, bar displacement is one of the major complications. Various strategies have been implemented to prevent this issue. This study aimed to compare the effectiveness of stabilizer fixation versus pericostal suture fixation in preventing bar displacement.

Method: We conducted a retrospective review of patients who underwent the Nuss procedure at two affiliated institutions between 2012 and 2024. From 2020 to 2024 (Group A), fixation was performed exclusively with bilateral stabilizers without pericostal suture fixation. From 2012 to 2019 (Group B), the bar was secured using pericostal sutures at three points (both lateral sides and the midline). The incidence of severe bar displacement was compared between the two groups.

Results: Group A included 15 patients, and Group B included 16 patients. There were no statistically significant differences in age, gender, or thoracic asymmetry between the groups. The Haller index was 4.2 ± 1.0 in Group A and 5.5 ± 2.1 in Group B ($p = 0.05$). Severe postoperative bar displacement was observed in 0 patients in Group A and in 5 patients (31%) in Group B ($p = 0.04$). Surgical site infection (SSI) occurred in 2 patients (13%) in Group A and in none of the patients in Group B, with no reoperations required due to SSI.

Conclusion: Stabilizer fixation was associated with a significantly lower incidence of severe bar displacement compared to pericostal suture fixation in patients undergoing the Nuss procedure for pectus excavatum.

Keywords: Nuss procedure, stabilizer fixation, pericostal suture fixation, bar displacement

Impact of the Nuss Procedure on Spinal Curvature Across Four Time Points

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Background and Aim: Pectus excavatum (PE), the most common congenital chest wall deformity, has been associated with spinal curvature abnormalities, particularly scoliosis. While the Nuss procedure effectively corrects PE, its impact on spinal alignment across different stages of the procedure remains unclear.

Method: This retrospective study analyzed 177 patients who underwent the Nuss procedure for PE correction between July 2011 and December 2020. Cobb Angle (CA) was measured at four key time points: pre-operative, post-operative, pre-removal, and post-removal. Subgroup analyses evaluated the influence of sex, age, thoracic morphology, pre-operative Haller Index (HI), and baseline CA on CA dynamics.

Results: Significant CA changes were observed primarily during the bar insertion and maintenance phases (pre-operative to post-operative: mean difference +1.09, p=0.003; pre-operative to pre-removal: mean difference +1.12, p=0.026). Subgroup analyses identified male sex (p=0.001), adolescence (10–19 years, p=0.047), asymmetric thoracic morphology

(p=0.043), severe HI (≥3.5, p=0.014), and baseline CA (both <10, ≥10, p<0.001) as key factors influencing these changes. No significant CA changes were found between the pre-operative and post-removal stages.

Conclusion: This study demonstrates the dynamic impact of the Nuss procedure on spinal curvature, with the most pronounced changes occurring during bar insertion and maintenance. These findings emphasize the importance of comprehensive spinal evaluation and follow-up even during the maintenance phase, particularly in high-risk patients such adolescents and those with baseline scoliosis.

Keywords: Pectus excavatum, Nuss procedure, Spinal curvature, Scoliosis

[Disclosure Statement of COI]

We have no conflicts of interest to declare.

Cryoablation Versus Epidural Analgesia: Evaluating Clinical Benefits After the Nuss-Bar Procedure

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Background and Aim:
Pectus excavatum (PE) is a common chest wall deformity that can be surgically corrected using the Nuss-procedure. While effective, this procedure causes significant postoperative pain, traditionally managed with epidural analgesia followed by oral opioids. Cryoablation is an emerging technique that may reduce postoperative pain through temporary nerve blockade, potentially leading to shorter hospital stays, reduced opioid use, and even complete replacement of epidural analgesia.
The aim of this study is to evaluate the effect of cryoablation during the Nuss-procedure at Thorax Centrum Twente, the Netherlands, with primary focus on hospital length of stay and secondary focus on pain, operating time, and oral analgesic use.

Method:
This retrospective, non-experimental cohort study compares two patient groups: a control group (n=20) treated with epidural analgesia and an intervention group (n=30) treated with cryoablation. Primary outcome measures include hospital length of stay, postoperative pain scores (NRS), operating time, and opioid consumption. Data were collected from the electronic patient record (HiX) and analyzed using statistical tests.

Results:
Patients treated with cryoablation had a significantly shorter median hospital stay (1 vs. 5 days, $p<0.001$). Cryoablation resulted in a lower median consumption of both short-acting (0 vs. 30 mg) and long-acting oxycodone (0 vs. 40 mg), all with $p<0.001$. Operating time was significantly longer in the cryoablation group (125 vs. 50 minutes, $p<0.001$). No significant difference was found in overall pain scores during hospitalization (median NRS 1.92 vs. 2.08, $p=0.561$). Notably, epidural analgesia was completely replaced by cryoablation in this group.

Conclusion:
Cryoablation as an analgesic technique for the Nuss-procedure is associated with a significantly shorter hospital stay and reduced opioid use, while providing comparable postoperative pain relief. Despite a longer operative time, these findings support the implementation of cryoablation instead of an epidural as a standard pain management strategy in Nuss-bar implantation.

Keywords: Nuss-bar, cryo-ablation, epidural, length of stay, pain.

A study on clinical characteristics and risk factors for the development of Surgical Site Infection after the Nuss procedure

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Background:

The Nuss procedure is the standard surgery for pectus excavatum (PE), but surgical site infection (SSI) is a significant postoperative complication. The factors contributing to SSI after PE repair are not well understood. This study aimed to identify clinical characteristics and risk factors for SSI after PE surgery.

Methods:

We conducted a retrospective analysis of 434 patients who underwent pulmonary embolism (PE) repair between 2014 and 2023. SSI was defined as wound discharge or a positive wound culture within one year of metal bar implantation. We performed univariate and multivariate analyses to identify factors related to SSI.

Results:

The study included 434 patients, with a median age of 23 years (range, 8-78 years), comprising 85% male participants. The median Body Mass Index was 19 (11 to 31), and the median surgical duration was 94 minutes (41 to 307 minutes). SSIs occurred in 29 patients (6.6%), with methicillin-sensitive Staphylococcus aureus being the most prevalent pathogen (27.5%). Severe infections (Grade 3 or higher) accounted for 70% of cases. All infected patients received wound cleaning and antibiotics, with no need for early bar removal. Multivariate analysis indicated that longer operative time ($p=0.047$), elevated white blood cell counts before discharge ($p<0.001$), and a higher Correction Index ($p=0.04$) were significant SSI risk factors. The placement of a subcutaneous drain was notably associated with severe SSIs ($p=0.01$).

Conclusion:

SSIs were observed in 6.6% of cases post-PE surgery. Early wound management and antibiotics allowed for the successful preservation of all implanted bars. Factors like operative time, pre-discharge white blood cell count, severity of thoracic deformity, and placement of subcutaneous drains were linked to SSI risk. Addressing these factors can improve perioperative care.

Keywords: SSI, Nuss Procedure, Pectus Excavatum

Thoracoscopic Repair of Harrison's Groove Using a Metal Implant

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Background and Aim:

Edwin Harrison first described Harrison's groove in the early 19th century as part of the clinical manifestation of rickets. It is a horizontal groove that appears above the costal margin centered over the 6th rib (Fig. 1). It is also associated with conditions such as pectus carinatum and excavatum despite its distinct etiology. The only prior surgical repair of Harrison's groove was reported by Henry Brodkin in 1956. This study aims to describe the first thoracoscopic repair of Harrison's groove using a metal implant, with a detailed review of the historical context and surgical technique (Fig. 2).

Method:

A 14-year-old boy presented with an asymptomatic depression of the left lower chest above the costal margin (Fig. 3). After one year of unsuccessful treatment with a suction device aimed at improving the chest's appearance, a surgical correction was planned. Thoracoscopy was utilized to insert a metal bar to elevate the depressed area (Fig. 4).

Results:

The metal bar was successfully removed in the operating room two years post-insertion, resulting in an excellent cosmetic outcome.

Conclusion:

This study presents the first successful thoracoscopic repair of Harrison's groove, demonstrating a positive cosmetic result. The technique offers a promising surgical option for patients with this condition.

Keywords: Harrison's groove, thoracoscopy

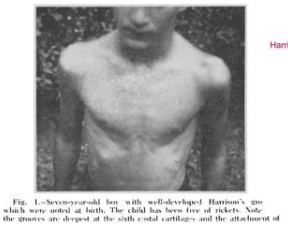

Fig. 1—Seven-year-old boy with well-developed Harrison's groove which were noted at birth. The child has been free of rickets. Note the grooves are deepest at the sixth costal cartilages and the attachment of

Fig. 1

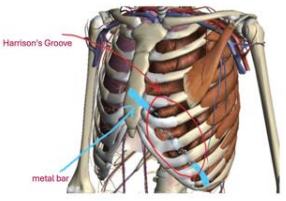

Fig. 2

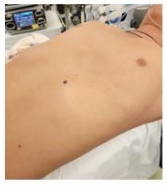

Fig. 3

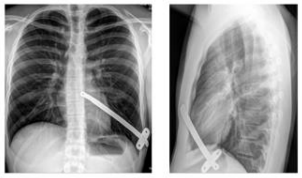

Fig. 4

OUTCOMES OF PROLONGED RETAINING PECTUS BARS AND PATIENTS' PERSPECTIVES BEHIND

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Background and Aim: Typically, pectus bars are removed 2-3 years after insertion. Literature suggests longer stay of bars may cause some surgical challenges. This study aims to investigate the health status of the patients who retain their bars beyond recommended time frame and reasons behind their decisions and motives.

Method: Out of 1246 pectus patients operated between 2006-2018 in Marmara University for bar insertion, 11 patients still retaining their bars were surveyed about their health and reasons for retaining their bars beyond the recommended period.

Results: Out of 11 patients, there were 10 males and 1 female, with a mean age of 21.36±6.45 years at the time of bar insertion. Two patients had Nuss and Abramson procedure together (Sandwich), the rest only had Nuss procedure. Mean duration of bar retention was 104.90±25.99 months. Regarding reasons for retaining their bars, ten patients have stated that they had no discomfort with bars, seven patients complained about being unavailable, five patients mentioned fear of surgery. None of the patients reported having any chronic disease. No hospitalization or surgery has been found related to thoracic problems. Most common complaint was chest pain between five patients. Three patients expressed no intention of undergoing bar removal surgery in the future.

Conclusion: Patients who retain their pectus bars beyond the recommended period reported minimal symptoms, mild chest pain being the most common complaint. Unavailability and absence of discomfort were the primary reasons attributed for the retention of bars. No chronic diseases or hospitalizations related to thoracic issues were reported by the patients. While the majority of patients did not experience significant issues, risks associated with prolonged bar retention such as urgent medical situations requiring cardiac compression or thoracotomy warrant careful consideration.

Keywords: Pectus, pectus bars, minimal invasive repair, pectus bar removal, bar retention

Bridging the Gap in Pectus Excavatum Care: A QI Project on Pre- and Postoperative Physical Therapy Integration

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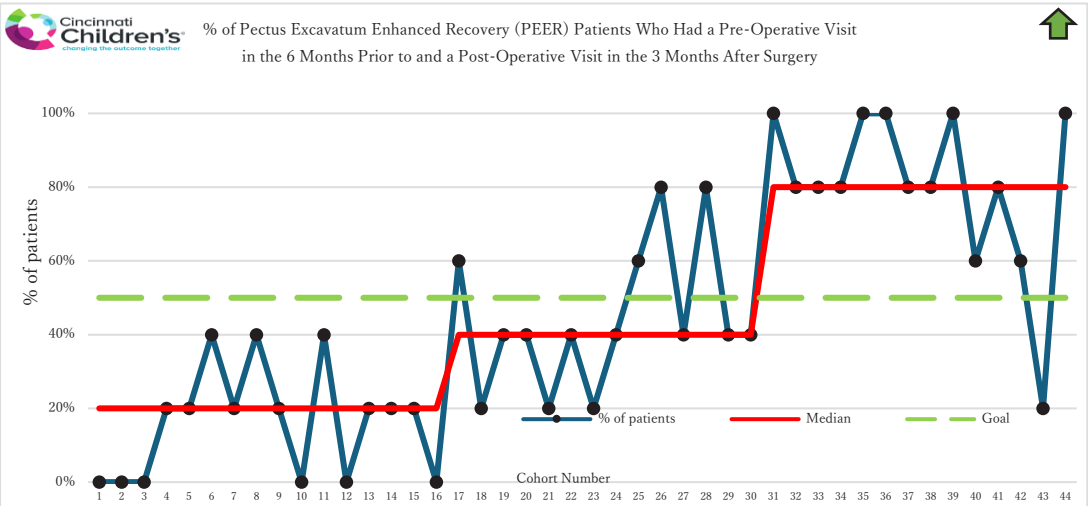
Background and Aim: While pre- and post-operative outpatient physical therapy (PT) is well-supported for major musculoskeletal surgeries, evidence is limited for pectus excavatum (PE). Structured perioperative PT may improve recovery by addressing functional limitations before and after surgery. This quality improvement (QI) project aimed to implement a perioperative PT program for PE repair to enhance postoperative outcomes using established PT principles.

Methods: PE patients scheduled for surgical repair within the institution's primary referral area were included. A QI framework guided implementation using the Improvement Guide's methodology. Interventions were refined through Plan-Do-Study-Act (PDSA) cycles. Preoperative PT (2–3 sessions) focused on posture, core strength, breathing mechanics, and recovery planning. Postoperative PT (3–4 months) emphasized pain management, endurance, and progressive return to activity with attention to postural alignment, thoracic mobility, and core stability. Interventions were individualized and adjusted throughout care.

Results: The primary outcome was the percentage of patients completing both pre- and post-operative PT. Completion increased from 20% (1/5) in early cohorts to 80% (4/5) in later cohorts using QI methods and cohort-based rapid-cycle testing. Between January 2022 and May 2025, 246 patients were tracked, with 1,036 unique encounters. Of these, 66 patients (27%) received no PT. Among the 180 who did, 32 (13%) received only preoperative PT, 30 (12%) received only postoperative PT, and 115 (47%) completed both pre and postoperative PT.

Conclusion: Implementation of a perioperative PT program using a QI approach significantly increased PT participation, demonstrating feasibility and improved care consistency for patients with PE. We plan to further investigate the program's impact on functional and surgical outcomes.



The impact of surgery for pectus excavatum on pulmonary function

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Background and Aim:

Pectus excavatum (PE) is often associated with restrictive respiratory issues due to the depression of the anterior chest wall. One of the primary objectives of surgery for PE is to improve pulmonary function. However, the effectiveness of treatment can vary depending on the type of depression and the patient's age, leaving some uncertainty in the field.

Method:

Of the 339 patients who underwent PE surgery at our hospital between 2016 and 2022, we included 269 patients who had bar removal and participated in postoperative pulmonary function tests in our analysis, which was conducted retrospectively. We evaluated changes in pulmonary function over time, comparing preoperative, postoperative, and post-extraction measurements. Additionally, we explored the relationship between pulmonary function and various clinical factors, including age, gender, and rib cage morphology.

Results:

The study involved 269 patients with a median age of 22 years. The Haller index was recorded at 5.8, and the correction index was 27%. The sternal torsion angle averaged 11 degrees. Among the patients, 150 were symptomatic (53.8%), and of these, 36.8% experienced cardiopulmonary dysfunction associated with restricted ventilation failure. The mean percentages of vital capacity (%VC) recorded preoperatively, postoperatively, and post-bar removal were 83.1%, 65.3%, and 71.8%, respectively, indicating a decline in pulmonary function resulting from the Nuss procedure. However, a 2-year long-term follow-up revealed a gradual improvement in pulmonary function, although the changes were comparable to those observed before surgery.

Conclusion:

The findings of this study indicate that the insertion of a metal plate during PE surgery leads to a significant reduction in lung capacity; however, lung capacity tends to improve gradually over time following the removal of the plate. It is essential to monitor long-term changes in pulmonary function after the plate's removal.

Keywords:

Pectus excavatum, Pulmonary function, Nuss procedure.

Is Multiple-Bar Repair Safe in Pediatric Pectus Excavatum? A Comparative Study with the Adult Population

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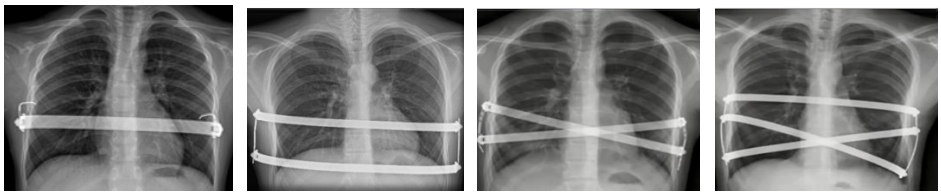
Background and Aim: Despite the growing trend toward multiple-bar repair in pectus surgery, the single-bar technique remains the predominant approach in pediatric patients, often leading to suboptimal correction and bar instability. To address concerns regarding the use of multiple bars in children, this study evaluated the safety and feasibility of the multiple-bar repair technique in the pediatric population.

Methods: We retrospectively reviewed 173 pediatric patients (aged 3–10) who underwent PE repair between 2020 and 2022. Patients were grouped by repair type: multiple-bar (Group M, n = 86) and single-bar (Group S, n = 87). Outcomes compared included Haller index changes, complications (including bar dislocation), analgesic use, and hospital stay.

Results: Baseline characteristics were comparable between groups. In Group M, most patients received two bars (n = 84, 97.7%). No major postoperative complications were observed, and complication rates did not differ between groups. Bar dislocation occurred in one patient in Group S (1.2%) and none in Group M (0%, p = 0.32). Length of hospital stay was similar (Group S: 4.63 days vs. Group M: 4.40 days, p = 0.22). Notably, total IV rescue analgesic consumption was significantly lower in Group M (16.5 mg vs. 13.92 mg, p < 0.01).

Conclusion: This study demonstrates that multiple-bar repair is both technically feasible and safe in pediatric patients, without increasing the risk of complications. These findings support the feasibility of a standardized multiple-bar approach for Entire Chest Wall Remodeling in pectus excavatum repair across all age groups.

Keywords: Pectus excavatum, Pediatric, Multiple bar, Single bar, Entire Chest Wall Remodeling



<Fig.1.> Chest X-rays showing single and multiple pectus bar configurations: parallel, cross, and XI-shaped.

Severe Pectus Excavatum and cardiac surgery: Sequential repair to ensure safety

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Background and Aim: The association of severe pectus excavatum (PE) and heart disease requires considering simultaneous correction, as post-surgical adhesions could hinder future PE repair. The concurrent Nuss procedure is controversial due to the complications that may arise from the implanted bars in the case of postoperative issues following complex cardiac surgery and extracorporeal circulation. We present two patients with severe PE and heart disease in whom sequential repair was performed, allowing a 48-hour safety period.

Method: Descriptive study of the surgical strategy and the results applied to patients with severe PE and heart disease.

Results: Two patients (2023-2024) underwent cardiac surgery under extracorporeal circulation and PE correction: a 14-year-old adolescent with Loeys-Dietz syndrome and severe aortic root dilation (Haller index 14 and Correction Index 65%), and an 11-year-old child with aortic valve insufficiency planned for re-intervention (Haller index of 6.8 and Correction index of 38%). Prior to the sternotomy, the bars were modeled, and the incisions were marked. After correction of the heart disease, removal from extracorporeal circulation, and closure of the pericardium (with suturing and Gore-Tex membrane), the subpectoral and retrosternal tunnels were created, and the bars were positioned to verify correction. The bars were then removed, leaving the tunnel guided by tapes buried in the subcutaneous tissue, and the sternotomy was closed with wire sutures. After 48 hours, once complications were ruled out, the pre-modeled bars (two in each case) were placed under manual sternal traction with good correction of the depression and no incidents (1 case parallel bars & one crossed bars). They were stabilized with bilateral bridges. Both cases evolved favorably without complications.

Conclusion: The combination of PE and heart disease requires a multidisciplinary approach and careful surgical planning with cardiac surgery. Sequential correction with a 48 hours period with pre-modeled bars represents a safe and effective alternative.

Keywords: Pectus excavatum, Nuss procedure, Cardiac surgery, safety

Minimally invasive treatment of pectus carinatum without anterior chest wall incision

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Background and Aim:

Conventional repair of pectus carinatum using a titanium bar typically requires an anterior chest wall incision, which can leave a visible scar. As plastic surgeons, aesthetic outcomes are a critical consideration. We aimed to perform a modified Nuss procedure using only lateral thoracic incisions to eliminate the need for anterior chest incision while achieving effective correction.

Method:

We applied a “four-point thoracic penetration” technique, a variation of the Nuss procedure. A subcutaneous tunnel was created from one lateral chest wall to the contralateral incision site. A vascular cotton tape was passed through the tunnel to serve as a guide, enabling precise insertion and positioning of the titanium bar without anterior access.

Results:

Two patients with pectus carinatum were treated using this technique. In both cases, the procedure was completed without any anterior chest incision. No intraoperative or postoperative complications were observed. The postoperative courses were uneventful, and both patients were satisfied with the cosmetic outcomes.

Conclusion:

This modified Nuss technique allows for effective correction of pectus carinatum while avoiding anterior chest wall incisions. The approach offers excellent cosmetic results and may be a valuable alternative in selected cases. Further accumulation of cases is necessary to fully evaluate its efficacy and safety.

ALTERNATIVE TREATMENT OF PECTUS EXCAVATUM

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Background and Aim: Pectus excavatum (PE) is the most common congenital chest wall deformity with symptoms affecting patients at different ages. In many cases, symptoms including dyspnea, tachycardia, dizziness, and chest pain manifest during exertion and exercise. Some evidence suggests that symptoms may progress as the patient ages. Adverse cardiopulmonary effects of PE may be underestimated by many physicians, in part because of the contradictory findings of previously published data. Surgical interventions are the most recognized methods of treatment. Various methods of work have been developed. The aim of the study was to improve the results of pectus excavatum correction due to a differentiated approach to each patient and the choice of the optimal treatment method.
Method: 320 patients with PE were corrected for the period 2023-2025. 246 patients of them were citizens of Uzbekistan, the rest of the patients are residents of Central Asian countries. There were 257 (80,3%) males and 63 (19,7%) females. The age of patients ranged from 3 to 22 years. The PE was corrected using Vacuum Bell. The most important study is the MSCT, which allows to calculate the Haller index, as well as perform 3D modeling of the chest deformation and provides information about the size and shape of the corrective vacuum bell (Fig. 1).
Results: The duration of wearing the bell varied from 12 months to 30 months. 6 patients who refused to wear the bell from the first days were excluded from observation. Figure 2 shows dynamics in deformation correction of the patient before and after treatment.

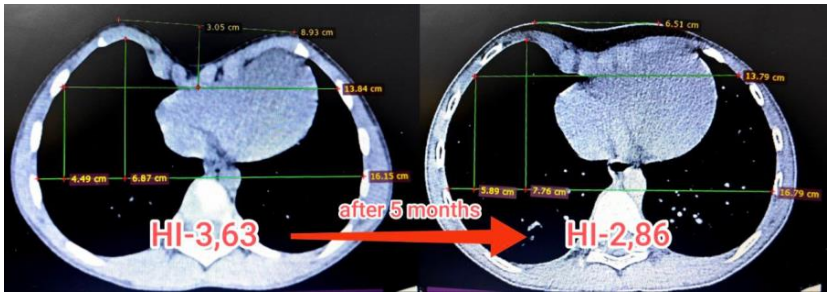

Fig. 1 MSCT of PE in dynamics.

Fig. 2. Defformation before wearing the bell and after 5 months

Conclusions: With timely treatment of patients, especially before the complete formation of the skeleton and the development of gross deformation, Vacuum Bell can completely correct the anomaly that has arisen, relieve a person from both physical illness and psychological problems. The Nuss surgery is necessary for patients with a Haller Index of more than 4, but mainly after growth arrest: girls after 13-14 years, boys after 18 years; lack of efficiency from Vacuum Bell.
Keywords: correction, pectus excavatum, alternative treatment, the Nuss surgery, Vacuum Bell.

Clinical application of vacuum bell therapy for pectus excavatum; finding suitable candidates.

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[5] The institute for Life sciences, Korea University Medical College, Korea University Ansan Hospital

Background and Aim: The aim of this study is to identify potential pretreatment characteristics of pectus excavatum patients and find appropriate candidates for application of vacuum bell therapy.

Method: Medical records of pectus excavatum patients who had undergone vacuum bell therapy for more than one year were reviewed retrospectively. Expected improvement in thoracic indices were evaluated using pretreatment chest computed tomography which was taken before and after applying vacuum bell device. Treatment results were evaluated using changes in Haller index before and after treatment. Included patients were categorized into two groups; Group1 showed reduced Haller index less than 0.5 and Group2 more than or equal to 0.5. Pre and post thoracic indices and clinical data were compared.

Results: A total of sixty-three patients were included in this study. Pretreatment Haller indices were significantly lower in Group1 than Group2 (3.1 ± 0.46 vs 4.2 ± 1.14, $p<0.001$), as well as correction index ($0.14 \pm 0.8.26$ vs 0.23 ± 0.125, $p=0.003$), not asymmetry index (1.00 ± 0.780 vs 0.97 ± 0.638, $p=0.336$). The expected improvement in Haller index of Group2 was significantly higher than Group1 (2.8 ± 0.54 vs 3.3 ± 0.60, $p=0.001$), and also with expected sternal elevation (9.3 ± 5.48 vs 15.0 ± 6.80, $p=0.001$). The cut-off value of expected improvement in Haller index was 0.45 with 83% sensitivity and 72% specificity (AUC= 0.846, $p<0.001$). Poor compliance and complication rates showed no significance between two groups ($p=1.000$ and $p=0.457$).

Conclusion: Estimation of changes in thoracic indices using vacuum bell applied chest computed tomography is useful for expectation of actual treatment response. Patients who showed pliability with vacuum bell could be suitable candidates.

Keywords: *Pectus excavatum, Vacuum bell, outcomes.*

P-14 CW250073

External Chest Wall Stabilizers in Rib Fractures: Impact on Clinical Outcomes

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Background and Aim:

Conservative treatment is the mainstay in managing rib fractures, yet complications such as prolonged pain, respiratory compromise, and hospital stay remain significant. This study aimed to evaluate the clinical effectiveness of external chest wall stabilizers in patients with rib fractures managed conservatively.

Method:

A retrospective analysis was conducted on 196 patients treated for rib fractures between May 2024 and May 2025. Patients were grouped into those who received only conservative management (n=143) and those who received additional external stabilizers (n=53). Data regarding demographics, trauma mechanism, fracture level and count, comorbidities, complications, and hospital stay were analyzed. Statistical analyses included Mann–Whitney U and Chi-square tests.

Results:

The median length of hospital stay was 2 days (IQR: 1–2) in the stabilizer group and 2 days (IQR: 1–4) in the control group, with a significant difference (p=0.004). T Among patients with lower rib fractures, the use of a stabilizer significantly reduced hospital stay (p=0.003). No significant association was found between stabilizer use and comorbidities.

Conclusion:

External chest wall stabilizers offer a safe and effective adjunct to conservative treatment in rib fracture patients, particularly those with lower rib involvement. Their use is associated with reduced complication rates and shorter hospital stay.

Keywords:

Rib fractures, external chest wall stabilizer, conservative treatment, complications, hospital stay.

Pericardial Effusion due to rib fracture

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[1] Division of Pediatric Surgery, Phoenix Children's Hospital; Phoenix, AZ USA.

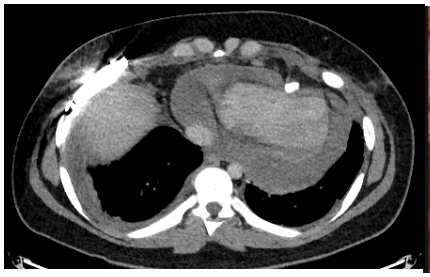
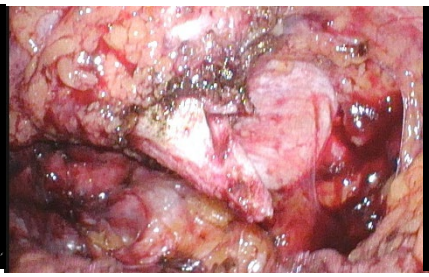
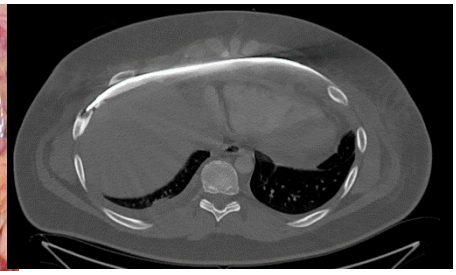
Background and Aim: To describe an unusual complication of pectus repair.

Method: Case Report

Results: 15-year-old 198cm (6'6") 120 kg male with Haller of 5.7 underwent a Nuss procedure with 2 titanium bars and 2 medial stabilizers (Pectus Blu, Zimmer-Biomet, Warsaw, Indiana, USA). He was discharged on the second post-operative day. On POD 7, he was re-admitted for 3 days due to lethargy. He was readmitted again POD 10 for tachycardia and bilateral pleural effusions and underwent drainage (2.4L right/ 1.4lL left). He was treated with ceftriaxone, clindamycin, and later vancomycin, followed by 42 days of linezolid. Cultures were negative. On POD 52 he was admitted again for fever, and a CT showed a pericardial effusion. An 850mL pericardial effusion was drained, and he was started on steroids. By POD 90, he was having constant pain, clammy skin, poor color, and fevers to 38.7. A CT at 8 months revealed slight migration of the hardware, and "similar posterior displacement of the left 7th rib." The family sought multiple additional surgical opinions before arriving at our center. At surgery, he underwent total hardware removal, lysis of extensive intra-thoracic and mediastinal adhesions, excision of a sharp, spiculated broken rib pressing against the pericardium (without perforation), and re-do pectus repair with 3 titanium bars and 6 connector bridge plates (Pure Pectus, KLS, Jacksonville FL, USA). Hammock reinforcement of all exit/entrance sites and closure of the chest defect were done with FiberTape (Arthrex, Naples FL, USA). He recovered uneventfully.

Conclusion: Rib fractures in adults are common, but children at extremes of size and pectus severity are at risk as well. Pericardial effusion and cardiac deformation from rib fractures are possible and may be under-appreciated on CT scan. Persistent chronic lethargy and pain were the dominant symptoms in this case.

Keywords: Complications; Pectus excavatum; pericardial effusion; Nuss procedure

CRYO-ANALGESIA FOR MULTIPLE FRACTURED RIBS.

Ivan Schewitz. (University of Cape Town, Cardiothoracic Department)

Background and Aim: The pain associated with multiple fractured ribs is a primary contributor to the morbidity and mortality of this condition. Cryo-neurolysis, utilized following Pectus excavatum repair using the Nuss procedure, has significantly shortened hospital stays, with most patients being discharged within 48 hours. Consequently, it can be inferred that if Cryo-neurolysis provides effective pain management for intercostal pain relief in the Nuss procedure, it may also benefit patients with multiple fractured ribs. For patients over the age of 65, the mortality rate increases substantially with more than three fractured ribs. The objective of the study was to demonstrate reduced morbidity by alleviating pain.

Method: This clinical study followed patients aged 46 to 92 with multiple fractured ribs for six months. Cryo-neurolysis was performed, and pain scores and discharge times from the Intensive Care Unit and hospital were assessed.

Results: All six patients are alive and well with little or no pain.

Conclusion: Cryo-analgesia enhances pain management and lowers morbidity and mortality in patients with multiple rib fractures.

Keywords: Cryo-analgesia, cryo-neurolysis, fractured ribs.

I have no conflicts of interest to declare.

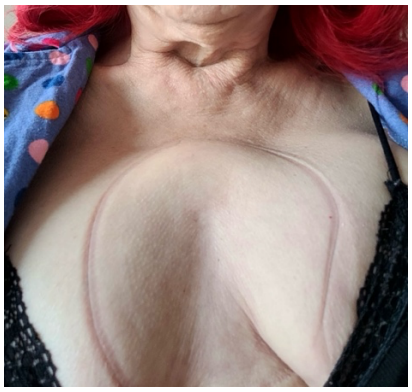
Brace Treatment in the Sternal Fracture

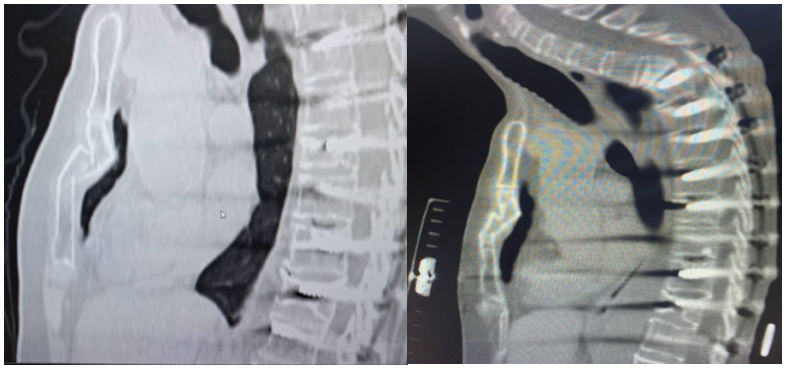
Authors: *Esra Yamansavcı Sirzai[1], Mustafa Yuksel[2]*

1 Suat Seren Chest Diseases and Surgery Training and Research Hospital, Thoracic Surgery Department

[2] Demiroglu Bilim University, Istanbul

A 72-year-old female patient, who has been under osteoporosis treatment, was found to have a compression fracture at the L1 vertebra following a fall in October 2008. In November 2016, she sustained an oblique incomplete fracture of the L3-L4 vertebrae along with multiple rib fractures due to a car accident. In March 2018, she experienced a spontaneous fracture of the thoracic (Th) 11 vertebra. The fractures healed with a primary kyphotic deformity. In October 2024, a spontaneous fracture of the thoracic 8 vertebra and increased kyphosis was observed. As a result, instrumentation was performed between the thoracic 3 and lumbar 3 vertebrae. At the 3-month follow-up, a surgical plan was developed for cervical flexion and upper thoracic kyphosis. Within 5 months, severe bilateral paravertebral spasms led to a compression fracture of the thoracic 2 vertebra. In April 2025, the fixation of the thoracic 3 vertebra was canceled. The patient underwent fusion reinforcement and allograft revision surgery at the thoracic 1-2-3 vertebrae. In May 2025, there was depression and opening at the sternal region, along with chest wall edema and pain. Thoracic CT revealed a sternal body fracture. The patient was advised to rest in bed with primary healing and osteoporosis treatment recommended. Vacuum therapy was initiated. After three daily sessions of 15 minutes, the patient experienced increased pain and frailty, leading to the cessation of the treatment. An anterior chest brace was applied for 22 hours a day along with bed rest. A follow-up thoracic computed tomography (CT) scan showed callus formation at the fracture site. A reduction in frailty at the sternal fracture was observed, and a repeat thoracic CT was planned for the sixth week.





Resection and reconstruction of tumors in the chest wall : experience in a national concentration center

AUTHOR: Miguel Martinez Arias*

***Head of pulmonology and chest surgery service ISSEMyM Medical Center State of Mexico, Mexico, Consultant Thoracic Surgeon ABC Medical Centre**

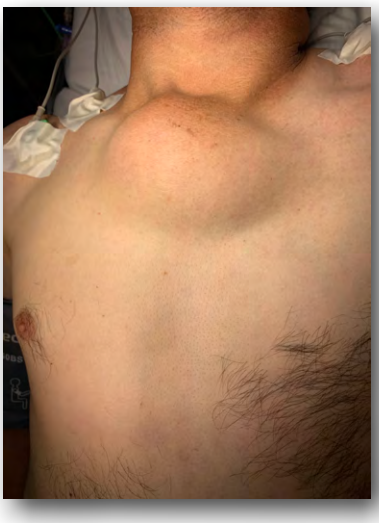
Background and Aim: Chest wall tumors are a challenge for the surgeon. This is due to the different structures that are affected. as well as the different causes that require resection and reconstruction of the chest wall.The complexity of cases is determined by the invasion of the lesion and its subsequent reconstruction. A complete evaluation is required with imaging studies with reconstruction that can give a better idea of how it will be performed.The objetive is to present the experience of resection and management of patients with Chets wall tumors.

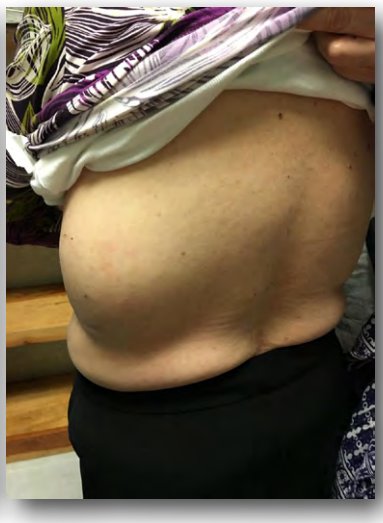
Method: This study included 11 patients with chest wall tumors who were treated from 2015 to 2024 were collected and analyzed. There were 6 males and 5 females. Chondrosarcoma was diagnosed in 4 cases, metastasis from breast cancer was diagnosed in 1 case. Clear cell sarcoma (CCS) 1 case, osteochondroma 2 cases, osteomyelitis 1 case, Clear cell chondrosarcoma (CCC) 1 case and 2 Mama Cancer mets. All patients underwent extensive tumor resection and had thoracic exposure after tumor resection, In all cases, reconstruction of the chest wall was performed.

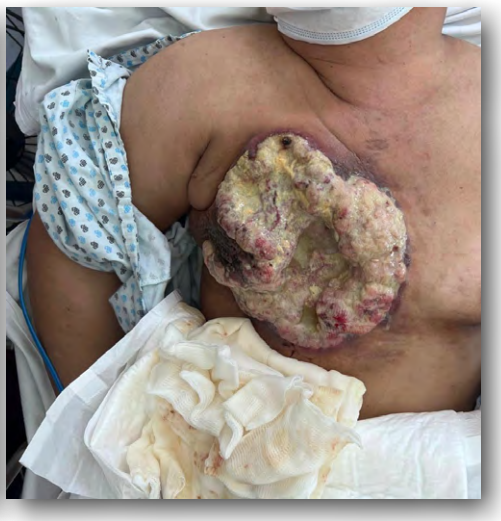
Results: One patient had rejection of the titanium material, we had to intervene again by removing the osteosynthesis material, all patients were followed up for 2–6 years, one tumor recurrence was noted during follow-up. With a reinvention, None of patients had abnormal breathing, dyspnea or other physical discomfort.

Conclusion: It is difficult to resect the huge tumors in the chest wall, and it is more reasonable and safer to choose a reconstruction method using mesh and titanium.The latissimus dorsi flap can achieve good results in repairing soft tissue defects. Close perioperative management and multidisciplinary team discussions can help to achieve better curative effects.

Keywords: Chest wall tumor, Resection, Reconstruction, Multidisciplinary, Perioperative period







Application of bridge technique for pectus bar fixation during Nuss procedure

Author(s)and Affiliation(s):* Yan Dong [1], Zeng Qi [2], Chen Cheng Hao [3], Zhang Nan [4], Yu Jie [5], Xu Chang Qi [6], Liu Ding Yi [7], Zhang Qian [8], Zhang Xu [9],Yang Ting[10]

[1] Department of Thoracic Surgery, Affiliated Beijing Children's Hospital

Background and Aim:

Objective To summarize the experience of bridge technique for pectus excavatum (PE).

Method:

From July 2018 to January 2021, 25 PE children undergoing thoracoscopic Nuss procedure with fixation by bridge technique.There were 21 boys and 4 girls with a mean age of 172(125-201) month.Haller index had a mean value of 4.93(3.16-6.78).Severity was mild (n=1, <3.2), moderate (n=2, 3.2-3.5), severe (n=18, 3.5-6) and extremely severe (n=4, >6).

Results:

There was one case of short-term postoperative complication.Bilateral pleural effusion was relieved after puncture under B-ultrasonic positioning.Two children (8%) had long-term complication of bridge connector nut and screw detachment.Both were of unilateral single fixator nut loss.Without bar displacement, appearance of chest wall was not affected.Loose nut was removed at the same time as bar removal.There was no recurrence.

Conclusion:

The application of bridge technique for pectus excavatum is safe and effective, which can reduce the risk of bar displacement and achieve satisfactory correction effect.

Keywords:

Funnel Chest; Orthopedic Procedures; Thoracoscopy; Bridge Technique

Surgical methods for removal of the pectus bar fixed with steel wire

Author(s)and Affiliation(s): Qian Zhang[1], *Qi Zeng[1], Chenghao Chen[1], Jie Yu[1], Na Zhang[1], Dong Yan[1], Changqi Xu[1], Dingyi Liu[1], Xu Zhang[1], Ting Yang[1]

[1] Department of Thoracic Surgery, Beijing Children's Hospital, Capital Medical University, National Center for Children's Health, Beijing, China.

Background and Aim:

Our center uses steel wires to fix pectus bar, which has the effect of easy to operate and more stable. However, when removing bars, we may encounter situations such as wire breakages and skeleton hyperplasia which will lead to difficulty of the bar removal operation. We summarize the experience in this aspect and introduce the surgical methods.

Method:

A retrospective analysis was conducted on the clinical data of 276 patients who underwent pectus bar removal surgery in our center from January 2024 to September 2024. The types of bars, operation time, skeleton hyperplasia, wire breakages and wound infection were analyzed. Whether the wire is broken could determine by preoperative images and the integrity of the wire during the operation. We will use a bone forceps to remove the skeleton hyperplasia, and the C-arm X-ray Unit will locate the broken wires for removal.

Results:

All 276 patients successfully completed the pectus bar removal surgery with a median age of 14.6 years (4-20years). The bar was placed on average 35.6 months (29-48 months), including 226 cases of serrated bars and 50 cases of perforated bars. Skeleton hyperplasia formation was observed in 90 patients, and wire breakages occurred in 104 patients; all broken wires were successfully removed. Postoperative wound infection occurred in 2 patients, with no other intraoperative or postoperative complications recorded. The average postoperative hospital stay was 1.2 days. Three-month follow-up showed no abnormalities.

Conclusion:

It is safe and feasible to perform wire-fixed bar removal surgery using appropriate surgical instruments and methods, and no increase in incision hematoma and infection has been observed. If the wire breaks, it can be quickly removed through an effective surgical method.

Keywords:

Pectus excavatum; Bar removal; Surgical methods

NBA XI: A Cheat Code to Multiple Bar Pectus Repair

Hyung Joo Park[1], John DiFiore[1], Manuel Lopez[1], Rajkamal Vishnu[1], Miguel Guelfand[1]
[1]Cleveland Clinic Pectus and Chest Wall Institute, Cleveland Clinic Children's Hospital, Cleveland, OH, USA

Background and Aim: Multiple-bar pectus excavatum (PE) repair is essential for comprehensive chest wall remodeling, but variability in bar configuration often complicates surgical planning and outcomes. The No-Brainer Approach (NBA), a crossbar plus an upper horizontal bar arranged in an "XI" pattern, provides a simplified, standardized strategy for consistent and efficient repair.

Methods: Since March 2024, we have adopted the NBA XI approach for PE repair, including 66 patients (mean age 16.4 years; range 10–42; 56 males, 85%). The procedure followed four steps: **1. Crane-powered pre-lifting:** The sternum was elevated using the Easy Crane® system to allow safe retrosternal dissection and full pre-lifting of the chest wall. **2. XI Bar placement:** Three bars were placed at 4, 5, 6 intercostal spaces: cross-bars below the nipple line ("X"), and a horizontal bar above ("I") (Fig. 1-3). **3. Bridge Fixation:** Bars were secured with bilateral bridge plates for rigid stabilization. **4. Chest Wall Contouring:** Flarebusters and Magic Strings were applied to correct costal flaring and restore normal anatomy.

Results: The mean operative time was 68 ± 19 minutes, with no intraoperative issues. Postoperative complications occurred in 3 patients (4.5%): 2 pneumothoraxes and 1 wound infection. There was no bar displacement or major complications were observed. The mean hospital stay was 5.1 days (range, 3–8).

Conclusion: The NBA XI technique offers a safe, efficient, and reproducible approach for multiple-bar pectus excavatum repair, with no major complications. By standardizing chest wall correction, it functions like a "cheat code," enabling reliable bar placement and uniformly favorable surgical outcomes.

Keywords: pectus excavatum, multiple-bar repair, XI bar configuration, crane-powered repair, no-brainer approach, NBA XI

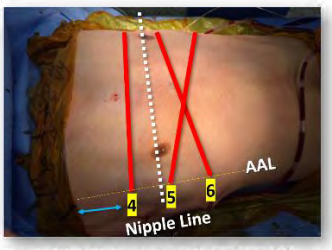


Fig. 1. NBA XI Approach: Crossbars (X) below Nipple line (6,5 ICS) and Horizontal bar (I) above Nipple line (4 ICS)

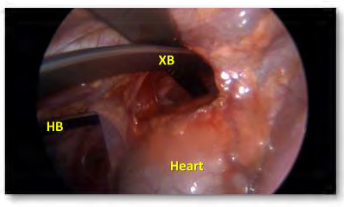
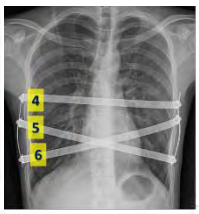


Fig. 2. NBA XI Approach, Internal View: Crossbars (XB) below and Horizontal bar (HB) above



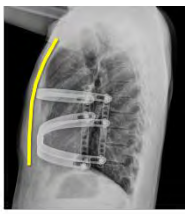


Fig. 1. NBA XI Approach: Crossbars (X) at 6,5 ICS and Horizontal bar (I) at 4 ICS

Use of Elevation-Compression Devices in Correction of Chest Deformities

Vladimir Kuzmichev[1], Murtazaali Ramazanov[1], Vladimir Gatsutsin[2]
[1]Moscow Regional Research and Clinical Institute (MONIKI), [2] Moscow Paediatric Speransky Hospital

Background and Aim: Elevation of the sternum while performing Nuss procedure is a well-known technology that ensures safety and reduces the number of potential complications. In the case of Pectus Carinatum deformity, while performing minimally invasive correction according to Abramson, intraoperative compression is a less common method, however, it also proved to be helpful. A comparative analysis of the 3 most common devices designed to help the surgeon in performing Nuss and Abramson procedures is of particular interest.

Method: A retrospective comparison of 3 table mounted devices - Park Pectus Crane (PPC), Rultract retractor (Rr) and Thomson Pectus Assist (TPA) was done used in a group of adults and children in surgeries for PDC and CDH (Table 1)

Table 1. Use of PPC, Rr and TPA

	Park Pectus Crane	Rultract retractor	Thomson Pectus Assist	
Adult PE	517	421	6	944
Pediatric PE	490	5	42	537
Adult PC	1	0	2	3
Pediatric PC	27	0	3	30
Total:	1035	426	53	1514

Results: PPC worked great in pediatric patients with PE and PC, but it was not well suited for rigid chests in adults, so since 2016 we have used it only in children. Rr - was ideal for PE operations in both children and adults, but naturally could not be used in the Abramson procedure. Our experience operating with TPA is small, however, in our opinion it is the most versatile device for operating on children and adults, both Nuss and Abramson procedures.

Conclusion:

Our experience may be useful when choosing a device for operations on chest deformities.

Keywords: Park Pectus Crane, Rultract retractor, Thomson Pectus Assist, Nuss procedure, Abramson procedure

Nuss procedure with cross-bar can correct isolated costal flaring

Vladimir Kuzmichev[1], Vladimir Gatsutsin[2]
[1]Moscow Regional Research and Clinical Institute (MONIKI), [2] Moscow Paediatric Speransky Hospital

Background and Aim: The crossed position of bars in Nuss procedure has entered clinical practice since 2016 after the publications of H.Pilegaard and H.J.Park. Soon it was noted that this position of the bars in a number of patients significantly corrects costal flaring, which often bothers patients aesthetically even more than the main deformation. Is the method applicable for isolated flaring in the absence of PE and how justified is the intervention in the absence of PE

Method: Two consecutive observations of isolated costal flaring correction in adolescent boys are presented. The operation was performed using the established technique with sternal elevation. The position of the bars was determined by the point of pressure on the rib that provoked the flaring (7th) and the lower bone edge of the sternum. The place of entry of the bar behind the sternum was the 3rd intercostal space. In cases where such a design was impossible due to a shortened sternum, the correction was abandoned.

Results: In both observations, a good immediate result was achieved, highly appreciated by patients and their parents.

Conclusion:

Nuss procedure with cross-bar positioning can be successfully used for correction of isolated costal flaring in the absence of PE in a strictly selected category of patients

Keywords: Crossed bars, Nuss Procedure, Costal flaring

Short Bars, Big Impact: The Innovative Short-Bar and Sandwich Techniques Redefining Pediatric Chest Wall Surgery

Anja Christina Weinhandl, Winfried Rebhandl
University Clinic of Pediatric and Adolescent Surgery, Medical University of Vienna

Background and Aim:
While the Nuss and Abramson procedures have become well established for the minimally invasive correction of pectus excavatum (PE) and carinatum (PC), traditional long-bar techniques remain limited in their adaptability to the pediatric thorax and to complex deformity subtypes. At our institution, we have systematically employed short bars—across multiple configurations, including single, parallel, crossed, and the so-called Sandwich approach—to remodel the entire chest wall in children and adolescents with pectus deformities.

Method:
This retrospective analysis includes 140 patients who underwent minimally invasive chest wall repair using short bar-based techniques. In all cases, anatomically adapted short bars were implanted and fixed with a single stabilizer positioned ventrally near the entry point. This concept was applied across all configurations, including in Sandwich procedures, which combine internal short bars with external compression bars to correct complex PE/PC deformities.

Results:
Of the 140 patients, 51 (36.4%) received parallel bar placement, 48 (34.3%) a 3-bar crossed (XI) configuration, 12 (8.6%) a 2-bar crossed setup, and 18 (12.9%) a single bar. Additionally, 8 (5.7%) underwent a combined Sandwich technique. Intercostal nerve cryoablation was performed in 94 patients (67.1%), of whom 8 received the treatment percutaneously under ultrasound guidance in the days leading up to surgery. Among 130 patients with available measurements, the median preoperative Haller Index was 5.25 (IQR 2.38), ranging from 2.17 to 14.8. The short-bar approach enabled anatomically precise correction, reduced soft tissue stress, and minimized implant migration. All configurations demonstrated high mechanical stability and low complication rates.

Conclusion:
The short bar technique, characterized by a ventrally positioned stabilizer and a modular configuration, offers a versatile and anatomically adaptive strategy for pediatric chest wall repair. This approach proves highly effective in both standard and complex deformity types and may serve as a new standard in minimally invasive thoracic surgery.

Keywords: short bar technique · sandwich technique · pediatric chest wall deformity · ventral stabilizer · pectus excavatum · pectus carinatum · minimally invasive repair

Correction of PE in women

Rustem Hayaliev[1,2], Viktor Markushin [1,3], Sharif Rahimiy[1], Dilyara Mazinova[4]

[1]Multidisciplinary international clinic "Surgemed", Urgench, Uzbekistan
[2]Republican Scientific-practical Center of Sport Medicine, Tashkent, Uzbekistan
[3]TS hospital, Krasnodar, Russia
[4]Central Clinical Hospital No. 1, Tashkent, Uzbekistan

Background and Aim: At the present stage of medical development, there is a differentiated approach to choosing a treatment method for a particular disease. In the case of Pectus excavatum, a comprehensive examination of the patient is necessary with an individual approach and the determination of optimal treatment tactics.

Method: With timely treatment of patients, especially before the complete formation of the skeleton and the development of severe deformity, Vacuum Bell can completely correct the anomaly that has arisen, rid a person of both physical illness and psychological problems. Nass surgery is necessary for patients with a Haler index of more than 3.5-4; the older age group (≥18 years for boys, ≥12 years for girls, but there may be individual exceptions); lack of effectiveness from Vacuum Bell.

Results: Are there differences in the correction of Pectus excavatum in girls and boys? Of course there is. And big ones at that. Unfortunately, the use of an alternative method of vacuum therapy in girls is limited to the age from 4 to 11-13 years, depending on the individual characteristics of puberty. In boys, however, this bar can be pushed back to 20-22 years in some cases. The fact is that the female body completes its full formation much earlier than the male body, often at the age of 13-15 - it is no longer a girl, but a fully formed woman with ossification of the ribs we need to correct, and there will be no growth. In addition, adolescents with Pectus excavatum, under the influence of an external defect, form a negative perception of their own body image, which leads to a decrease in self-esteem, increased anxiety and the actualization of depressive manifestations in the structure of the psycho-emotional state.

Conclusion: Therefore, the correction of Pectus excavatum in girls should be started as early as possible.

Keywords: Pectus excavatum, women, differences, Vacuum Bell

SEVERE FORMS OF PECTUS EXCAVATUM

Rustem Hayaliev[1,2], Viktor Markushin [1,3], Sharif Rahimiy[1]

[1]Multidisciplinary international clinic "Surgemed", Urgench, Uzbekistan
[2]Republican Scientific-practical Center of Sport Medicine, Tashkent, Uzbekistan
[3]TS hospital, Krasnodar, Russia

Background and Aim: Anatomically, before puberty, the lower half of the anterior chest wall is represented by a cartilaginous part, especially the costal arch is malleable. It is in this place that deformations develop the most, and it is here that we will apply force to correct it.
Method: There are two main methods of treating pectus excavatum: surgical operation and conservative alternative method of using a vacuum bell. But the laws of physics are still taken into account. If external pressure is used when using the bell, then steel bars are used during surgical treatment, which will have a physical effect from inside the chest.
Results: Is it possible to correct severe long and wide deformities with vacuum therapy? - Yes. And we already have many such patients who have completely recovered from large-area deformities with the help of a bell (Fig. 1, 2). There are only 2 limiting factors: age and gender. If a child has a severe deformity, but the age is up to 9 years for girls and up to 13-14 years for boys, then correction is still possible without surgery.

Conclusion: If the patient believes in the method, is motivated, and sees a positive effect after the initial application of the bell, then success is assured. It only takes time and patience.

Keywords: correction, pectus excavatum, plastic surgery, the Nuss surgery, Vacuum Bell.

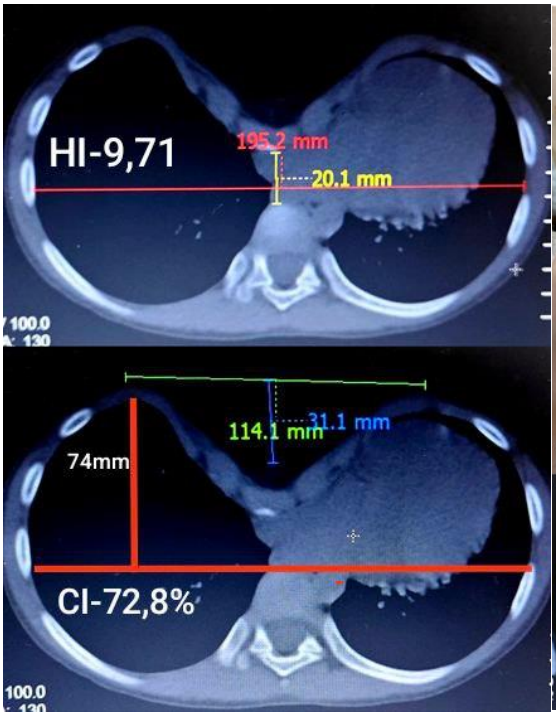
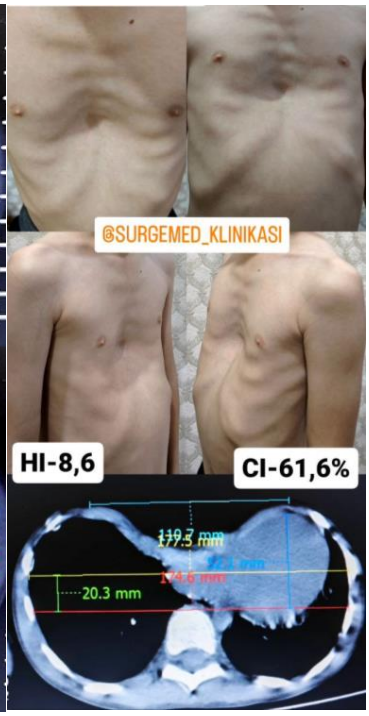


Fig. 1.



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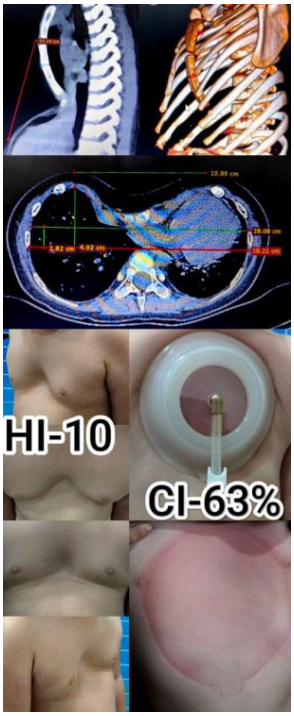

Fig. 3.

Fig. 1. Severe PE in a 7-year-old boy. The Haller index is 9.71.
Fig. 2. Severe PE in a 9-year-old boy. The Haller index is 8.6.
Fig. 3. Severe PE in a 4-year-old girl. The Haller index is 10.

Over 1000 cases of Nuss procedure

Author(s)and Affiliation(s): Yasushi Kasagi,M.D.Phd [1],
Machiko Kasagi M.D., Akihiro Matsuoka M.D.

Background and Aim:

Since 2000 July,

Method:

Improved Nuss procedure over 1000 cases

Results:

Good result.

Conclusion:

For the pectus excavatum especially aged cases improved Nuss procedure is better than the original Nuss procedure especially aged cases

A Twelve-year-old Child with a Sunken Sternum and Progressive Muscle Weakness

Author(s)and Affiliation(s): *Siman Chen[1], *Qi zeng[1], Chenghao Chen[1], Jie Yu[1], Na Zhang[1], Dong Yan[1], Changqi Xu[1], Dingyi Liu[1], Qian Zhang[1], Xu Zhang[1], Ting Yang[1]

[1] Department of Thoracic Surgery, Beijing Children's Hospital, Capital Medical University, National Center for Children's Health, Beijing, China.

Please structure your abstract within a single page, following the format below. The abstract should not exceed 300 words. You may include images and charts as long as they fit within a single page.

Background and Aim:

A 12-year-old girl was admitted to the hospital due to a 5-year history of chest wall depression, which had significantly worsened in the past two years. She experienced obvious chest tightness and shortness of breath after exercise. The patient had difficulty closing her eyelids and mouth, and was unable to puff out her cheeks. Her upper limbs were restricted in movement, with muscle strength at grade 3. Shoulder joint flexion and abduction were limited, and elevation was restricted, with a prominent trapezius muscle appearance and visible winged scapula. The thorax was asymmetrical on both sides, with the chest wall depressed inwardly centered on the middle of the sternum, and the costal margins were outwardly flared. Chest CT showed a Haller index of 4.8. Beevor's sign was positive. Pulmonary function tests indicated restrictive ventilatory dysfunction.

Keywords:

Facioscapulohumeral muscular dystrophy, Children

P-29 CW250123

Nuss procedure after sternal cleft repair: challenging but feasible

Ana Laín Fernández, Laura García Martinez, Manuel López Paredes, María Díaz Hervás, Carlos Giné Prades
Pediatric Surgery Department, Vall´d´Hebron Barcelona Hospital Campus, Barcelona-Spain

Background and Aim: Pectus excavatum(PE) can develop following the repair of a sternal cleft(SC). The Nuss procedure is particularly challenging in these cases due to adhesions and the altered positioning of the sternal bars after cleft repair, often leading surgeons to opt for more invasive approaches. We report a case of PE in a patient with a previously repaired SC, successfully treated using a modified Nuss procedure.

Method: A newborn with SC underwent successful primary repair at one month of age. Postoperative outcome related to the cleft was favorable; however, the patient later developed PE with right ventricular compression. At age six, vacuum bell therapy was initiated, but the deformity progressed, and by age twelve, the patient experienced exertional dyspnea. MRI revealed a Haller Index of 5.8, Correction Index of 52%, and evidence of right ventricular compression with decreased cardiac function. The CT scan with sternal reconstruction showed lack of approximation of the sternal bars in the upper two-thirds—findings not evident on physical examination. Given the progression, a Nuss procedure with sternal stabilization was planned.

After thoracoscopic cryoanalgesia, an attempt was made to elevate the sternum using wires resulting unsuccessful. A small presternal incision was performed exposing the sternum and 2 wires holding both sternal bars were placed, achieving sternal elevation. Retrosternal dissection was challenging due to firm adhesions and bilateral thoracoscopy was employed to enhance safety. Two parallel retrosternal Nuss bars were placed and fixed with lateral bridges. To gain stability both sternal bars were secured with external titaneum plates.

Results: The patient was discharged on postoperative day six without complications. Nine months after surgery, she remains asymptomatic, with excellent functional and cosmetic outcomes.

Conclusion: Nuss procedure after SC repair is challenging but feasible. In our experience, key elements include effective sternal elevation, bilateral thoracoscopy with meticulous retrosternal dissection, and sternal stabilization with plates.

Keywords: Pectus excavatum, sternal cleft, Nuss procedure

Simultaneous Pericardial Cyst Excision and Nuss Procedure in a Patient with Pectus Excavatum

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Background and Aim:
Pectus excavatum is the most common congenital deformity of the chest wall and typically requires surgical correction for cosmetic or functional reasons. Pericardial cysts, on the other hand, are rare benign mediastinal masses that are usually asymptomatic but may become symptomatic when they enlarge. This report presents the case of a patient with pectus excavatum who was also found to have a concomitant pericardial cyst, both of which were treated in a single surgical session.

Method:
A 31-year-old female patient with a one-year history of dyspnea was diagnosed with pectus excavatum. Imaging also revealed the presence of a pericardial cyst. During surgery, the pectus deformity was first corrected using the Nuss procedure. In the same session, the pericardial cyst was excised via a thoracoscopic, minimally invasive approach.

Results:
Under general anesthesia, the patient was intubated with a double-lumen endobronchial tube and operated on in the supine position. Vertical incisions were made in the right 5th and left submammary regions. After subcutaneous dissection, 5 mm camera and surgical ports were placed. Two bars were inserted between the right 2nd and left 5th intercostal spaces and stabilized using lateral stabilizers. With thoracoscopic guidance, the anterior mediastinum was dissected, the cystic cavity drained, and the pericardial cyst completely excised. A 32 Fr chest tube was placed, and the anatomical layers were closed to complete the operation.

Conclusion:
Simultaneous repair of pectus excavatum and excision of a pericardial cyst can be safely and effectively performed in appropriately selected patients. This combined approach allows for single-anesthesia surgery, shortens recovery, and reduces both complication risk and healthcare costs.

Keywords:
Pectus excavatum, pericardial cyst, minimally invasive surgery, Nuss procedure, thoracoscopy

P-31 CW250056

Minimally invasive repair of Pectus excavatum in Montenegro

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Background and Aim: The most common sternal deformities are pectus excavatum and carinatum. The aim of this study is to provide an overview after repair of pectus excavatum using the minimaly invasive Nuss technique .

Method: At the Clinical Center of Montenegro, correction was performed in 16 patients with pectus excavatum. The average age of the patients was 12-27 years. All patients had aesthetic problems. We analyzed the surgical technique and time, aesthetic result, postoperative pain, length of hospital stay and complications.

Results: After the surgical procedure, we achieved satisfactory aesthetic results in all patients after bar placement in 91-97%. We have 16 Nuss cases. Postoperative pain was moderate on a scale of 3-5. Operative time ranged from 40 min to 80 min on average. Average hospital stay was 5.5 days. We have one patient with prolonged subfebrile fever and one with partial pneumothorax.

Conclusions: Minimally invasive pectus repair using the Nuss procedure is effective and safe. Its efficacy is demonstrated by excellent to satisfactory results in 91% to 97.% of patients after bar placement. Pectus repair has low morbidity and excellent cosmetic results in the treatment of pectus deformities.

Keywords: Chest wall; Pectus excavatum; Nuss repair

Impact of Surgery on Quality of Life, Psychological States, and Personality Traits in Patients with Pectus Excavatum

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Background and Aim:
The impact of surgery on the quality of life (QOL) and psychological states of patients with pectus excavatum (PE) have yet to be well understood. This study aimed to investigate the impact of surgery on the health-related QOL, psychological states, and personality traits of patients with PE.

Method:
Patients who underwent pectus excavatum surgery and bar removal between July 2019 and August 2024 were included in the study. A self-administered questionnaire was used to assess their QOL, psychological states (including depression, social anxiety, and self-efficacy), and personality traits before and after surgery.

Results:
A total of 116 patients who underwent both bar insertion and subsequent bar removal were included in the analysis. Comparison between pre- and post-operative data showed a significant improvement in social-role QOL ($p = 0.0127$) and self-efficacy ($p = 0.0258$). In contrast, no significant differences were observed in physical QOL, mental QOL, depressive tendency, social anxiety, or personality traits before and after surgery. However, no clinically meaningful correlation was found between the degree of improvement in the Haller Index (HI) and these outcomes.

Conclusion:
Surgical correction of pectus excavatum significantly improved patients' social-role QOL and self-efficacy, suggesting psychosocial benefits in addition to physical correction. On the other hand, no clinically significant correlation was observed between the degree of improvement in the HI and these psychological outcomes. These findings highlight the importance of considering psychosocial aspects, along with anatomical improvements, when evaluating the effectiveness of surgical treatment for PE.

Keywords:
Pectus excavatum, Quality of life, Self-efficacy, Psychological outcomes

Freeze or Heat for Pain Control After the Nuss Procedure

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Background and Aim: Cryo-analgesia is widely used for postoperative pain control following the Nuss procedure; however, it may not be available in certain regions. In Japan, cryoablation is commonly used to treat arrhythmias, but it is not covered by insurance for postoperative analgesia. Conversely, thermal radiofrequency (RF) ablation is frequently employed for chronic pain management but has rarely been applied for postoperative pain relief. Its efficacy and postoperative outcomes remain unclear. Given the unavailability of cryo-analgesia in Japan, we investigated whether thermal RF ablation could serve as an alternative method for postoperative pain control.

Method: We retrospectively reviewed 170 cases of Nuss surgery in which intercostal nerve thermal radiofrequency ablation (INTRA) was performed intraoperatively. The procedure was performed using a Top Region Generator. A 20-gauge, 15 cm pole needle was inserted into the intercostal space under thoracoscopic guidance. RF ablation was applied at 70°C for 60 seconds to the main trunk and branches of the intercostal nerves between the third and seventh ribs. Following ablation, 10 mg of hydrocortisone was injected around each treated nerve.

Results: No complications related to the INTRA procedure were observed.
Epidural anesthesia, previously used for postoperative pain control, was not required.
No narcotics were administered postoperatively. Patients were able to ambulate on the first postoperative day, and 97% were discharged by the sixth postoperative day.
Anterior thoracic paresthesia was observed in all patients as an expected effect of intercostal nerve thermal ablation. At 6 months postoperatively, 8% of patients reported mild residual skin paresthesia; however, no cases of neuropathic pain were identified.

Conclusion: Peripheral nerves appear to recover following thermal RF ablation at 70°C for 60 seconds. Similar to cryoanalgesia, INTRA is effective for postoperative pain management. Its advantages include lower equipment costs and the ability to administer corticosteroids to reduce peripheral nerve inflammation and thermal injury.

Keywords: cryo-analgesia, radiofrequency, intercostal nerve, Nuss procedure

Enhancing Technical Mastery of Intercostal Cryoanalgesia in MIRPE: Development and Validation of Two Procedural Simulation Models

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Background and Aim:

Intercostal cryoanalgesia is increasingly used in minimally invasive repair of pectus excavatum (MIRPE), requiring both anatomical knowledge and technical skill. However, structured training remains limited. This study introduces two high-fidelity simulation models designed to address this gap and support safe implementation of cryoanalgesia.

Method:

Two procedural models were constructed using biocompatible and anatomical materials to emulate operative settings (Figure 1.):

1. Percutaneous Access Model: A thoracic cavity replica with 3D-printed PLA structures, porcine ribs, and latex balloons to replicate tissue resistance. Cryoprobe insertion was guided under ultrasound with a high-frequency linear probe.
2. Thoracoscopic Visualization Model: A synthetic thoracic shell covered with EVA rubber and goat ribs, integrated with a custom 30° golden-tip cryoprobe and endoscopic system.

During a training workshop, participants performed both approaches and rated each model's realism, technical transferability, and educational impact using a 5-point Likert scale.

Results:

Among 24 participants [median age 44 years (IQR: 39.0; 50.0)], 15 (62.5%) had over a decade of surgical experience and 8 had performed over 40 MIRPE. Both models received scores > 4 for structural realism and > 4.5 for technical replicability with no significant differences when comparing expertise levels (p: 0.945; p: 0.432, respectively).

Conclusions:

These simulation tools offer a realistic, accessible platform for mastering intercostal cryoanalgesia in MIRPE. Their positive reception underscores the need for structured training to safely expand cryoanalgesia use in thoracic pediatric surgery.

Keywords:

Simulation, MIRPE, pectus excavatum, cryoanalgesia

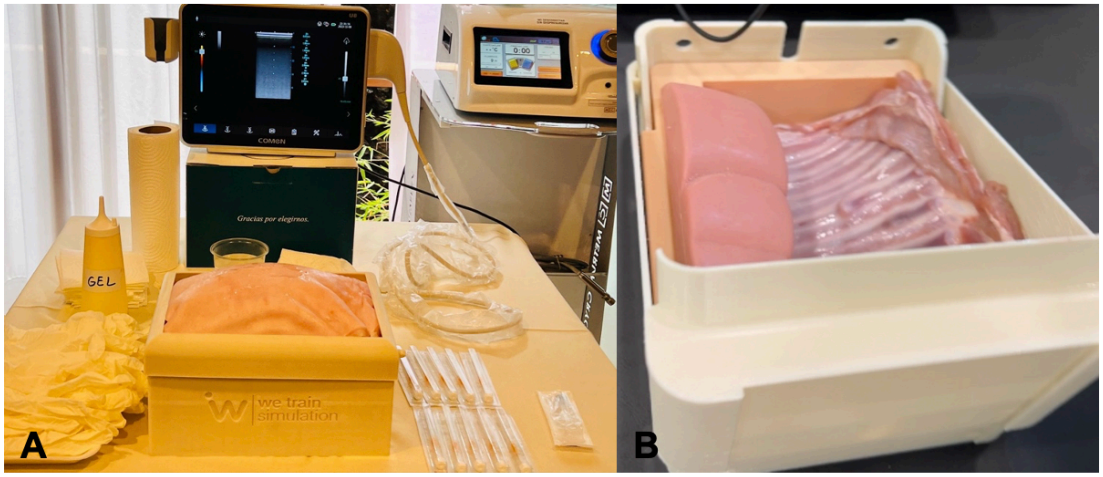

Figure 1. A. Percutaneous Cryoanalgesia model. **B.** Thoracoscopic cryoanalgesia model

Clinical analysis of the Nuss procedure for pectus excavatum in patients under 10 years of age.

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Background and Aim: Patients with pectus excavatum (PE) may develop depression in the anterior chest immediately after birth, and psychological effects may be observed from around the time of entering elementary school. Therefore, PE repair is sometimes performed before the optimal age of 10-12 years. However, the recurrence rate is reportedly high. In this study, we reviewed cases of the Nuss procedure (NP) for PE in patients aged < 10 years and evaluated its usefulness.

Method: We conducted a retrospective study for patients under 10 years who underwent NP and bar removal between January 2012 and December 2024.

Results: NP was performed in 20 patients < 10 years (12 males). The age at diagnosis was 1-9 years (4.9±2.62 years), the age at surgery was 6-9 years (7.9±1.16 years). The period from diagnosis to NP was 0.9-89 months (37.1±29.25 months). Haller index at the time of NP was 3.1-6.3 (4.2±0.92). In all cases, only one pectus bar was inserted, with a length of 240-310 mm (268.2±18.49 mm) and a width of 12-15 mm (13.3±1.44 mm). The operation time was 35-96 mins (67.1±16.27 mins). There was one case of wound infection as a postoperative complication, which improved with conservative treatment. The period from NP to bar removal was 2.6-3.3 years (3.0±0.13 years). There was one case (5%) of recurrence after bar removal.

Conclusion: Although there is a risk of recurrence, NP for patients under 10 years has demonstrated good results. We believe that NP would be a good option in patients under 10 years.

Keywords: Nuss procedure, Pectus excavatum, Young children

Prevention of lung damage during the correction of Pectus excavatum (PE) deformity by using a cross bars

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Background and Aim: PE is a complex malformation which leads to cosmetic and cardiopul monary problems. Prevention of lung damage during the correction PE by using seagull-shaped cross bars.

Method: This study was conducted 2018-25 for 140 patients aged 11-20 with PE were treated by cross method. This surgical therapy was based on H.J. Park's morphological classification (2009)

Type I	Symmetric 76(54,3%)	Repair Technique Symmetric Cross Bars	Type II	Asymmetric 64 (45.7%)	Repair Technique Asymmetric Cross-Bars
1A1	Focal -48(34,3%)		2A1	Eccentric focal-23(16,4%)	
1A2	Broad-flat-12(8,6%)		2A2	Shallow broad-14(10,0%)	
1A3	Long-channel- GC6(4,3%)		2A3	Long-channel- GC-9(6,4%)	
1B	Focal protrusion-10(7,1%)		2B	Unbalanced-11(7,9%)	
			2C	Combined-7(5,0%)	

The moderate and severe levels of PE with Haller Index more than 3.2 needed surgery, there were 86 (61.4%) boys and 54 (39.6%) girls with symmetrical and asymmetrical type.

All patients were divided into 2 groups depending on placement of bars:

1 – symmetrical cross bars in 76 (54.3%),

2 – asymmetrical seagull-shaped bars in 64 (45.7%).

For the correction of symmetrical PE during the placement of symmetrical cross-bars while rotation second bar by 180 degrees the bars crossing is localized above the heart,
and the asymmetrical seagull-shaped cross bars for the asymmetric PE bars crossing above the lungs and the lung is pinched between the bars, causing rupture of the lung and hematomas as complications as pneumothorax and hemothorax.

To prevent this complication of the placement the second bar and its rotation moment is recommended to disconnect the artificial ventilation for 3-7 seconds.
In this case, the pressure in the lung decreases and not pinched between the bars. The surgery carefully monitored with a thoracoscope.

Results: The control radiographic examination is intraoperatively and after 12-24 hours, the pathological changes as pneumothorax and hemothorax were not observed.
Consequently, the above complications during the placement of asymmetric seagull-shaped cross bars according to the results of the proposed method was decreased from 7(5.0%) to 0%.

Conclusions: For the placement of seagull-shaped cross bars while rotation of the second bar its recommended to disconnect the artificial ventilation for 3-7 seconds, which leads to decrease in intrapulmonary pressure and absent damage of the lung tissue.

THE OPTIMAL AGE FOR NUSS SURGERY. OUR VISION.

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Most of the children who came to us had already been consulted by traumatologists and only surgical treatment was recommended for them. We also perform operations on chest deformities, but only minimally invasive and according to strict indications. The operation gives the best results after the age of 14-15, with the patient growing more than 80% of the possible. Surgeries in young children cause many immediate and long-term complications.

We will give you some examples of the fact that it is not only undesirable, but also unnecessary, to operate on children under 10 years of age, and even more so under 7 years of age. The first photos show MSCT scans of the chest of a 12-year-old girl who was disabled as a result of having steel plates installed at the age of 5, now she has a terrible deformity of the skeleton, the lower ribs are flattened and brought together, the upper ribs with the consequences of multiple "helical fractures" (Fig. 1). Also the case of a patient who was operated on by traumatologists at the age of 2 and again at the age of 10 is presented (Fig. 2). Our team also operates on patients with pectus excavatum, but mainly after growth arrest: girls after 13-14 years, boys after 18 years. Currently, more than 93% of patients with timely treatment can be treated conservatively using vacuum therapy!

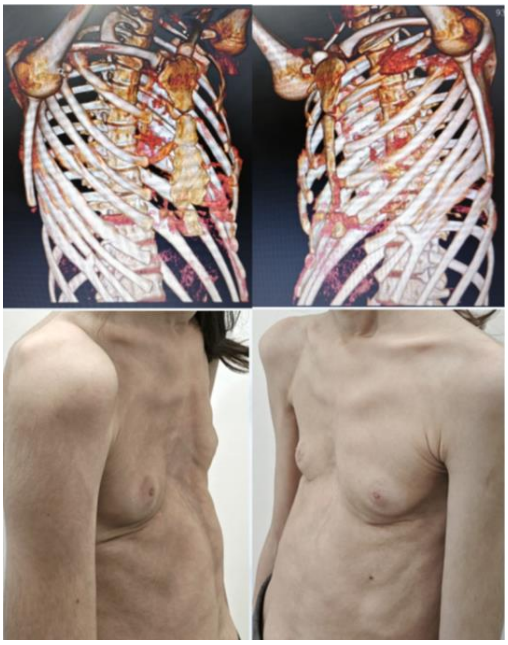

Fig. 1. Deformed chest of a 12-year-old girl who underwent surgery at the age of 5

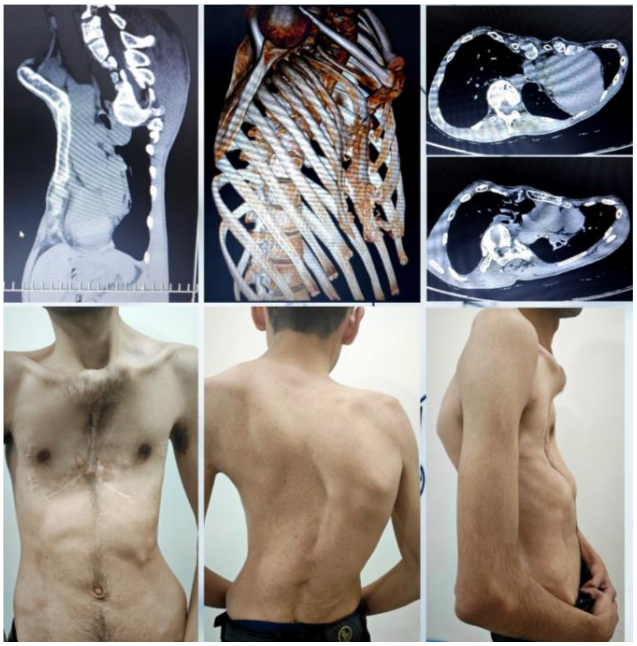

Fig. 2. Patient born in 2001, operated at the age of 2 and 10 years. Irreversible deformity of the chest and spine with severe ossification.

Evaluation of Costal Morphology in Pectus Excavatum Using Geometric Morphometrics: A Comparison with Normal Thorax

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Background and Aim:
The parameters using traditional morphometrics such as the Haller Index and Correction Index are commonly used to evaluate thoracic morphology in patients with pectus excavatum. These parameters obtained from this method are univariate and computationally simple but fail to retain geometric information (spatial relationships). In contrast, geometric morphometrics (GM) mathematically represents shape variation using coordinate points and vectors in coordinate space. However, its application in the medical field remains limited due to the complexity of data processing and mathematical analysis. This study aimed to evaluate the morphology of the fifth rib in patients with pectus excavatum and healthy individuals using GM.

Method:
Chest CT images of patients who underwent Nuss procedure between 2015 and 2016 were analyzed. Cases with symmetry pectus excavatum were included, and CT images with a slice thickness of ≤2 mm were used. Control cases were selected from individuals who underwent chest CT for other diseases in 2020. Surface data were extracted from the fifth ribs and the fifth vertebrae in 20 patients with pectus excavatum and 19 control subjects using DICOM data. Landmarks were placed on the ribs, and generalized Procrustes analysis (GPA) and principal component analysis (PCA) were performed.

Results:
Morphological variation along the first principal component (PC1) score indicated changes in rib curvature in the cranio-caudal direction. Correlation coefficients between PC1 scores and the Haller Index, Correction Index were -0.45 ($P=0.004$), -0.639 ($P<0.001$) respectively. A higher Correction Index was associated with a lower PC1 score, indicating increased rib curvature.

Conclusion:
The curvature of the fifth rib in patients with pectus excavatum differs from that in individuals without sternal depression.

Keywords:
Geometric Morphometrics, costal shape, Pectus excavatum

The contribution of 3D-printing in the minimally invasive corrective surgery of Pectus Excavatum.

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Background and Aim:

Pectus excavatum (PE), or "funnel chest" is a congenital deformity of the anterior chest wall believed to be caused by abnormal growth of the cartilages in the chondrocostal region.

The Nuss procedure is a preferred alternative to open corrective surgery for Pectus Excavatum. However, it is characterized by a steep learning curve, and its perioperative complications largely depend on the surgeon's experience.

This raises the question of the value of 3D printing in the field of minimally invasive pectus excavatum surgery.

Method:

To assess the contribution of 3D printing to the different technical stages of the Nuss procedure, we conducted a study in two phases: the first phase was a case study of a Nuss surgery performed with the assistance of 3D printing.

In the second phase, we organized a training workshop using a physical simulator of the Nuss technique obtained through 3D printing; targeting surgeons with no prior experience of the procedure.

Results:

Results showed that 3D printing not only allows precise surgical planning, reducing potential complications, but can also provide teaching opportunities for healthcare professionals and educational materials for patients and trainee surgeons.

Conclusion:

With the increasing availability of 3D printers in teaching hospitals, Pectus Excavatum cases should be simulated using 3D printing frequently prior to the surgery to allow for proper surgical planning; all while providing teaching opportunities for healthcare professionals and educational materials for patients.

Keywords:

Pectus Excavatum, 3D printing, Nuss Procedure, Surgical Education.

Implant Failure after Minimally Invasive Repair of Pectus Excavatum; a Case-Series

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Background and Aim: Surgical correction of pectus excavatum through the Nuss procedure makes use of implants such as pectus bars and stabilizers. These implants are designed to withstand prolonged mechanical stress, and failure could compromise intrathoracic stability and lead to bar dislocation. This single center retrospective case series is the first report to discusses implant failure using the MedXpert Pectus Excavatum System.

Case presentation: Five cases of implant failure after initial correction of pectus excavatum via Nuss procedure were reported during the inclusion period (January 2021-March 2025). Patients were males between the ages of 14 and 18 years, all initial Nuss procedures used one bar and two or three stabilizers. Three cases of implant failure were identified during routine consultation before bar removal. These patients did not experience any complaints, and the fractured stabilizers were incidental findings upon routine chest X-ray. Two other patients presented to the outpatient clinic at 15 and 26 months post initial correction with complaints of pain and instability. The first patient could provide an identifiable traumatic cause while mountain biking, the second occurred spontaneously. Both cases required revision surgery to remove the fractured stabilizer; replacement of the stabilizer or early bar removal were not deemed necessary. Notably, in all five patients all stabilizers were fractured at the same location (see figure 1) indicating a weakness in the design which at times seems to be unable to bare the prolonged mechanical stress. Bar dislocation due to implant failure was not observed.

Conclusion: Implant failure of the MedXpert Pectus Excavatum System stabilizers is a notable complication and may necessitate revision surgery when pain or subjective instability occurs.

Keywords: Pectus excavatum, Nuss procedure, implant failure

Figure 1. Fractured stabilizer ex vivo

The influence of thoracic morphology on recurrence of primary pneumothorax

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Background and Aim:

Spontaneous pneumothorax (SP) is more common in young males than in other age groups. The clinical problem with SP is recurrence, and the causes have not been identified. Previous research has suggested that SP is more likely to occur in people with tall, flat chests, but some cases doesn't fit this description. This study aimed to figure out the thoracic morphology characteristics contributing to the occurrence and recurrence of SP.

Method:

We conducted a retrospective analysis of patients who diagnosed with SP at our hospital from 2012 to 2023. To analyze the thoracic morphology, we calculated Haller Index (HI). These measurements were performed at the height of the lower edge of the first rib (Rib 1 HI), the fourth rib (Rib 4 HI), and the xiphoid process (Xiphoid HI).

Results:

Of the 390 patients diagnosed with SP at our hospital, 68 patients (Group A) who improved without surgery for primary SP and did not experience recurrence, and 97 patients (Group B) who required treatment (surgery or conservative treatment) for recurrent SP were included in the study. In addition, 50 healthy volunteers who underwent CT imaging were included as a control group (Group C). The median values for Rib 1 HI, Rib 4 HI, and Xiphoid HI were 3.48, 2.81, and 2.90 in Group A, 3.82, 2.76, and 2.93 in Group B, and 3.52, 2.86, and 2.79 in Group C, respectively. Multivariate analysis revealed that increased Rib 4 HI /Rib 1 HI and increased Xiphoid HI /Rib 1 HI were significant risk factors for SP occurrence ($P < 0.01$) and recurrence ($P < 0.01$).

Conclusion:

It has been suggested that a thoracic morphology that is flatter at the apex of the lung compared to the trunk may contribute to the occurrence and recurrence of SP.

Keywords:

spontaneous pneumothorax, thoracic morphology

Diagnostic and Therapeutic Challenges of Pleural Effusion After the Nuss Procedure: A Case Series

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Background and Aim: Pleural effusion following the Nuss procedure is a poorly understood complication. Symptoms and imaging findings closely resemble pneumonia, making diagnosis challenging. This can lead to delayed treatment and preventable interventions.

Method: A retrospective case series of three exemplary patients (<18 years), who developed symptomatic pleural effusion after the Nuss procedure, was conducted. Clinical history, imaging, laboratory results, treatment, and outcomes were reviewed. We propose a stepwise approach for diagnosis and management.

Results: All patients presented within five weeks with pain, fever, dyspnea, and raised inflammatory markers. Imaging could not clearly distinguish pneumonia from sterile pleural effusion, and cultures of drained fluid were consistently negative. In the first patient, pleural effusion coincided with post-pericardiotomy syndrome; steroids were started but withdrawn prematurely, leading to recurrent effusion which was treated with multiple courses of antibiotics. In the second patient, symptoms persisted despite antibiotic treatment. Symptoms resolved quickly after corticosteroid therapy was initiated but soon recurred; a dislocated Nuss bar was then identified which required surgical repositioning of the bar. The third patient received no corticosteroids and experienced a complicated clinical course with drainage and multiple courses of antibiotics. Ultimately, this patient underwent surgery, followed by an extended period of antibiotic therapy.

Conclusion: Pleural effusion after the Nuss procedure can result from a reactive inflammatory response, triggered by pleural or mechanical irritation (caused by multiple bars, bar dislocation, crane elevation). Diagnosis requires pleural fluid analysis and careful radiologic assessment. Once pneumonia, infection and bar displacement are ruled out, corticosteroid therapy may be effective.

Keywords: Pleural effusion, Nuss procedure, complex pneumonia, corticosteroid therapy

P-44 CW250143

Thermodermography as useful tool to assess effects/side effects of thoracal cryoablation after surgical repair of chest wall deformities

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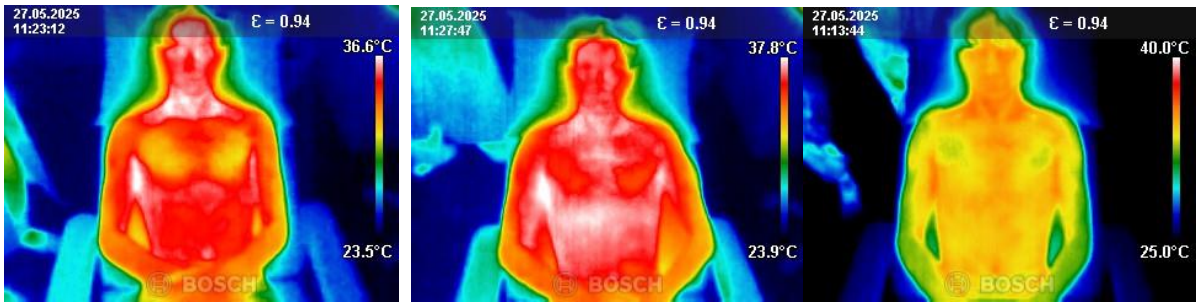
Background

Surgical repair of chest wall deformities is associated with significant pain, and efforts to control pain impact resource utilization. Efficient pain management is a crucial and mandatory measure to ensure a good outcome and to reduce hospital stay. Vice versa, poor pain control not only increases hospital stay, but also can raise opioid consumption, limit mobility and/or favour readmissions. Within the last couple of years, an increasing number of authors reported on their experience with cryoablation for pain management. However, applicants have to be aware of possible side effects such as neuropathic pain and/or long-term sensory function impairment. In a pilot study, we started to include thermodermography as a routine measure to assess intermediate and possible long-term side effects after thoracal cryoablation.

Methods

The regulation of blood flow and temperature control on the skin of the thorax is controlled by the intercostal nerves. Temperature control may be used as a confidential marker to assess the vitality of the intercostal nerves. We analyze the step by step recovery of these nerves by using thermal skin imaging in our postoperative outpatient clinic follow-up program.

Results



Base Line imaging | after heat application | after cold application

Conclusion

We consider thermodermography as an additional useful tool and would like to present our preliminary results with this new assessment method.

Bilateral Hemothorax Following Chest Wall Reconstruction in a Noonan Syndrome Patient with Chest Wall Deformity: A Case Report

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Background and Aim: Chest wall deformity can be the initial presentation of certain genetic syndromes and warrants comprehensive evaluation.

Method(Case Description): A 14-year-old boy presented with abnormal chest wall appearance and was scheduled for minimally invasive repair using the Nuss procedure. On admission, the patient exhibited distinctive facial features, and his height and weight were both below the 10th percentile for age. He demonstrated abnormal gait, and his heels could not touch the ground when squatting. The Babinski sign was positive. Additionally, he had speech and learning disabilities. His past medical history included bilateral cryptorchidism corrected by surgery.

Result(Management and Outcome): Given the combination of characteristic facial features, short stature, bilateral cryptorchidism, speech impairment, and neurological abnormalities, a syndromic diagnosis was strongly suspected. Genetic testing was conducted for the patient and his parents. A mutation in the PTPN11 gene confirmed the diagnosis of Noonan syndrome. The patient underwent minimally invasive repair of the chest wall deformity. Postoperatively, he developed respiratory failure and moderate anemia due to abnormal bleeding, along with significant electrolyte disturbances. Bilateral thoracoscopic-assisted surgery was used during the procedure. A postoperative chest radiograph was performed to rule out intraoperative vascular injury or displacement of the Nuss bar as potential causes of the bleeding. Emergency bilateral closed thoracic drainage was performed to evacuate the hemothorax and relieve lung compression. Blood transfusions corrected the anemia. Recombinant activated factor VIIa (rFVIIa) and other hemostatic agents were administered to control the bleeding, and electrolyte imbalances were corrected simultaneously. The bleeding was successfully controlled, and the patient's condition gradually stabilized. Follow-up at three months post-discharge showed good recovery and satisfactory correction of the chest wall deformity.

Conclusion: Pediatric patients presenting with short stature, abnormal facies, chest wall abnormalities (e.g., pectus carinatum or pectus excavatum), and congenital heart disease should prompt consideration of Noonan syndrome. Noonan syndrome may predispose patients to unexplained postoperative bleeding; therefore, preoperative screening for coagulation factor deficiencies is recommended. Recombinant activated factor VIIa can be effective in managing abnormal coagulation or surgical bleeding by enhancing the extrinsic coagulation pathway.

Key words: Chest wall deformity, Noonan syndrome, Postoperative hemothorax

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Concurrent Pericardial Cysts and Pectus Excavatum: Insights from Two Adolescent Cases

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Background and Aim: Pericardial cysts are uncommon, often asymptomatic lesions, most frequently identified incidentally in adults ages 30-50. Presenting symptoms can include dyspnea, persistent cough, chest pain, and back pain. Although these cysts are commonly considered congenital, their management, especially for larger ones or those causing compression, typically involved excision, either through percutaneous aspiration or minimally invasive thoracoscopic resection. Here, we review two adolescent cases with pectus excavatum undergoing corrective surgery during which pericardial cysts were discovered and excised.

Methods: A retrospective review was conducted of two adolescents (ages 16 and 19), who underwent minimally invasive chest wall correction (Nuss procedure), between 2023-2024. Preoperative assessment included computed tomography and echocardiography. Intraoperative identification of these pericardial cysts Histopathology and postoperative outcomes at follow-up were evaluated.

Results: Both patients had incidentally-detected pericardial cysts, which were successfully excised using blunt dissection and electrocautery during the planned pectus repair. Final pathology confirmed benign mesothelial-lined cysts. Both procedures were completed without major complications. The younger patient experienced a small apical pneumothorax postoperatively, which resolved without intervention.

Conclusion: Although not typically identified in adolescents, pericardial cysts can coexist with pectus excavatum and may be identified during workup or intraoperatively. Thorough preoperative imaging and surgeon readiness for simultaneous excision are recommended. Thoracoscopic cyst resection during repair of pectus excavatum appears to be both safe and effective, with minimal additional risk.

Keywords: pericardial cyst, pectus excavatum, adolescent, Nuss procedure, minimally invasive thoracic surgery

Complications of pectus excavatum surgery using the Nuss procedure.

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Background and Aim: Since starting to perform pectus excavatum surgeries using the Nuss procedure, the author has operated on 21 cases. This study examines the complications in these cases.

Method: Twenty-one cases of pectus excavatum surgery performed by the author using the Nuss procedure from April 2021 to March 2025 were included. The medical records were reviewed retrospectively to identify complications and their treatments.

Results: The median age was 15 years (range, 12-29 years); the median Haller Index was 4.70 (range, 3.50-7.37). Nine cases had complications: neuropathy of the upper extremity in one; bar displacement in two; pleural effusion in four; atelectasis in one; and pneumothorax in one. The neuropathy improved with vitamin B12; the two cases of bar displacement required reoperation. Two of the four cases of pleural effusion resolved spontaneously and two improved with oral steroids. Atelectasis improved with postural drainage. One patient had four episodes of pneumothorax, two of which improved with conservative treatment, and two of which required drain placement, including one thoracoscopic exploratory thoracotomy.

Conclusion: The complication rate was higher than in previous reports. We implemented measures for each complication and gradually modified the protocol. For upper extremity neuropathy, we changed the surgical position from 90-degree abduction of the upper extremity to suspension. For pleural effusion, we considered invasion of the chest wall during surgery to be a factor and began using sternal elevation by the crane technique. We also revised the method of adjusting the bar bending. We reviewed the number and design of implanted bars for bar displacement. For atelectasis, we implemented active rehabilitation. Since the number of patients is still small, we have not yet verified whether these protocol changes have improved outcomes. Further consideration is required.

Keywords: pectus excavatum, Nuss procedure, complications