



**CWIG** | Chest Wall  
International  
Group



**MARMARA**  
UNIVERSITY

# **23<sup>RD</sup> ANNUAL CONGRESS OF THE CHEST WALL INTERNATIONAL GROUP**

**JUNE 22-24, 2023 TURKEY**

*Istanbul*



[www.cwigcongressistanbul2023.com](http://www.cwigcongressistanbul2023.com)

**GENH**  
CONGRESS



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## 22 June 2023, Thursday

**08:00-08:15 REGISTRATION**

**08:15-08:45 Welcome Speeches**

08:15-08:30 Dean, Faculty of Medicine, Marmara University

*Ümit S. Şehirli*

Chief Physician, Faculty of Medicine, Marmara University

*Hakan Gündüz*

08:30-08:45 *Jose Ribas M de Campos, Mustafa Yüksel, Tunç Laçın*

**08:45-09:45 LECTURES FROM EXPERTS**

**Moderators:** *Mustafa Yüksel, Bedrettin Yıldızeli*

08:45-09:05 Chest Wall deformities- remodeling: Physiologic Effect and Change in Quality of Life

*Robert Obermeyer*

09:05-09:15 Discussion

09:15-09:35 Update on the Indications of Surgery: Indexes, Subtypes of deformities, Preop Workup

*Marcelo Martinez – Ferro*

09:35-09:45 Discussion

**09:45-10:00 Coffee Break**

**10:00-11:00 Live Surgery – Pectus Carinatum Surgery**

**Auditorium Moderator:** *Jose Ribas M de Campos*

**Operator:** *Tunç Laçın, Esra Yamansavcı Şirzai*

**Operating Theater Moderator:** *Marcelo Martinez – Ferro*

**12:00-12:15 PRESIDENTIAL ADDRESS**

*Manuel Lopez*

**12:15-12:30 DRY LAB Information Session**

**12:30-13:30 Lunch Time**



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## 12:30-13:30 POSTER PRESENTATION I

*5 minutes (3 min. presentation – 2 min discussion)*

**Moderators:** *Sjoerd A. de Beer, Tunç Laçın*

- PA-5** Does nutrition education affect adolescents with pectus excavatum's nutritional status, growth, and development?  
*Gözde Artıncı Colak*
- PA-6** Results of Orthosis Application in Pediatric Age Group Pectus Carinatum Patients  
*Fatih Aydoğın*
- PA-7** Combined minimal invasive repair of pectus carinatum and limited sterno-costo-chondroplasty for correction of complex and rigid deformity  
*Stephan Rohleder*
- PA-8** Preoperative imaging of clinically relevant intrathoracic abnormalities in pectus excavatum patients  
*Nicky Janssen*
- PA-9** Relationship between 3D imaging-derived morphological features and psychosocial distress in pectus excavatum patients; Preliminary results.  
*Nicky Janssen*
- PA-10** Cardio-Respiratory Investigation & Management of Adolescents with Pectus Excavatum  
*Carolyn Rennie*
- PA-11** Awake minimally invasive repair of pectus carinatum patients: results of 14 patients – first report in the literature  
*Reyhan Ertan*
- PA-12** Pectus excavatum and carinatum- Treatment with Orthose( Brace), Vacuum and bandage  
*Agron Poniku*
- PA-13** Correction of Pectus Excavatum  
*Viktor Markushin*
- PA-14** Treatment Results of the Combined Ravitch and Nuss Procedure for Severe Pectus Excavatum  
*Kyohei Masai*
- PA-15** Depression, social anxiety, quality of life and personality traits in patients with pectus excavatum  
*Kyohei Masai*

## 13:30-18:30 DRY LABS at Workshop Rooms



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## 13:30-14:30 New Ideas for Surgery

**Moderators:** Tunç Laçın, Hans V. Veer

13:30-13:50

Do One Size Really Fit for All?

Number of bars, length of bar, alignment of bars.

*Hyung Joo Park*

13:50-14:00

Discussion

14:00-14:20

When to Operate, when to Apply? (Surgery vs nonsurgery)

*Antonio Messineo*

14:20-14:30

Discussion

14:30-15:30

**Live Surgery – Grand Canyon Pectus Excavatum Surgery**

**Auditorium Moderator:** Jose Ribas M de Campos

**Operator:** Mustafa Yüksel, Nezih Onur Ermerak

**Operating Theater Moderator:** Marcelo Martinez – Ferro

15:30-15:45

Coffee Break

15:45-16:30

**Abstract Session I**

*7 minutes (5 min. presentation – 2 min discussion)*

**Moderators:** Esra Yamansavcı, Caroline Fortmann

OA-1

3D Surgical Planning and Implant Customization for Excavatum/Carinatum Complex using the “Sandwich Technique”

*Luzia Toselli*

OA-2

Thoracoplasty for Poland Syndrome based on TBN classification: options and outcomes in a single center pediatric cohort

*Michele Torre*

OA-3

Institutional experience with bracing for pectus carinatum by means of a 2-shell compression orthosis-initial experience

*Hans Van Veer*

OA-4

Public and Private Collaboration for Suction pump treatment of Pectus Excavatum: A promising alternative for Ecuadorian patients

*Luis Enrique Zea*

OA-5

Introducer director: a new nuss procedure instrument to facilitate introducer extraction

*Sunghoon Kim*

OA-6

Time optimization of cryo-analgesia one versus two minutes during Nuss procedures.

*Slawomir Zacha*



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- 16:30-17:20** **Films with Technique (Video Abstracts)**  
**5 minutes (3 min. presentation – 2 min discussion)**  
**Moderators: Manuel Lopez, Michael J. Goretsky**
- VA-1** Reconstruction of the chest wall with a dynamic 3D prosthesis  
*Jose Ramon Cano*
- VA-2** Size Selection and Shaping of Pectus Bars Aided by Free Software-a  
Step-by-step Guide for the MIRP Novice.  
*Tibor Krajc*
- VA-3** Modify Nuss Operation  
*Arif Nuri Gürpınar*
- VA-4** Hammock Technique during minimally invasive repair of pectus  
excavatum of the rigid adult chest wall: preliminary findings  
*Luzia Toselli*
- VA-5** Nuss surgery in a 51-year-old patient  
*Viktor Markushin*
- 17:20-18:00** **Pectus Excavatum Surgery**  
**Moderators: Donald Nuss, Hyung Joo Park**
- 17:20-17:35 Ideal age for surgery  
*Gaston Bellia*
- 17:35-17:40 Discussion
- 17:40-17:55 The double bar technique: A new insight improve asymetry  
*Sungsoo Lee*
- 17:55-18:00 Discussion
- 18:00-18:45** **Pectus Carinatum Treatment**  
**Moderators: Horacio Abramson, İkröm Eralboew**
- 18:00-18:15 Abramson Surgery  
*Tunç Laçın*
- 18:15-18:30 Bracing  
*Sjoerd A. de Beer*
- 18:30-18:45 Discussion
- 20:00** **OPENING RECEPTION**



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## 23 June 2023, Friday

### 08:00-09:00 LECTURES FROM EXPERTS

**Moderators:** Dawn Jaroszewski, Claus Petersen

08:00-08:15 Ideal Time for Bar Removal

*Ivan Schewitz*

08:15-08:30 Management of Complications

*Nezih Onur Ermerak*

08:30-08:45 Management of Pectus using Pectus up

*Shyam Kolvekar*

08:50-09:00 Discussion

### 09:00-10:00 Live Surgery - Pectus Excavatum Surgery

**Auditorium Moderator:** *Caroline Fortmann*

**Operator:** *Tunç Laçın, Nezih Onur Ermenak*

**Operating Theater Moderator:** *Lisa McMahon*

10:00-10:15 Coffee Break

### 10:15- 11:30 Abstract Session II

*7 minutes (5 min. presentation – 2 min discussion)*

**Moderators:** *Gaston Bellia, Vladimir Kuzmichev*

**OA-7** Institutional experience of Abramson procedure for pectus carinatum

*Hans Van Veer*

**OA-8** Sternal Elevation By The Crane Technique During Bilateral Lung Transplant

*Hans Van Veer*

**OA-9** Does pectus carinatum treatment have effect on thoracic kyphosis?

*Huseyin Yildirim*

**OA-10** Open Surgical Repair for Atypical Chest deformities

*Hiroshi Iida*

**OA -12** Sternal elevation with the "Crane technique": Tips and tricks learned

*Laura Garcia-Martinez*

**OA-13** Sternal Cleft: Case Series

*Mustafa Yüksel*

**OA-14** Experience with 3d dynamic prostheses in chest wall pathology

*Jose Ramón Cano*

**OA-15** Lack of agreement between specialized chest wall surgeons regarding a widespread morphological pectus excavatum classification: do we need to dig further?

*Toselli Luzia*

**OA-16** Serratus Anterior Plane Block in Pectus Surgery as an Alternative Pain Management Modality: A Preliminary Study

*Hyung Joo Park*



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**OA-17** COPPER (Cryoanalgesia Or Pain management after Pectus Excavatum Repair): a randomyzed controlled study about pain management after Pectus Excavatum Repair

*Michele Torre*

**11:30-12:30 PRO AND CON WITH EXPERTS**

**Moderators:** *Ian Hunt, Winfried Rebhandl*

11:30-11:50 Pro: 3D Modelling

*Jean-Pierre Chavoïn*

11:50-12:10 Con: MIRPE

*Sadashige Uemura*

12:10-12:30 Discussion

**12:30-13:30** Lunch Time

**12:30-13:30 POSTER PRESENTATION II**

*5 minutes (3 min. presentation – 2 min discussion)*

**Moderators:** *Jean-Marie Wihlm, Sadashige Uemura*

**PA-16** Minimally Invasive Repair Of Pectus Arcuatum With Modified Sandwich Technique

*Anas Salhab*

**PA-17** Physiotherapy for chest deformities

*Dilyara Mazinova*

**PA-18** Preliminary Results Of The Treatment Of Pectus Excavatum With The Vacuum Bell In Uruguay

*Maria Celina Sienna*

**PA-19** 15 Years of Experience with Modifications of the Nuss Technique in Young Adult Patients with Pectus Excavatum

*Horia Sirbu*

**PA-20** Results of Vacuum Therapy in Pediatric Age Group Pectus Excavatum Patients

*Diñçer Yılmaz*

**PA-21** Preliminary Results of Dynamic Compression Therapy for Children with Pectus Carinatum

*Hayrūnisa Kahraman Esen*

**PA-22** Pectus bar features

*Figen Türk*

**PA-23** Late pectus bar infection after Nuss procedure: when to remove the bar?

*Sesia Sergio B*

**PA-24** Tension reduction of large chest wall reconstruction by framework segmentation

*Aron Elsner*

**PA-25** Postprematurity thoracic dysplasia: Is there more than meets the eye?

*Luzia Toselli*





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**PA-26** Initial experience with new modified Ravitch approach combining Nuss and Abramson techniques for Pectus Arcuatum correction in adult patients.

*Jose R. Matilla S.*

**PA-27** Single-center experience on cross-bar technique for pectus excavatum  
*Qi Zeng*

**13:30-18:30 DRY LABS at Workshop Rooms**

**13:30-14:30 Young Investigator Award I**

*5 minutes (3 min. presentation – 2 min discussion)*

**Moderators:** *Frank- Martin Haecker, Ana Lain*

**YIA-1** The Cross-Bar (Park HJ) Method for Repairing Pectus Excavatum in Patients with Symmetric or Asymmetric Complex Morphology.

*Ikrom Uralboev*

**YIA-2** Automatic Implant Shape Design for Minimally Invasive Repair of Pectus Excavatum Using Deep Learning and Shape Registration

*Chenghao Chen*

**YIA-3** Compression system for the treatment of pectus carinatum in pediatric practice.

*Vladimir Gatsutsyn*

**YIA-4** Correction of Mixed Type Deformities: Outcomes of Sandwich Technique

*Ceyhun Pasayev*

**YIA-5** The shortening of minimum anterior-posterior diameter of the thorax in the upright compared with the supine in patients with pectus excavatum

*Takahiro Suzuki*

**YIA-6** Cross-bar for nuss procedure in a pediatric practice

*Vladimir Gatsutsyn*

**YIA-7** Echocardiogram Does Not Adequately Predict Cardiopulmonary Impairment in Pediatric Pectus Excavatum

*R Scott Eldredge*

**14:30-15:30 Live Surgery – Cryoanalgesia in Pectus Excavatum Surgery**

**Auditorium Moderator:** *Caroline Fortmann*

**Operator:** *Tunç Laçın, Manuel Lopez*

**Operating Theater Moderator:** *Lisa McMahon*

**15:30-16:00** Coffee Break



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## 16:00-17:00 Young Investigator Award II

*5 minutes (3 min. presentation – 2 min discussion)*

**Moderators:** *Nezih Onur Ermerak, Laurin Titze*

- YIA-9** Usefulness of ultrasonographic guidance for accurate bar force application in pectus excavatum  
*Masahiko Noguchi*
- YIA-10** Surgery in Primary Tumors of the Chest Wall: A Single Center Experience  
*Esra Yamansavcı Şirzai*
- YIA-11** Abramson procedure or brace system for the treatment pectus carinatum in pediatric practice.  
*Vladimir Gatsutsyn*
- YIA-12** Cryoablation versus Subcutaneous Catheters versus Epidural: An Analysis of >10 Years Utilizing Different Analgesic Modalities After Adult Pectus Excavatum Repair  
*Dawn E Jaroszewski*
- YIA-13** Pectus repair small Montenegro series  
*Branko Campar*
- YIA-14** Reconstruction of the Chest Wall using 3D-Printed Polyethylene Ester Ketone (PEEK) Prosthesis  
*Mathew Thomas*
- YIA-15** Our experience correction Acquired Pectus Carinatum (APC) after open heart surgery.  
*Ikrom Uralboev*
- YIA-16** Recent Advancement in Pectus Surgery: Crane Lifting, Multiple-Bar, Bridge Stabilization, and Sandwich Technique  
*Rajkamal Vishnu Sudha Krishnagopal*
- YIA-17** Pectus Repair After Prior Sternotomy: Clinical Practice Review and Practice Recommendations based on a 2200 patient database  
*Lisa M. Kenney*
- YIA-18** Outcomes associated to custom-made 3D-printed silicon prostheses for Pectus Excavatum repair  
*Sara Ugolini*



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## **17:00-18:30 LECTURES FROM EXPERTS**

**Moderators:** *Serdar Evman, Tunç Laçın*

17:00-17:20 Use of Sternal Elevation during Nuss Surgery  
*Vladimir Kuzmichev*

17:20-17:30 Discussion

17:30-17:50 Management of Rib Flaring  
*Jean-Marie Wihlm*

17:50-18:00 Discussion

18:00-18:20 ERAS in Pectus Surgery  
*Frank- Martin Haecker*

18:20-18:30 Discussion

**20:00 GALA DINNER (CWIG History)**



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## 24 June 2023, Saturday

### 08:00-09:20 LECTURES FROM EXPERTS

**Moderators:** *Mustafa Yüksel, Frank- Martin Haecker*

08:00-08:15 Long Term Follow-up in Pectus Surgery

*Michael Goretsky*

08:15-08:20 Discussion

08:20-08:35 Percutaneous Cyroanalgesia

*Laura Garcia Martinez*

08:35-08:50 Thoracoscopic Cryoanalgesia

*Gaston Bellia*

08:50-09:00 Discussion

09:00-09:15 Sternal resection and reconstruction for primary and secondary tumors

*Lequaglie Cosimo*

09:15-09:20 Discussion

### 09:20-10:20 Abstract Session III

*7 minutes (5 min. presentation – 2 min discussion)*

**Moderators:** *Maira Kalil, Albert Bolanos*

**OA-18** Comparison Of Dislocation Rate Of Nuss Bar Between Three Groups Of Patients Operated With Different Techniques: Bar Without Stabilizer; Bar With Single Stabilizer; Multiple Bars With Bridge Stabilizer

*Michele Torre*

**OA-19** Quality of life after Nuss-procedure: experience in a ten-year cohort of minimally invasive repair of pectus excavatum

*Hans Van Veer*

**OA-20** Right Ventricular Improvement after Bar Removal in Patients with Pectus Excavatum Assessed with Serial Exercise Stress Echocardiography

*Luzia Toselli*

**OA-21** Correction of pectus excavatum is high-risk surgery in adults: A retrospective cohort study

*Frank de Paoli*

**OA-22** Application of sandwich surgery in pectus excavatum mixed with carinatum

*Jie Yu*

**OA-23** Minimal Invasive Approach for Rib Fractures: Feasibility and Safety

*Miguel Martinez Arias*

**OA-24** Defining the optimal annual case volume for the minimally invasive repair of pectus excavatum

*Jean H.T. Daemen*

**OA-25** Inadequate Scientific proof of improvement of VO<sub>2</sub>max after correction of Pectus Excavatum: A systematic review and meta-analysis

*Frank de Paoli*



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**10:20- 10:30** Coffee Break

**10:30-11:30** **ROUND TABLE**

**Moderators:** *Esra Yamansavcı, Rebecca Brown*

10:30-11:30 Role of Women Surgeons in Management of Pectus Patients in Different Continents, Difficulties in Diagnosis and Management of Female Pectus Patients

*Lisa McMahon, Dawn Jaroszewski, Caroline Fortmann, Ana Lain, Maira Kalil, Esra Yamansavcı*

**11:30-12:30** **LECTURES FROM EXPERTS-ESTS Joint Session**

**Moderators:** *Ian Hunt, Murat Akkuş*

11:30-11:50 Plating for Trauma

*Erik de Loos*

11:50-12:00 Discussion

12:00-12:20 Techniques for Chest Wall Resection and Reconstruction

*Jeroen M. Hendriks*

12:20-12:30 Discussion

**12:30-13:30** Lunch Time

**12:30-13:30** **POSTER PRESENTATIONS III**

*5 minutes (3 min. presentation – 2 min discussion)*

**Moderators:** *Claus Petersen, Hasan Ersöz*

**PA -28** Thoracic Augmentation Surgery for Jeune Syndrome

*Esra Yamansavcı Şirzai*

**PA-29** Minimally Invasive Repair of Pectus Excavatum

*Jeyhun Pashayev*

**PA-30** The use of patient specific 3 dimensional modeling and printing in chest wall instability with sterno-costal pseudo-arthritis following a modified Ravitch procedure: a case report

*Pieter Jan Van Huijstee*

**PA-31** Rapid Enlargement of Ascending Aortic Aneurysm after Nuss Procedure

*Mathew Thomas*

**PA-33** Nuss surgery for Pectum Excavatum

*Viktor Markushin*

**PA-34** Short term quality of life improvement following the minimally invasive repair of pectus excavatum with cryoablation

*R Scott Eldredge*

**PA-35** The effect of rib osteotomy on severe asymmetric pectus excavatum: Case studies

*Sadashige Uemura*

**PA-37** Pectus excavatum and scoliosis does order of repair matter? A case report

*R Scott Eldredge*



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**PA-38** Presentation of two cases with severe pectus excavatum

*Tuba Apaydin*

**PA-39** MIRPC-Procedure and Sandwich-Techniques for asymmetric Pectus Carinatum and combined Excavatum/Carinatum Complex

*Anja Christina Weinhandl*

**13:30-15:30** **Greatest of All Team**

**Moderators:** *Hans Pilegaard, Jose Ribas M de Campos, Andre Hebra, Ivan Schewitz*

13:30-13:50 Nuss Surgery

*Donald Nuss*

13:50-14:20 Abramson Surgery

*Horacio Abramson*

14:20-14:40 Wihlm Surgery

*Jean-Marie Wihlm*

14:40-15:10 Yüksel Surgery

*Mustafa Yüksel*

15:10-15:30 Park Surgery

*Hyung Joo Park*

**15:30-16:00** Coffee Break

**16:00-16:40** **Abstract Session IV:**

**Non-Pectus; Chest wall tumor, Infection, trauma, etc..**

**Moderators:** *Sergio Sesia, Nurettin Yiyit*

**PA-1** Chest wall tumors requiring rib resection: Is reconstruction always necessary?

*Huseyin Yildiran*

**OA-26** Repeated chest wall reconstruction after resection of a sternal chondroid chordoma with long-term postoperative infection of the reconstructive material

*Laurin Titze*

**PA-2** Sternal resection and semi rigid reconstruction to isolated breast cancer metastasis treatment

*Maira Kalil Fernandes*

**PA-3** The Reconstruction of the Chest Wall with Ovitex™ Reinforced Tissue Matrix and RibFix Blu™ Thoracic Fixation System

*Klohs Stefan*

**OA-28** An Algorithmic Approach to the Surgical Management of Sternal Dehiscence

*Esra Yamansavcı Şirzai*

**PA-40** Surgical and local treatment of pain in Tietze syndrome: Our experience in University Hospital "Shefqet ndroqi"

*Fadil Gradica*



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- 16:40-17:25 POSTER PRESENTATIONS IV**  
*5 minutes (3 min. presentation – 2 min discussion)*  
**Moderators:** *Ana Lain, Nezh Onur Ermerek*
- PA-41** Experience in the management of pectus excavatum with procedure of nuss in children in at pediatric hospital in mexico.  
*Gabriela Ambriz González*
- PA-42** A retrospective analysis of chest wall deformities incidentally detected in emergency department patients: an observational study  
*Osman Sezer Çınaroğlu*
- PA-43** Treatment of extra deep local pectus excavatum (case report).  
*Vladimir Kuzmichev*
- PA-44** Impact of Recurrent Spontaneous Pneumothorax on the Treatment of Chest Wall Deformities  
*Ana Lain*
- PA-45** 3D modeling as a tool to improve asymmetric pectus carinatum surgical repair  
*Patricio Herrera*
- PA-46** use of fat to promote healing to save nuss bar exposure  
*Gabriela Ambriz González*
- PA-47** Surgical Treatment in a Complicated Recurring Pectus Excavatum Case  
*Haktan Uygur Önen*
- PA-48** Interactive Case Report: Management of pectus excavatum in an adolescent with undifferentiated connective tissue disease, recurrent pneumothorax, and intraoperative diagnosis of atrial mass  
*Ana Lain*
- PA-49** Modern technologies in the correction of the pectus carinatum  
*Viktor Markushin*
- 17:25-18:05 PRO AND CON WITH EXPERTS – SCOLIOSIS SESSION-ESTS Joint Session**  
**Moderators:** *Erik de Loos, Stephan Rohleder*
- 17:25-17:40 Pro: First Scoliosis Surgery  
*Murat Bezer*
- 17:40-17:55 Con: First Pectus Surgery  
*Hans V. Veer*
- 17:55-18:05 Discussion
- 18:05-18:35 Consensus Opinion**
- 18:05-18:20 A case of severe pectus carinatum  
*Sergio Sesia, Jean-Marie Wihlm*
- 18:20-18:35 A case of frozen chest wall  
*Nezh Onur Elmerak, Mustafa Yüksel*
- 20:00 DINNER**



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**ORAL  
PRESENTATIONS**





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## OA-01 3D SURGICAL PLANNING AND IMPLANT CUSTOMIZATION FOR EXCAVATUM/CARINATUM COMPLEX USING THE “SANDWICH TECHNIQUE”

Luzia Toselli<sup>1</sup>, Gaston Bellia-Munzon<sup>1</sup>, Gaston Elmo<sup>2</sup>, Daniela Sanjurjo<sup>1</sup>, Maxroxia Valle<sup>1</sup>, Marcelo Martinez-Ferro<sup>1</sup>

<sup>1</sup>*Clinica Mi Pectus, Buenos Aires, Argentina*

<sup>2</sup>*Hospital Italiano de Buenos Aires, Argentina*

**Background and Aim:** The “sandwich technique” (ST) is an innovative, effective technique for the resolution of excavatum/carinatum complexes (ECC) introduced by Dr. Hyung Park. This technique requires much expertise, particularly in the bending of the intra and extrathoracic implants. In parallel, for the last 10 years, 3D surgical planning and implant customization is our standard approach for all our pectus excavatum patients. We, therefore, aim to report our experience using this tactic with the sandwich technique for the first time.

**Method:** Retrospective study including consecutive patients with ECC undergoing ST since January 2020. 3D surgical planning process: 1) Physical exam and patient selection. 2) Chest CT scan with 3D reconstruction. 3) Determination of number and positioning of implants. 4) Virtual design of intra and extrathoracic implants. 5) 3D printed template check at outpatient clinic. 6) Manufacture of final customized implants (steel or titanium). 7) Surgery

**Results:** We operated 11 patients, 7 males (median age: 16 years (interquartile range (IQR): 14;17). Ten patients had vertical ECC; 8 with right and 2 with left protrusion. One case had a horizontal ECC with superior protrusion and inferior bilateral chondral excavation. All patients received 3 implants, 2 intrathoracic and 1 extrathoracic bar at the site of maximal protrusion. Median duration of surgery was 150 minutes (IQR: 115; 180). None of the implants required rebending or reshaping during surgery (implant/ deformity match: 100%). There were no intraoperative complications. Results were optimal in all cases, evidenced by a patient satisfaction rate of 4.5 on a 5-point Likert scale (91% response rate).

**Conclusions:** We report the first cohort of ECC patients treated with the ST undergoing 3D surgical planning and implant customization. Implant/deformity match and patient satisfaction were excellent in this early experience.

**Keywords:** 3D technology, mixed pectus, Sandwich Technique, complex pectus, customized implants



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## OA-02 THORACOPLASTY FOR POLAND SYNDROME BASED ON TBN CLASSIFICATION: OPTIONS AND OUTCOMES IN A SINGLE CENTER PEDIATRIC COHORT

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<sup>2</sup>*University of Genova, Italy*

**Background and Aim:** Poland Syndrome (PS) is a rare congenital syndrome, characterized by the unilateral partial or complete absence of pectoralis major muscle which may be associated with a wide range of chest and ipsilateral upper limb defects. In 2016, our unit proposed the TBN (Thorax, Breast, and Nipple-areola complex) classification of PS and a treatment algorithm based on it. The objectives of the present study are to evaluate the effectiveness of the algorithm as a tool for planning reconstructive thoracic surgery in severe adolescent PS and the role of TBN classification in the assessment of postoperative outcome

**Method:** 60 PS patients classified according to TBN classification were treated. Every patient was evaluated by a multidisciplinary team composed of pediatric surgeons and plastic surgeons and was treated surgically or conservatively based on the algorithm and TBN classification. Post-operative re-assessment of thoracic malformation and TBN classification were used to evaluate the effectiveness of treatment

**Results:** All patients were treated according to the algorithm. Surgical techniques included: lipofilling; pectoral expanders, breast or pectoral prosthesis implant; Nuss procedure; open sternochondroplasty; patch, metal bar, or 3D prosthesis implant. Conservative treatments included Vacuum bell and corset. All patients with defect from T2 to T4 experienced T downstaging after treatment, and 90% were reclassified as T1 (no residual skeletal malformations) after treatment

**Conclusions:** The proposed algorithm can be considered an useful tool for surgical decision-making in the treatment of PS. A multidisciplinary and minimally invasive approach, whenever possible, should be preferred in pediatric patients

**Keywords:** poland syndrome



## OA-03 INSTITUTIONAL EXPERIENCE WITH BRACING FOR PECTUS CARINATUM BY MEANS OF A 2-SHELL COMPRESSION ORTHESIS - INITIAL EXPERIENCE

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**Background and Aim:** Pectus carinatum is a thoracic deformity of the sternum that can be treated in a non-invasive manner by compressive bracing. Therapeutic compliance can be a challenge, especially in adolescents for whom the bracing treatment can cause social discomfort and psychological distress. We report our institutional experience in treating pectus carinatum patients with a Wilmington brace.

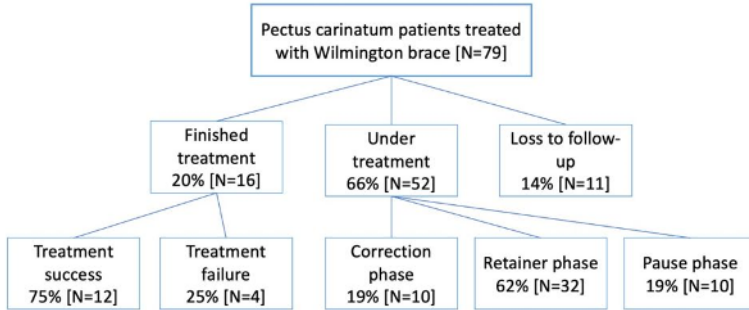
**Method:** All patients who started bracing therapy between 2019/01/01 and 2021/12/31 in our hospital, and who subsequently received follow-up by the same physician, were collected. Firstly, we retrospectively collected data from clinic reports. Secondly, we used the validated PCEQ (Pectus Carinatum Evaluation Questionnaire) and PeCBI-QOL (Pectus Carinatum Body Image-Quality of Life) questionnaires to investigate treatment compliance, complications, physical limitations and social and psychological well-being during and after brace use.



*picture illustrating our brace (Vigo - Ottobock) with pre and post-reduction phase results*

**Results:** 79 patients were included, with a median age at the start of treatment of 14 years old. 16 patients finished treatment and 52 patients are still under treatment. 14%(n=11) were lost to follow-up. Twelve patients finished treatment successfully and 4 experienced treatment failure. A complete correction was obtained after a mean treatment duration of 7 months. Mean total treatment duration was 16 months. Skin problems occurred in 11%(n=9) of patients. Pain during bracing treatment was present in 11% (n=9) of patients and was mainly manifested by chest pain (n=3) and back pain (n=4). In regards to QoL, patients responded to have been compliant 'many times' regarding the prescribed wearing time. The degree of chest pain, back pain, dyspnoea and limitation in activities during brace wearing was reported as low.

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JUNE 22-24, 2023 TURKEY *Istanbul**study flow chart**Study flow chart*

**Conclusions:** In this study, the Wilmington brace seems to be an effective and safe non-invasive treatment for pectus carinatum in combination with regular clinic follow-up as a key to treatment success. Complications were minor and were related to skin problems, pain during bracing treatment and minor brace damage.

**Keywords:** Chest wall deformities, Pectus carinatum, Non-surgical treatment of pectus carinatum, bracing, wilmington, Quality of life

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## OA-04 PUBLIC AND PRIVATE COLLABORATION FOR SUCTION PUMP TREATMENT OF PECTUS EXCAVATUM: A PROMISING ALTERNATIVE FOR ECUADORIAN PATIENTS

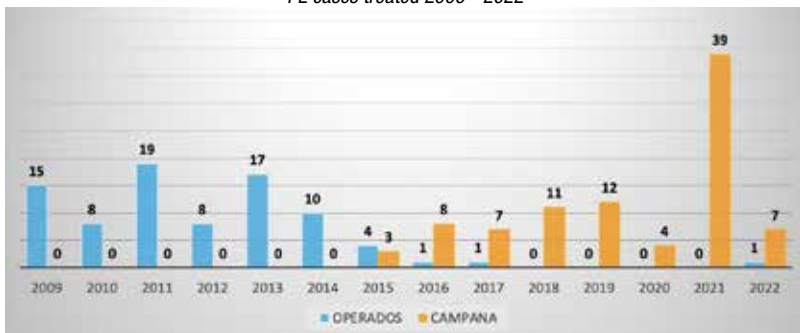
Luis Enrique Zea<sup>1</sup>, Virginia Margarita Garcia<sup>1</sup>, Maria Eugenia Guarquilla<sup>1</sup>

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**Background and Aim:** •We started in 2009 treating PE patients with the Nuss procedure in a public hospital. •We started the use of Suction Pumps in 2015 in our private practice, after retiring from the public service. •In 2021 a program for treating PE with suction pumps was negotiated between the leading distributor of PE treatment supplies in Ecuador and the Guayaquil City Mayor's Office. •We participated as medical expert in charge of treating a group of 35 patients sponsored by the Guayaquil's city Mayor for treating their PEs with the suction pump method. •Our Aim was to make city authorities conscious of the problem of PE patients in Guayaquil. Find another source of financing for treatment of PE patients. Make a prospective study of this group treated with suction pumps only.

PE cases treated 2009 - 2022



number of cases of Pectus Excavatum treated by the Author. Nuss Technique and Suction Pump since 2009

**Method:** •The program included for each patient the Pump, 3D photography, Initial CAT scan, and follow up for a year. •Selection of patients was done by de Municipality. •We describe Problems in selection and Problems in follow up. •Procedure Overview and description. Measurements for evaluation at beginning, 1 month, 6-month, 1 year.

**Results:** •Outcomes of the suction pump treatment for Pectus Excavatum in this treatment group are presented. •INITIAL NUMBER OF PATIENTS: 35. FINAL NUMBER OF PATIENTS FOR ESTUDY 25 •FOLLOW UP LESS THAN 6 MONTH DESCARTED: 10 •MORE THAN 50% CORRECTION: 11 •LESS THAN 20% CORRECTION: 3 •BRAND: VB 9, TK 16



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*Results of 25 PE patients treated with suction pump 2023*

CASO	H. INICIAL	H. ULTIMO	% MEJORIA	T. DE CONTR SEXO	MARCA
1	3,5	3,3	6%	9 M	VB
2	4	1,8	55%	15 H	VB
3	2,2	1	55%	11 H	TK
4	3,7	3,1	16%	9 M	TK
5	4,5	4,5	0%	9 M	VB
6	2,3	1	57%	9 H	VB
11	3,7	1,5	59%	9 H	VB
12	3	0,7	77%	9 H	VB
13	3,5	1,2	66%	14 H	TK
14	2	1,22	39%	14 H	TK
15	3	1	67%	8 H	VB
20	2,8	1,5	46%	14 H	TK
22	1,9	1	47%	15 H	TK
23	3,1	2	35%	14 H	VB
24	3,2	1,5	53%	12 H	TK
26	2,9	2,3	21%	14 H	TK
27	3	0,5	83%	14 H	TK
28	3,5	1,8	49%	7 H	TK
29	1,6	0	100%	12 H	TK
30	1,5	0,8	47%	11 H	TK
31	3	1,8	40%	14 H	TK
32	2,7	1,3	52%	14 H	TK
33	2,7	2	26%	13 H	TK
34	3,5	3	14%	7 H	VB
35	3	2,4	20%	14 H	TK

*Patients treated with suction pump 2023*

**Conclusions:** •Implications for other cities and countries with limited resources•Potential for future improvements and development of suction pump treatment programs•Summary of the public and private collaboration for suction pump treatment for Pectus Excavatum in Ecuador

**Keywords:** Pectus Excavatum, suction pump, Pectus Excavatum, suction pump

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## OA-05 INTRODUCER DIRECTOR: A NEW NUSS PROCEDURE INSTRUMENT TO FACILITATE INTRODUCER EXTRACTION

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<sup>2</sup>University of California San Francisco-East Bay

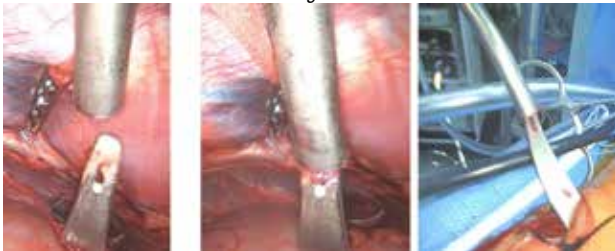
**Background and Aim:** One of the technical difficulties encountered during the Nuss procedure is the extraction of the introducer instrument from the contralateral chest once it has crossed the anterior mediastinum. Typically, this maneuver is done with imprecise estimation and brute force. Therefore, a construction of a surgical tool to facilitate precise extraction of the introducer without the need for excessive force would be beneficial to the surgeon.

**Method:** Introducer director is made of a curved steel with a hollow tip and a handle. Once the introducer has traversed the anterior mediastinum, the introducer director is passed from the contralateral chest and enters the chest cavity at the exact location where the introducer is expected to come out. Under a thoracoscopic vision, two instruments are joined. While keeping the two instruments mated by applying opposing forces, the introducer is pushed with a greater force to exit the contralateral chest with both instruments joined together.

Fig 1



Fig 2



**Results:** Introducer director was used in multiple Nuss procedures with success. It is possible to extract the introducer at the exact location on the contralateral chest. Guess work is no longer needed. No complications occurred due to the use of the new instrument.

**Conclusions:** Introducer director is a useful tool that facilitates precise placement of the Nuss bar at the planned location on the patient's chest.

**Keywords:** introducer, introducer director, Nuss Procedure



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## OA-06 TIME OPTIMISATION OF CRYOANALGESIA ONE VERSUS TWO MINUTES DURING NUSS PROCEDURES.

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**Background and Aim:** The surgical correction of a funnel chest is a challenge for the treatment team because of the risk of the patient experiencing severe pain in the postoperative period. The use of intraoperative intercostal nerve cryoanalgesia is a recognised complement to multimodal analgesia. A two-minute application time of cryoanalgesia to the nerve is used as standard, although there is no evidence whether shortening this time will achieve similar surgical results. The presented study protocol is the first of its kind. The aim of the study was to compare the effectiveness of an application time of one minute versus two minutes per intercostal nerve during Nuss surgery on the quality of the postoperative period.

**Method:** The study was conducted prospectively including twenty-two patients (mean age  $14.95 \pm 1.73$  years, six girls) with a diagnosis of funnel-shaped anterior chest wall deformity who underwent Nuss correction surgery under general and regional anaesthesia. The eleven patients (standard) underwent intraoperative cryolesia using a device and probe from Metrum - Cryoflex applying for two minutes bilaterally at six levels. In another eleven patients (intervention), intraoperative cryoablation was performed by applying two minutes on the right side, and one minute on the left side. The results were compared in terms of demographics, pain severity, onset of sensory disturbances, quality of the course of rehabilitation and duration of hospitalisation.

**Results:** There were no statistically significant differences in acute pain intensity between the right side with a two-minute cryotherapy application time on the intercostal nerve and the left side with a one-minute cryotherapy application time on the nerve. There were no differences in acute pain, sensory disturbances, quality of rehabilitation, or surgery and hospitalisation time between two groups.

**Conclusions:** The study confirmed the equally effective use of a one-minute versus two-minute application time for intraoperative intercostal nerve cryotherapy as a method of postoperative pain relief.

**Keywords:** cryoanalgesia, application time, funnel chest





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## OA-07 INSTITUTIONAL EXPERIENCE OF ABRAMSON PROCEDURE FOR PECTUS CARINATUM

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<sup>1</sup>Department of thoracic surgery, University Hospitals Leuven, Leuven, Belgium

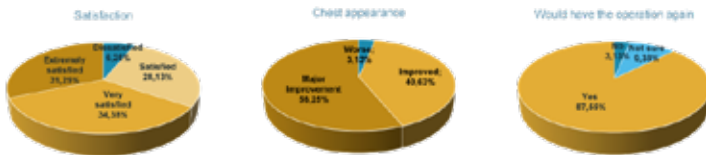
<sup>2</sup>BREATHE laboratory, CHROMETA Department, KU Leuven, Leuven, Belgium <sup>3</sup>Faculty of Medicine, KU Leuven, Leuven, Belgium

**Background and Aim:** Congenital deformities can have a broad impact on the self-awareness of adolescents. Being an intermediate solution between Ravitch and bracing, the Abramson procedure with the placement of a presternal bar is performed as a less invasive but still operative treatment for pectus carinatum. We analysed the institutional experience with the Abramson-procedure in view of complications and patient satisfaction.

**Method:** We analysed the patient records from all patients who underwent the Abramson procedure in our institution from 2013 until 2021 (n=59). For the assessment of quality of life (QoL), we conducted prospective research whereby 3 questionnaires (EQ-5D-5L, SF-36v2, SSQ) were sent. All questionnaires probed patients about their QoL and satisfaction about the result of the operation. Thirty-two patients responded to these questionnaires.

**Results:** A total of 216 complications were registered within these 59 patients; 84,72% classified as Clavien-Dindo grade I, 7,41% as grade II and 7,87% as grade IIIb, respectively. Based on the EQ-5D-5L questionnaire, no significant difference was observed between treated patients and a Belgian reference population. Also no significant difference was observed in QoL and result of the operation between patients with no or mild complications and those with severe complications based on the SSQ questionnaire. In terms of overall satisfaction, patients scored higher than the means on the domains probed by the SF36. A large majority (93.76%) was at least satisfied with the outcome of the operation and 96.88% considered their chest as improved.

Evaluation of quality of life



SSQ score in 3 domains Complications after bar placement



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Complications after placement Abramson bar	Clavien- Dindo	Number of complications	Number of patients	% patients N= 126 in 99 patients
Early postoperative pneumothorax (conservative)	1	46	46	77.67
Early postoperative pleural effusion (conservative)	1	53	53	54.24
Early postoperative pulmonary consolidation (conservative)	1	18	18	32.51
Chronic hydropneumothorax (conservative)	3	1	1	1.89
Woundhealing		4	4	6.78
Woundproblems (conservative)	1	1	1	1.89
Woundproblems (surgical)	3	3	3	5.08
Problem with overlying soft tissue (premature removal)	3b	3	3	5.86
Basis erosion (surgical) + osteomyelitis with empyema (surgical)	3b	1	1	1.89
Hypertrophic scar (conservative)	1	1	1	1.89
Endothelial bumps with bleeding (conservative)	1	1	1	1.89
hyposthesia (conservative)	1	1	1	1.89
ribcage neuroparic (conservative)	1	1	1	1.89
Worsening scoliosis (conservative)	1	2	2	3.36
Chronic painproblems		23	23	42.27
Chronic painproblems (conservative)	1	18	18	32.58
Chronic painproblems (TCC, 3, pain in Nervous)	3	5	5	10.17
Underestimation (epidural catheter)	1	2	2	3.53
Nausea (surgical)	1	1	1	1.89
Heat (conservative)	1	1	1	1.89
Constipation (conservative)	1	3	3	5.08
Prolonged drainage (after PCFA, conservative)	1	1	1	1.89
Late pneumothorax (conservative)	1	2	2	3.36
Late pneumothorax (surgical)	3b	1	1	1.89
Late pneumothorax (surgical)	3b	1	1	1.89
Pneumonia (postoperative)	3	3	3	5.08
Hiccups (surgical)	3	1	1	1.89
Material failure		31	31	62.71
Wire leakage total		36	36	81.22
Wire leakage (conservative)	1	35	35	80.52
Wire leakage (surgical)	3b	1	1	1.89
Screw loosening		3	3	6.47
Screw loosening (surgical)	3b	3	3	6.00
Screw loosening (premature removal)	3b	2	2	3.59
Residual structural deformity (sternum, pleurothorax)	3b	1	1	1.89
Overcorrection to pectus excavatum (conservative)	1	1	1	1.89
Residual pectus carinatum (conservative)	3b	1	1	1.89
Residual pectus carinatum (surgical)	3b	1	1	1.89

**Conclusions:** Patients should make a thoughtful consideration between the risk of complications and the profit in QoL and self-esteem following this operation. This consideration can differ depending on the extent to which the patient is disturbed by this congenital abnormality. Despite mostly minor complications, the responders stated to be satisfied with their new appearance. Further research must be done with larger study groups to detect significant differences.

**Keywords:** pectus carinatum, abramson

## OA-08 STERNAL ELEVATION BY THE CRANE TECHNIQUE DURING BILATERAL LUNG TRANSPLANT

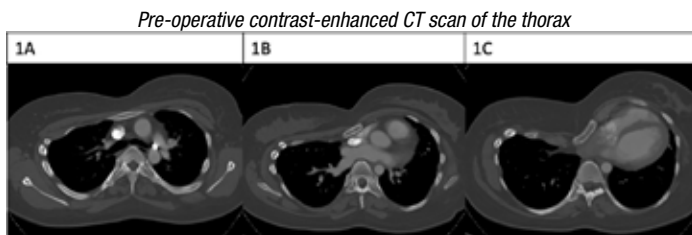
Arizona Binst<sup>1</sup>, Yanina Jansen<sup>1</sup>, Laurens Ceulemans<sup>1</sup>, Dirk Van Raemdonck<sup>1</sup>, Hans Van Vee<sup>1</sup>

<sup>1</sup>Department of Thoracic Surgery, University Hospital Leuven, Leuven, Belgium.

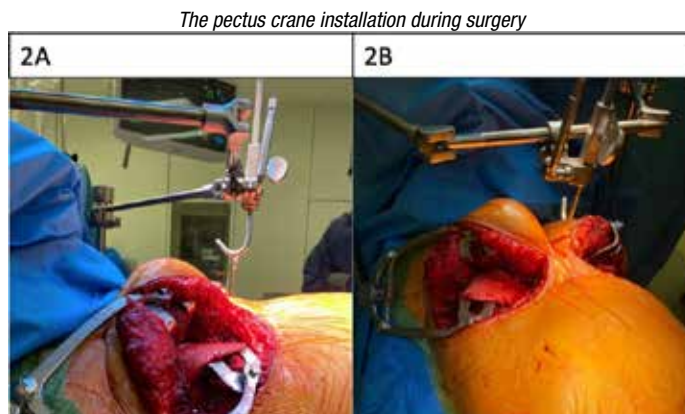
<sup>2</sup>BREATHE laboratory, Department of CHROMETA, KU Leuven, Leuven, Belgium.

**Background and Aim:** To describe the use of the wired sternal crane technique to lift the sternum during bilateral lung transplantation in a patient with severe pectus excavatum deformity.

**Method:** The presence of significant chest wall or spinal deformity is currently a relative contra- indication for lung transplantation according to ISHLT guidelines. We present the case of a 28- year-old female patient who underwent a bilateral lung transplantation for underlying terminal bronchopulmonary dysplasia with a deep pectus excavatum (Haller index 11). Bilateral anterior thoracotomy was performed. Per-operatively, the view of the right pulmonary artery was significantly compromised due to the presence of the pectus. We used a wired sternal crane technique to elevate the sternum and gain exposure of the mediastinum.



*Figure 1: contrast-enhanced CT scan of the chest with moderate asymmetrical pectus excavatum and platythorax type chest. A. axial image of the sternum at the level of the carina. B. axial image of the chest at the level of the truncus of the pulmonary artery showing a rotation of the sternum. C. axial image of the chest at the deepest point of the pectus excavatum at the level of the ventricles showing a banana shaped heart with a compression of the sternum on the right ventricle.*



*Figure 2 A: lateral view of pectus crane installation during surgery. Figure 2 B: anterior view of pectus crane installation during surgery.*



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**Results:** The use of the crane technique resulted in an additional 4 centimeters gain in anteroposterior distance and significantly increased access to the right pulmonary artery. Both lungs could hereafter be successfully implanted. Release of the crane after implantation went smoothly, as did the postoperative recovery. The patient could be weaned and extubated on postoperative day 5 and could be discharged home on day 27.

**Conclusions:** To our knowledge, this is the first case reporting the use of the pectus crane during transplantation. The sternal crane provided us an easy and safe method to gain additional exposure without the need for a more morbid clamshell incision. We suggest considering the use of the pectus crane in recipients with pectus excavatum at the moment of transplantation, thus avoiding having to decline an otherwise good transplant candidate. Similar cases should be discussed with experts in the field, both concerning surgeons dedicated to lung transplantation and to pectus excavatum, before denying the patient access to the waiting list. A staged approach can be an alternative, depending on the urgency to transplantation. Changes in the ISHLT guidelines should be reconsidered.

**Keywords:** Pectus excavatum, Pectus crane technique, Bilateral lung transplantation



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## OA-09 DOES PECTUS CARINATUM TREATMENT HAVE EFFECT ON THORACIC KYPHOSIS?

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<sup>3</sup>Department of Orthopedics, Selcuk University Medical Faculty, Konya, Turkey.

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**Background and Aim:** Pectus carinatum can be seen together with posture disorders and kyphoscoliosis. The aim of this study is to compare the degree of thoracic kyphosis in pectus carinatum cases before and after treatment.

**Method:** Pectus carinatum cases who applied to Selcuk University Thoracic Surgery between 2020-2022 and followed-up for at least one year were analyzed retrospectively. Characteristics, type of treatment (orthosis vs MIRPC), global and regional Cobb angle values were recorded. The patients were divided into two groups: "Orthosis group" and "bar group". The pre-and post-treatment Cobb angles were statistically compared in both groups.

**Results:** Twenty-five patients with a mean age of 14±2.2 years were included in the study. In the orthosis group(n:13), the mean g-Cobb angle measurements were 49.75 and 47.74 degrees, and the mean r-Cobb angle measurements were 22.1 and 23.5 degrees before and after the treatment, respectively. The pre- and posttreatment values for both g-Cobb and r-Cobb angles did not differ statistically in the orthosis group(p>0.05). In the bar group(n:12), the mean g-Cobb angle measurements were 40.66 and 48.8 degrees, and the mean r-Cobb angle measurements were 19.37 and 22.93 degrees pre- and postoperatively, respectively. Preoperative and postoperative values of both g-Cobb and r-Cobb angles in the bar group showed significant difference(p<0.05).

**Conclusions:** The increase in kyphosis after treatment in the bar group may be due to the pain associated with the bar or the effect of the correction force on the vertebra. The absence of an increase in the degree of kyphosis in the post-treatment orthosis group was attributed to the fact that the orthosis also supports the vertebrae in the sagittal plane. When the findings of this study were evaluated, the use of orthoses in the treatment of pectus carinatum was thought to be a safe option for vertebral balance and health.

**Keywords:** pectus carinatum, Cobb angle, orthosis

**OA-10 OPEN SURGICAL REPAIR FOR ATYPICAL CHEST DEFORMITIES**

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<sup>1</sup>*Hayama Heart Center*

<sup>2</sup>*Shonan Kamakura General Hospital*

**Background and Aim:** A novel method for pectus excavatum correction which Nuss developed has gained popularity, however it has been associated with relatively high morbidity, limitation in the patient's age and difficulties to adapt for irregular deformities. We review our experiences of open repair procedure that does not require prosthesis.

**Method:** From 1993 to December 2021, 685 patients (3-56, 16.2+/-10.0 years old) underwent surgical repair of chest deformity. Modified Sternocostal Elevation procedure (SCE) was adapted for 674 patients. In our standard procedure of SCE modification 3, a section of the third or fourth to the seventh costal cartilages and the lower tip of the sternum were resected. All the cartilage stumps were drawn and resutured to the sternum. The secured ribs generate tension, pull the sternum, then raise concavity and correct irregularities. Further modifications were done for the patients with severe asymmetric deformity. Before 2007, sternal turnover was employed for 11 adult patients, and we have adapted modified SCE for all patients since 2007.

**Results:** In all patients the deformities were corrected satisfactorily by a single procedure. None of the patients required mechanical ventilation after the surgery. None of them developed life-threatening complications. Patients resumed daily activities, including contact sports, within three months after the surgery. Atypical deformities such as severe asymmetric chest, protruded costal arch, thin chest and pectus carinatum were also satisfactorily corrected.

**Conclusions:** Modified SCE provided a satisfactory postoperative figure for various chest deformities. We believe that modified SEC represents an alternative procedure for repair of chest deformity.

**Keywords:** Open correction, Atypical chest deformities, Sterno costal elevation



## OA-12 STERNAL ELEVATION WITH THE “CRANE TECHNIQUE”: TIPS AND TRICKS LEARNED

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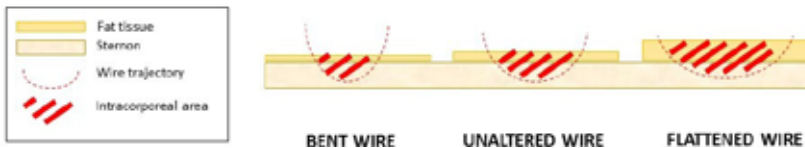
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**Background and Aim:** Intraoperative sternal elevation (ISE) is a critical step in pectus excavatum (PE) repair that enables safe retrosternal dissection. While the “Crane technique” (CT) described by Park et al is commonly used, some surgeons may be hesitant to apply it due to its blind suturing approach. We report our experience with the CT and provide tips and tricks to make the procedure safer and more effective.

**Method:** We performed a retrospective study (2016-2023) of patients with PE who underwent the CT for ISE. A minimum of 2 stainless-steel wire sutures (5 diameter/V-40 Ethicon) are longitudinally passed through the anterior sternal cortex at the deepest point of PE, increasing the number of sutures in severe cases. To ensure the wire remains within the sternal matrix, it is previously molded based on patient phenotype (Figure 1). For classical thin patients the wire is bent to make its intracorporeal trajectory shorter, avoiding the posterior cortex. For patients with more fat tissue the wire is either unaltered or discreetly flattened to enlarge its intracorporeal trajectory, ensuring it reaches the sternum. All the procedure is carefully assisted by a right thoracoscopy to rule out complications. The sutures are then attached to an operating table retractor system and the sternum is slowly lifted until PE is corrected.

*Wire modeling based on patient phenotype*

**Figure 1:** Wire modeling based on patient phenotype. After modeling, the wire trajectory is adjusted to ensure correct location within the sternal matrix.



*Wire modeling based on patient phenotype. After modeling, the wire trajectory is adjusted to ensure correct location within the sternal matrix.*

**Results:** The CT with wire modeling was used in 95 patients, achieving in all cases the sternal matrix without perforating the posterior cortex. Wire dislodgement was reported in two patients due to superficial sternal trajectory and wire reposition was needed. ISE was successfully achieved in all cases, facilitating retrosternal dissection without complications, and the punctures were imperceptible on follow-up.

**Conclusions:** The CT is a quick, safe and scar-free method of ISE. Wire modeling based on patient phenotype can adjust the wire intracorporeal trajectory to ensure safety and effectiveness.

**Keywords:** sternal elevation, pectus excavatum, crane technique

**OA-13 STERNAL CLEFT: CASE SERIES**

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**Background and Aim:** The sternal cleft develops as a result of the failure of the sternum to join at the midline. It is a congenital anomaly defined as a defect of different sizes. It is a benign disease when not accompanied by cardiac anomalies. Surgical repair is recommended to protect the heart and great vessels from injury, to improve respiratory dynamics, and to eliminate cosmetic concerns.

**Method:** Eight patients with sternal cleft are presented.

**Results:** Case 1: A 5-day old male baby (Picture 1) with total sternal reconstruction was reconstructed with polytetrafluoroethylene (goretex®).Case 2: 1-month-old boy with total sternal cleft was reconstructed with polytetrafluoroethylene (goretex®) and titanium plate.Case 3: 1.5- month-old boy with partial sternal cleft was reconstructed with a Bowine pericardial patch.Case 4: The partial sternal cleft was closed with a primary wire suture in a 2-month-old boy, and revision was performed with reoperation due to recurrence in the early postoperative period (Picture 4).Case 5: 2 month-old male patient with partial sternal cleft is followed up with regular outpatient visit.Case 6: 3-years-old male patient with partial sternal cleft is followed up with regular outpatient control.Case 7: 7-years-old female patient with partial sternal cleft was reconstructed with a primary wire suture.Case 8: Asymptomatic 23-year-old adult female partial sternal cleft was closed primarily with wire suture.

Picture 1



Picture 2



**Conclusions:** The first-line treatment is surgical reconstruction of the defect in the neonatal period. Accompanying malformations, especially the cardiac ones, should be considered in the preoperative assessment. Surgical repair performed at an early age gives better results. Surgery is more difficult as the chest hardens at older ages and may require more complex repair methods. Autologous bone grafts, patches, or titanium plates can be used for reconstruction if the defect is large or in adult patients.

**Keywords:** Sternal kleft





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## OA-14 EXPERIENCE WITH 3D DYNAMIC PROSTHESES IN CHEST WALL PATHOLOGY

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**Background and Aim:** To present our experience using 3D technology in the design and implantation of personalized, dynamic prostheses in complex chest wall surgeries.

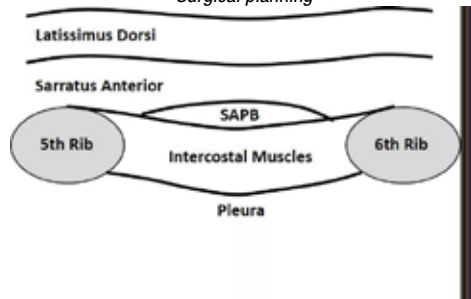
**Method:** It is a descriptive study, from 2016 to the present so we carried out a total of 19 outbreaks with the application of personalized and dynamic 3D prostheses. 5 surgeries for traumatic pathology (giant thoracic hernias and winged scapula) and 14 for oncological pathology (extensive involvement of the anterior wall, sternal involvement -bilateral clavicular and extensive cost-vertebral involvement). A 3D CT reconstruction of the defect to be corrected was previously performed, followed by the individualized titanium printed prosthesis. In anterior wall we use a prosthesis that simulates a sternum with articulated ribs, which gives rigidity and flexibility like a normal chest. In the winged scapula, a personalized prosthesis prevents bone breakage when arthrodesing it to the ribs; in giant hernias, a dynamic prosthesis that provides rigidity and does not limit respiratory movements. In bilateral sterno-clavicular involvement, a neoarticulation with ligament reinforcement. In costovertebral involvement with rib replacement and a fixation system to vertebral bodies. The follow-up time of the first cases is 6 years, with an average of 3.5 years. Average surgical time: 240 minutes (150-540). No breakage or displacement in any of the implants

Type of reconstructions

Winged escapula	2
Thoracic hernia	3
Ribs-vertebral involvement	1
Chest wall + sternum	9
Chest wall	3
Sternal involvement -bilateral clavicular	1

**Results:** Good correction of the defect, functionality and stability of the chest wall, easy placement as it is personalized, surgical time was reduced, there were no breaks or displacements in the series.

Surgical planning





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**Conclusions:** 3D personalized prostheses are a good alternative for the correction of large anterior chest wall defects, giant thoracic hernias and chest wall pathologies with joint involvement thanks to their perfect adaptability, easy placement, reduction in surgical time and their capability to provide correct stability without limiting respiratory movements.

**Keywords:** Chest wall, 3D printed, Prostheses, Reconstruction



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## OA-15 LACK OF AGREEMENT BETWEEN SPECIALIZED CHEST WALL SURGEONS REGARDING A WIDESPREAD MORPHOLOGICAL PECTUS EXCAVATUM CLASSIFICATION: DO WE NEED TO DIG FURTHER?

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**Background and Aim:** Attempts to classify pectus excavatum (PE) have been extensive, being the most frequent the discrimination in three groups comprising cup-shaped, Grand-Canyon, and saucer-shaped PE. This classification may have therapeutical repercussions when deciding surgical approach. However, PE phenotypes can be widely variable. We therefore explored the variability of such classification within the same surgical team, and its relationship with chest malformation indexes.

**Method:** A sample of 100 patients with PE were randomly selected. Medical photographs were analyzed independently by six chest wall surgeons, and classified as having a cup-shape, Grand- Canyon, and saucer-shape, or else to define it as other phenotype. Chest CT scan Haller (HI), Correction (CI), and Titanic (TI) indexes were calculated.

**Results:** The mean age was  $16.9 \pm 4.5$  years, with a mean Haller index (HI) of  $5.1 \pm 1.8$ , a mean correction index (CI) of  $43.2 \pm 15.1\%$ , and a mean titanic index (TI) of  $71.3 \pm 20.4\%$ . Of the 600 classifications (comprising 100 classifications by 6 surgeons) made, full agreement was achieved in only 30% of cases, whereas we found agreement between 5, 4, 3, and 2 surgeons in 19%, 26%, 23%, and 2% cases. We further selected only the cases with agreement of at least 5 surgeons ( $n=49$ ) (Table 1), and did not find significant differences between agreement and disagreement regarding age ( $16.6 \pm 4.4$  years, vs.  $17.1 \pm 4.6$  years,  $p=0.62$ ), body surface area ( $1.67 \pm 0.1$  m<sup>2</sup>, vs.  $1.67 \pm 0.2$  m<sup>2</sup>,  $p=0.99$ ), HI ( $5.2 \pm 2.0$ , vs.  $4.9 \pm 1.6$ ,  $p=0.45$ ), or CI ( $42.3 \pm 15.6\%$ , vs.  $44.2 \pm 14.7\%$ ,  $p=0.52$ ); whereas the TI was higher among patients with disagreement ( $64.1 \pm 22.4\%$ , vs.  $78.1 \pm 15.5\%$ ,  $<0.0001$ ).

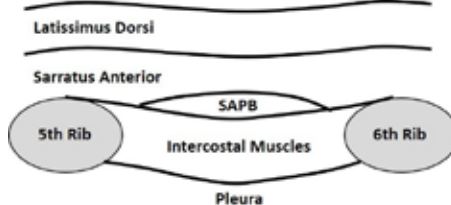
**Conclusions:** In this study we identified substantial rates of disagreement regarding PE morphology even within the same team of surgeons. Our findings suggest that therapeutic decisions based solely on the classic morphologic classification should be cautious.

**Keywords:** Pectus Excavatum, classification, grand-canyon, cup-shape, saucer-shape

**OA-16 SERRATUS ANTERIOR PLANE BLOCK IN PECTUS SURGERY AS AN ALTERNATIVE PAIN MANAGEMENT MODALITY: A PRELIMINARY STUDY**Hyung Joo Park<sup>1</sup>, Gongmin Rim<sup>1</sup>, Seung Youn Kang<sup>2</sup>, Seung Keun Yoon<sup>3</sup><sup>1</sup>Department of Thoracic Surgery, Gangnam Nanoori Hospital<sup>2</sup>Department of Anesthesiology, Gangnam Nanoori Hospital<sup>3</sup>Department of Thoracic and Cardiovascular Surgery, Seoul St. Mary's Hospital, The Catholic University of Korea

**Background and Aim:** Pain management after pectus deformity repair with pectus bars has limited efficacy with conventional methods such as patient-controlled analgesia and cryo intercostal nerve ablation. Therefore, there is a need for alternative pain management strategies. Serratus anterior plane block (SAPB) has the potential to block nerves in the 2nd to 9th intercostal space along the chest wall. This study reports initial observations on SAPB as an alternative pain management strategy.

**Method:** Following pectus deformity repair, continuous SAPB was performed. Under sonographic guidance, a catheter was inserted through the 5th intercostal space at the mid-axillary line and advanced to the serratus anterior plane (Fig. 1). Then, 40 ml of 0.375% ropivacaine was administered below the serratus anterior muscle, with a background infusion of 0.3% ropivacaine at a rate of 7 ml/h. Pain control outcomes were compared between the SAPB group and our previous patients who received cryo intercostal block: the SA block group (Group S, n=7) or Cryoanalgesia (Group C, n=14). Pain scores were measured using the visual analog scale (VAS) at postoperative 6/12/24/48/72 hours in each group.

*Fig. 1. The diagram of serratus anterior plane block*

The serratus anterior plane between the serratus anterior muscle and the intercostal muscle is developed and a catheter is inserted for continuous local anesthetic infusion postoperatively.

SAPB: serratus anterior plane block

**Results:** The pain scores (VAS) for both groups are presented in Table 1. No complications related to the SAPB procedure, such as pneumothorax, bleeding, or neurologic complications, were observed.

Table 1. The results of pain management (Visual Analogue Scale, VAS) between Serratus anterior plane block (Group S) and Cryoanalgesia (Group C)

VAS	Group S	Group C
6h	4.3	5.1
12h	3.5	4.9
24h	3.4	4.6



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**Conclusions:** This preliminary study suggests that SAPB is an effective and safe pain management strategy for patients undergoing pectus deformity repair with pectus bars. Compared to cryoanalgesia, SAPB appears to be simpler, less invasive, and avoids intrathoracic interventions. Further studies with larger sample sizes are needed to confirm these findings.

**Keywords:** Pectus excavatum, Pain management, Serratus anterior plane block, Local anesthetic infusion



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## OA-17 COPPER (CRYOANALGESIA OR PAIN MANAGEMENT AFTER PECTUS EXCAVATUM REPAIR): A RANDOMIZED CONTROLLED STUDY ABOUT PAIN MANAGEMENT AFTER PECTUS EXCAVATUM REPAIR

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<sup>2</sup>*University of Genova, Italy*

**Background and Aim:** Post-operative pain management is a relevant challenge after MIRPE. Our traditional approach is to place an epidural catheter, in association with the administration of opioid drugs. Recently, intra-operative cryoanalgesia has been introduced in other centers, using a thoracoscopic probe which freezes intercostal nerves. The aim of the study is to compare these two analgesic methods in MIRPE procedure.

**Method:** A prospective single center randomized controlled study was designed for patients older than 12 years, who underwent MIRPE from February 2022. A target cross-section of 88 patients was established. Participants were randomly assigned to one of the two study arms: thoracoscopic cryoanalgesia vs standard of care. Cryoanalgesia was administered bilaterally on 5 to 6 intercostal levels. As main comparison criteria, we considered: length of stay; quantity of morphine requested, numeric rating scale (NRS), and PEDQL 14, an index of quality of life after the discharge. All comparisons were performed by the Student t test.

**Results:** Sixty-five patients were recruited in Copper Study from February 2022 to April 2023. Among them, 42 completed the first follow-up and were included in the analyses: 22 were assigned to Epidural arm and 20 to Cryoanalgesia. In the majority of them, two bars were implanted. No intra-operative or significant postoperative complications were reported. The mean length of stay was 3.9 days, with a statistically significant difference ( $p = 0.0058$ ) between Epidural group (4.45 days) versus Cryoanalgesia group (3.3 days). The mean total quantity of morphine used in the post-operative period was 43.4 mg versus 22.6 mg ( $p=0.03$ ). NRS and PEDQL14 did not differ between groups.

**Conclusions:** Cryoanalgesia decreased hospitalization length and morphine consumption in post-operative period. Quality of life of operated patients did not show any difference between the two groups.

**Keywords:** cryoanalgesia, MIRPE, postoperative pain



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## OA-18 COMPARISON OF DISLOCATION RATE OF NUSS BAR BETWEEN THREE GROUPS OF PATIENTS OPERATED WITH DIFFERENT TECHNIQUES: BAR WITHOUT STABILIZER; BAR WITH SINGLE STABILIZER; MULTIPLE BARS WITH BRIDGE STABILIZER

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**Background and Aim:** Bar dislocation has always been considered a fearsome complication of Minimally Invasive Repair of Pectus Excavatum (MIRPE), therefore different techniques and types of stabilization were introduced. The aim of the study is to compare different stabilization techniques in a single center

**Method:** This is a unicentric retrospective analysis, including all patients operated for MIRPE by the same surgical team during the last 10 years (January 2013 - October 2022) with at least six months of follow-up. Some patients had the bars fixed with multiple bilateral pericostal sutures without any stabilizer (group A: no stabilizer); in other patients, each bar was stabilized with at least one stabilizer (group B: single bar fixation); recently, we have used multiple bars fixed with bridge stabilizers (group C: bridge fixation). All patients were followed prospectively by the same team and dislocation was diagnosed when a bar was found rotated of more than 30° or displaced laterally for more than 1.5 cm. We compared bar dislocation rate in each group. Analyses were performed using SPSS® version 26, categorical variables were expressed as absolute frequencies and percentages were compared using the Fisher's exact test. Significance was defined as  $p < 0.05$

**Results:** We positioned 752 bars in 480 patients. Group A included 113 bars (15%), group B 411 bars (55%), group C 228 bars (30%). No patients were lost at follow-up. Total dislocation rate was 4.6% (35 bars), whose 30 (4.0%) required re-operation. Dislocation was observed in 13 bars of group A (11.5%), 22 bars of group B (5.4 %), 0 bars of group C (0%). Differences between groups were statistically significant (A versus B  $p=0.02$ ; B versus C  $p=0.001$ ; A versus C  $p=0.00002$ ).

**Conclusions:** The use of stabilizers reduced dislocation rate. In particular, bridge fixation technique reduced to zero bar dislocation and is now our preferred technique of stabilization

**Keywords:** Pectus excavatum, Nuss bar, bridge stabilizer



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## OA-19 QUALITY OF LIFE AFTER NUSS-PROCEDURE: EXPERIENCE IN A TEN YEAR COHORT OF MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM

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<sup>1</sup>*KU Leuven*

<sup>2</sup>*UZ Leuven*

**Background and Aim:** Pectus excavatum is the most common chest wall deformity. Commonly reported symptoms are dyspnea, problems of self-confidence, loss of endurance, palpitations and chest pain. The Nuss-procedure is a minimal invasive surgical technique where metal struts are inserted beneath the sternum to push the deformed sternum forward and removed 3 years later. Studies have shown that patients with pectus excavatum have a significant lower disease-specific and general quality of life. With this project we wanted to investigate the QoL-evolution with a large study population, albeit single center, while also comparing the general health of the participants with those of their peers in a national reference health survey data set.

**Method:** All patients who underwent the Nuss-procedure in UZ Leuven between 2013 and 2021 were included in this study. They got sent 3 questionnaires about their quality of life, more specifically the EQ-5D-5L, the SF-36 and the single step questionnaire. We looked at the overall responses, the differences between genders and age-groups and compared our results of the EQ- 5D-5L with those of a national reference database.

**Results:** Of the 200 responders 95.5% think the look of their chest has improved and only 3% of all participants were unsatisfied with the overall result. Seventy percent of participants state their health has improved after the Nuss-procedure and sees improvement in their exercise capacity. About 35% state that the procedure had a positive effect on their social life. Our results of the EQ-5D-5L questionnaire were significantly better than or at least comparable with those of the national reference.

**Conclusions:** It appears safe to state that the Nuss-procedure has a positive effect on the quality of life of patients with pectus excavatum and that their quality of life after surgery is at least as good, if not better than the one of their peers.

**Keywords:** Quality of life, Nuss procedure, Pectus excavatum





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## OA-20 RIGHT VENTRICULAR IMPROVEMENT AFTER BAR REMOVAL IN PATIENTS WITH PECTUS EXCAVATUM ASSESSED WITH SERIAL EXERCISE STRESS ECHOCARDIOGRAPHY

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**Background and Aim:** Minimal invasive repair of pectus excavatum (MIRPE) has shown early improvement in diverse cardiac parameters, although it remains uncertain whether such benefits endure after bar removal. We thus evaluated stress echocardiography (SE) outcomes before MIRPE and after bar removal.

**Method:** This retrospective study involved consecutive patients with diagnosis of isolated PE who underwent exercise SE before MIRPE and after bar removal between August 2012 and June 2020. The right ventricular (RV) systolic function was evaluated using the tricuspid annulus plane systolic excursion (TAPSE), and the compression of the atrioventricular groove using the trans-tricuspid gradient and the tricuspid area. A resting abnormal RV diastolic function was defined as the presence of an E/e' ratio  $\geq 7$ .

**Results:** We included 43 patients, with a mean age of  $15.7 \pm 4.0$  years (91% male). Thirteen (30%) reported exercise intolerance. After bar removal, 35/41 (83%) patients referred improvement of exercise capacity. Compared to baseline, we identified significant improvements in the maximal workload achieved during exercise ( $7.95 \pm 1.3$  METS, vs.  $10.85 \pm 3.3$ ,  $p < 0.0001$ ), despite a similar left ventricular ejection fraction ( $p = 0.73$ ). After bar removal, we found a significant reduction in the RV E/e ratio ( $6.09 \pm 2.8$  vs.  $4.37 \pm 1.2$ ,  $p < 0.0001$ ), and in the rates of abnormal diastolic function at rest (29% vs. 5%,  $p = 0.02$ ); whereas the systolic function showed a significant improvement (TAPSE  $18.2 \pm 3.9$  mm, vs.  $21.6 \pm 4.5$  mm,  $p < 0.0001$ ). The trans-tricuspid mean gradient during exercise was significantly lower after bar removal ( $7.6 \pm 3.4$  mmHg, vs.  $5.6 \pm 1.5$  mmHg,  $p < 0.0001$ ). Before surgery, the tricuspid area was unable to increase during exercise (rest  $1.61 \pm 0.6$  cm<sup>2</sup>/m<sup>2</sup> vs. exercise  $1.65 \pm 0.5$  cm<sup>2</sup>/m<sup>2</sup>,  $p = 0.65$ ), with a significant increase after removal (rest  $1.64 \pm 0.6$  cm<sup>2</sup>/m<sup>2</sup> vs. exercise  $2.08 \pm 1.0$  cm<sup>2</sup>/m<sup>2</sup>,  $p < 0.0001$ ).

**Conclusions:** In this study, the first reporting stress echocardiography outcomes after bar removal, we identified significant improvements in anatomic and functional cardiovascular parameters, particularly involving right ventricular filling.

**Keywords:** Exercise Stress Echocardiography, Pectus Excavatum, cardiac compression, exercise intolerance



**OA-21 CORRECTION OF PECTUS EXCAVATUM IS HIGH-RISK SURGERY IN ADULTS: A RETROSPECTIVE COHORT STUDY**

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**Background and Aim:** Minimal invasive Repair of Pectus Excavatum (MIRPE) is standard treatment of Pectus Excavatum and consists of two invasive procedures e.g., correction with bar insertion followed by bar removal after 2-3 years. The objective of this study was to describe the Compounded Complication Rate (CCR) of the two procedures of MIRPE and identify predisposing risk factors and evaluate optimal timing of correction.

**Method:** A retrospective cohort study identifying children, adolescents and adults of both genders corrected with MIRPE between 2001 and 2022 at Aarhus University Hospital, Denmark. Complications were defined in relation to bar insertions and removal procedures. Complications were categorized according to Clavien-Dindo-Classification (CDC).

**Results:** In all 2013 patients were corrected by MIRPE with mean age for correction of 18.5±7.5 years. Overall CCR occurred at a frequency of 16.4% and 9.3% required invasive re- interventions (CDC≥IIIa). Complication rate related to bar insertion was 2.7-fold higher compared to bar removal (12.2% vs 4.5%, respectively). Multivariable analysis revealed age (OR<sub>adj</sub>=1.05, p<0.001) and pre-correction Haller index (OR<sub>adj</sub>=1.12, p<0.033), and early phase institutional correction (OR<sub>adj</sub>=1.59, p<0.002) as independent predisposing risk factors. Furthermore, optimal age of correction was 12 years and CCR correlate exponentially with age with a doubling time of 7.2 years (Fig. 1A). Complications increased 2,2-fold when Haller index increased to >5 unit (Fig 1B). Figure 1. Sub-analyses of independent pre-correction risk factors.

*CCR is shown as a function of age. The red line marking best fit of an exponential equation.  
Over-all CCR as function of Pre-correction Haller Index.*

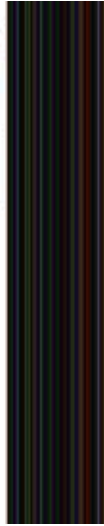
*Figure 1*



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Figure 2



**Conclusions:** MIRPE is associated with high CCR and increase exponentially with age and with high Haller Index. Consequently, MIRPE should be performed during late childhood and early adolescence and surgeons are obligated to inform patients and relatives about risks, the significant risk of two consecutive procedures and take the complication profile into account before planning surgery.

**Keywords:** Pectus Excavatum, MIRPE, Complications, Age, Haller Index

**OA-22 APPLICATION OF SANDWICH SURGERY IN PECTUS EXCAVATUM MIXED WITH CARINATUM**Jie Yu<sup>1</sup><sup>1</sup>*Beijing Children's Hospital*

**Background and Aim:** To introduce the application of a surgical method in the treatment of pectus excavatum mixed with carinatum and discuss the safety and feasibility of this surgical technique.

**Method:** A retrospective analysis was performed on 26 patients with mixed chest wall malformation treated with pectus excavatum combined with carinatum by sandwich surgery in our center from March 2012 to March 2022. The diagnosis of these patients should meet the following two criteria: □ The main diagnosis was pectus excavatum, and the chest CT showed Haller index >3.0, indicating pectus excavatum operation; □ The secondary diagnosis was pectus carinatum, and the appearance of chest wall was convex deformity on one side of chest wall or superior sternum segment. In this group, 6 patients had recurrent pectus excavatum, and 13 patients had complications.

**Results:** All the 26 cases in this group successfully completed the operation, there were no serious complications during the operation, no short-term complications after the operation, but two cases of long-term complications after the operation. One case had the displacement of the pectinus excavatum bar 27 months after the operation, and one side of the bar fell off into the chest, and the bar was removed by emergency operation. One case was found to have idiopathic scoliosis at return visit 12 months after surgery, who underwent bar removal and spinal orthosis surgery. The patients in this group were followed up for 13 to 130 months after surgery, and 22 patients had received bra removal, in which 3 patients underwent twice bar removal surgeries, and there was no recurrence during follow-up.

**Conclusions:** Sandwich surgery is safe and feasible in the treatment of mixed chest wall malformations with pectus excavatum combined with carinatum. The postoperative effect were good, and sandwich surgery could be used as a choice in the treatment of mixed chest wall malformations.

**Keywords:** pectus excavatum; pectus carinatum; chest wall deformity; minimally invasive surgery; sandwich surgery

## OA-23 MINIMAL INVASIVE APPROACH FOR RIB FRACTURES: FEASIBILITY AND SAFETY

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<sup>1</sup>ISSEMYM MEDICAL CENTER

<sup>2</sup>ABC MEDICAL CENTER

**Background and Aim:** Background: Current pathologies and the concepts applied for chest trauma, both for revision of thoracic cavity, and to solve some traumatisms, have allowed to develop minimal surgery approach techniques for the resolution of multiple nosologies, thanks to their various benefits, currently this has been classified as a vanguard surgical technique worldwide. Aim: The objective of the work is to present the proposal to fix ribs based on the principle of minimum invasion, sharing results and benefits of the approach

**Method:** Material and methods: Patients undergoing ribs fixation with minimal invasive technique, at ISSEMYM Medical Center, Thoracic Surgery Service, were analyzed according to age, gender, number of ribs fixed, days of hospital stay, days with endopleural tube, type of anesthesia and complications. We present a series of cases with retrospective, descriptive design in a period of 72 months.

**Results:** Results: this is the largest case series reported for fixing ribs by minimal invasive approach, a final sample N = 105 was used, favorable results and description of the same technique was described. The analysis demonstrates only 2 complications, at a follow-up period of 72 months, the average amount of ribs fixed was 3.8 (1-10). And the intrahospital stay evaluated after the procedure was an average of 5.08 days (1-24).

*Minimal Invasive Approach 1*

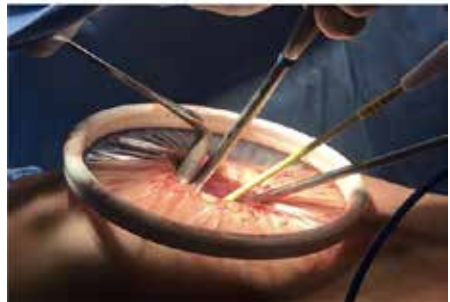
Figure 2



*scheme that exemplifies the approach and the way to fix the rib,*

*Minimal Invasive Approach 2*

Figure 4



*scheme that shows the placement of instruments for dissection and preparation for rib fixation*

**Conclusions:** The technique of fixing ribs by minimal invasive approach, continues to be a choice technique to reduce postoperative complications and reduce intrahospital staying days, it is a reproducible, safe and pioneering technique for chest surgery.

**Keywords:** minimal invasive approach, chest surgery, rib fixation.



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## OA-24 DEFINING THE OPTIMAL ANNUAL CASE VOLUME FOR MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM

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<sup>1</sup>Zuyderland Medical Centre

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**Background and Aim:** The purpose of this study is to investigate the relationship between hospital volume and outcome after minimally invasive repair of pectus excavatum (MIRPE), and to determine a threshold for the optimal annual case-volume based on perioperative complications.

**Method:** Electronic databases were systematically searched for studies that reported on (i) consecutive MIRPE, (ii) years of inclusion, and (iii) perioperative complications. Primary outcome was the frequency of perioperative complications in relation to annual hospital case- volume. Cubic spline analysis was used to demonstrate the relationship between volume and perioperative complications and differential calculus to determine the optimal threshold for annual hospital volume.

**Results:** Thirty-six studies from 36 worldwide hospitals were included with a total of 11,353 patients. Hospital volume ranged from 1 to 209 procedures per year. A significant, nonlinear relationship between volume and frequency of perioperative complications was found ( $p < 0.001$ ). The optimal annual hospital volume after which outcomes did not improve further was 57 procedures per year. This optimal volume of 57 was associated with a 66% relative risk reduction for the occurrence of a complication compared with an annual hospital volume of 10 procedures.

**Conclusions:** For MIRPE, there is a distinct relationship between volume and complications with the optimal annual hospital case-volume being 57 procedures per year.

**Keywords:** pectus excavatum, complications, volume

## OA-25 INADEQUATE SCIENTIFIC PROOF OF IMPROVEMENT OF VO<sub>2</sub>MAX AFTER CORRECTION OF PECTUS EXCAVATUM: A SYSTEMATIC REVIEW AND META-ANALYSIS

Ara Media<sup>1</sup>, Peter Juhl-Olsen<sup>1</sup>, Thomas Christensen<sup>1</sup>, Niels Katballe<sup>1</sup>, René Petersen<sup>2</sup>, Hans Pilegaard<sup>1</sup>, Kristian Overgaard<sup>3</sup>, Frank de Paoli<sup>4</sup>

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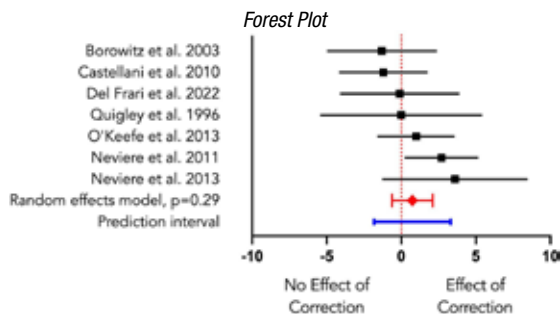
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**Background and Aim:** From a cosmetic and psychologic point of view correction of Pectus Excavatum (PE) has major impact on patient self-perception and self-esteem. However, convincing and consistent objective data to support an improvement in exercise tolerance after correction is up for debate. Therefore, the aim of this study was to evaluate the effect of PE correction on VO<sub>2</sub>max by means of a systematic review of the literature and a meta-analysis.

**Method:** The study was conducted in accordance with PRISMA-guidelines and registered in the PROSPERO database. PubMed, Embase and Scopus databases were searched systematically for studies measuring VO<sub>2</sub>max before and after correction of PE.

**Results:** Fifteen hundred ninety-eight studies were identified for abstract screening of which 90 underwent full-text assessment. Eighteen cohort or case-control studies were included deriving from 15 independent cohorts. Six studies were excluded as VO<sub>2</sub>max was not indexed for body weight. Assessment by ROBINS-I-tool revealed severe to critical risk of bias in all studies. Crude meta-analysis including 12 studies showed a mean effect size of 1.8 ml O<sub>2</sub>/min\*kg<sup>-1</sup> (0.6- 3.1), p=0.005. A subsequent meta-regression analysis, uncovered a positive correlation between effect size and ΔHRmax (Post-HRmax – Pre-HRmax, i.e., higher ΔHRmax leading to higher effect size of VO<sub>2</sub>max), r=0.63, p=0.03. Consequently, studies with positive ΔHRmax were excluded as this points to a critical bias in outcome measurements. In the finalized meta-analysis, the mean effect size was 0.7 ml O<sub>2</sub>/min\*kg<sup>-1</sup> (-0.6-2.2) with a prediction interval of -1.8 to 3.3 ml O<sub>2</sub>/min\*kg<sup>-1</sup>, n=7, p=0.29.



**Conclusions:** Despite numerous attempts to elucidate the physiologic effects of PE correction on functional capacity, only 18 studies measuring VO<sub>2</sub>max were identified all with severe to critical risk of bias. The meta-analysis found no scientific proof of clinically or statistically significant improvement of VO<sub>2</sub>max after correction of Pectus Excavatum. There is a need of high-quality randomized trials in this field.

**Keywords:** Pectus Excavatum, VO<sub>2</sub>max, Functional Capacity, Exercise Tolerance



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### OA-26 REPEATED CHEST WALL RECONSTRUCTION AFTER RESECTION OF A STERNAL CHONDRROID CHORDOMA WITH LONG-TERM POSTOPERATIVE INFECTION OF THE RECONSTRUCTIVE MATERIAL

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**Background and Aim:** We present the case of a 23-year-old man with a chondroid chordoma of the sternum. The patient underwent chest wall resection, and chest wall stabilization was achieved with a sandwich graft of Prolene mesh and methylmethacrylate, which was covered by M. pectoralis flaps from both sides. After adjuvant radiotherapy and two years of follow-up, he developed an infection of the reconstructive material. We removed the allogeneic material with an encapsulated abscess, and the wound was conditioned through repeated VAC therapy. This time, wound closure and chest wall stabilization were achieved with a Prolene mesh covered by an anterolateral thigh flap (ALT flap). This case demonstrates carefully considering choice of material for chest wall stabilization and the requirement of established multidisciplinary cooperation.

**Method:** Case Report

*preoperative*



*Situs in final operation, before stabilization Postoperative result*



*Postoperative image*

**Results:** The patient showed 2 weeks after surgery a well-healed ALT flap and a stable chest wall. A yearly follow-up was recommended. The patient was again referred to a pain specialist center

**Conclusions:** Complex chest wall resection and reconstruction should be performed in multidisciplinary settings and according to oncological guidelines. Implantation and type of prosthetic material and using local or distant muscle flaps for soft tissue reconstruction must be carefully considered and individually adapted to the respective situation.

**Keywords:** Chest wall reconstruction, Chest wall stabilization, Chondroid Chordoma, Postoperativ Complications



**OA-28 AN ALGORITHMIC APPROACH TO THE SURGICAL MANAGEMENT OF STERNAL DEHISCENCE**

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**Background and Aim:** Deep sternal wound complications following sternotomy represent a complex challenge. Management can involve debridement, flap reconstruction, and rigid sternal fixation. We present our 8 -years experience in the surgical treatment of deep sternal wound dehiscence using a standardized treatment algorithm.

**Method:** Between January 2015 and March 2023, 42 patients (25 males, 17 females, mean age: 63.42 years (33-80) years) who developed dehiscence after sternotomy were evaluated retrospectively. The causes of sternotomy were coronary bypass (n=26), pulmonary endarterectomy (n=11), valve replacement (n=3), thymectomy (n=1) and ASD repair (n=1). Deep surgical debridement and negative pressure wound care (VAC) (mean 92.3 days) treatment was initiated in the patients with growth under appropriate antibiotics according to the microbiological culture examination. The VAC system was replaced twice a week in each patient. Sternal reconstruction was performed after three consecutive culture negatives.

**Results:** Spontaneous closure was completed with debridement and negative pressure wound care in 8 of 42 patients, primary closure with pectoral muscle flap in 31 patients and reconstruction with rigid sternal fixation in 3 patients. Three patients died while under VAC therapy (2 due to underlying disease, 1 due to sepsis). The treatment was completed successfully in 38 (90.4%) of 42 patients. Dehiscence recurred in 1 patient. The mean duration of treatment was 3.5 (1-10) months.

Picture



**Conclusions:** Although sternal dehiscence remains a complex challenge, an aggressive treatment algorithm, including debridement, flap closure, and consideration of rigid sternal fixation, can achieve good long-term outcomes in experience center.

**Keywords:** Sternal Dehiscence, negative pressure wound care



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**ORAL  
PRESENTATIONS  
FOR YOUNG  
INVESTIGATORS**



# 23<sup>RD</sup> ANNUAL CONGRESS OF THE CHEST WALL INTERNATIONAL GROUP

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## YIA-01 THE CROSS-BAR (PARK HJ) METHOD FOR REPAIRING PECTUS EXCAVATUM IN PATIENTS WITH SYMMETRIC OR ASYMMETRIC COMPLEX MORPHOLOGY.

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**Background and Aim:** Pectus excavatum (PE) is a complex malformation that can result in cosmetic issues and impact the cardiopulmonary system, leading to physical limitations. This study Aim the repair efficiency of PE in patients using the Cross-bar method following the Park technique and to explore the impact of anatomical variations on the surgical outcomes.

**Method:** This retrospective study was conducted between 2016,2023 for 112 patients aged 9-24 years with PE were treated using the Cross-bar method. This surgical therapy was based on H.J. Park's morphological classification (2009). The pectus bar stabilizing method of "Cross- bar/Bridge" is safe to prevent bar rotation. Symmetric cross-bars were placed or asymmetric seagull-shape bars were crossed into the deformity center and connected with the bridge plate using the clip-nut.

**Results:** All patients had moderate or severe levels of pectus excavatum (PE) with a Haller Index of more than 3.2, needed surgical therapy. The bars crossed into deformity center and connected with the bridge, clip, and nut. Symmetric cross-bars in 52 (46.4%) patients; XI bars were in 3 (5.8%). The Asymmetric seagull-shape bars crossed at the deformity center in 60 (53.6%) patients; XI seagull bars in 7(6.2%). After 26-30 months: 95 (85.0%) patients showed "Good" result; 14 (12.5%) were "Satisfied"; However, 3 (2.7%) were "Unsatisfied": from them 2 (1.8%) patients showed asymmetry after 4 months, and 1 (0.9%) experienced detachment of the fixing bolt-nut. A second surgery yielded positive results for these patients.

**Conclusions:** The Cross method for operative therapy of PE in different ages provided "good" results. The symmetric or asymmetric seagull-shape bars connected with the Park's method of Cross-bar/Bridge was safe and effective in correcting moderate to severe PE including complex deformities. Considering anatomical variations leads overall success when selecting the surgical approach. An individualized treatments important for patients with PE.

**Keywords:** Cross-bar/Bridge, asymmetric seagull-shape, Symmetric cross-bars, H.J. Park's morphological classification (2009).

**YIA-03 COMPRESSION SYSTEM FOR THE TREATMENT OF PECTUS CARINATUM IN PEDIATRIC PRACTICE.**

Vladimir Gatsutsyn<sup>1</sup>, Vladimir Kuzmichev<sup>1</sup>, Dmitriy Pykhteev<sup>1</sup>, Vladislav Duryagin<sup>1</sup>

<sup>1</sup>*Moscow Regional Research and Clinical Institute ("MONIKI"), department of pediatric surgery, 129110, Moscow, Russia.*

**Background and Aim:** Pectus carinatum (PC) is estimated to occur in up to 0,3–0,7% of all live births, with an incidence of approximately 1-3 per 10000. Since 2011, in department of pediatric surgery of the Moscow Regional Research and Clinical Institute correction of the costal type of PC was performed by non-invasive Abramson procedure, which is characterized with low injury rate, rapid activation and a short rehabilitation period. Compression brace system (CBS) is the main method of treatment PC from 2018, which in most cases allows achieving satisfactory results in the correction of PC. The main indications for the correction of PC by a conservative method remain the same as for Abramson procedure, but the main reason for refusing CBS is disclaim using and relative high cost

**Method:** Correction PC with compression brace system has been introduced in 2018, which we applied in 47(93.6%) children, Abramson procedure was performed in 3(6.4%) patients who refused conservative treatment. There were 2 patients (4,3%) who were non-compliant to use brace system. In 1(2.1%) case patient disclaim using CBS because it was relative high cost. Result estimation was: own evaluation scale, as rated by the patients, Haller index

**Results:** Treatment by CBS was performed in 47 (N) patients: 6(12.8%)-female, 41(87.2%)- male. The age starting of treatment was 13±3 years; duration of outpatient treatment, including examination, selection of the system and training of parents was 18 months±1. Relapse PC were noted in 2(4.25%) cases, the duration of wearing the compression system was 2years. The result of treatment was examined every 3 months: a good result in 43(91.5%) cases, satisfactory in 2(4.25%), unsatisfactory in 2(4.25%) patients, who were non-compliant to use brace system.

**Conclusions:** for treatment PC with costal type, preference should be given to a compression brace system. Abramson procedure was making for those patients, who were unwilling to use CBS.

**Keywords:** pectus carinatum, dynamic compression system.

**YIA-04 CORRECTION OF MIXED TYPE DEFORMITIES: OUTCOMES OF SANDWICH TECHNIQUE**

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**1**Department of Thoracic Surgery, Faculty of Medicine, Marmara University, Istanbul

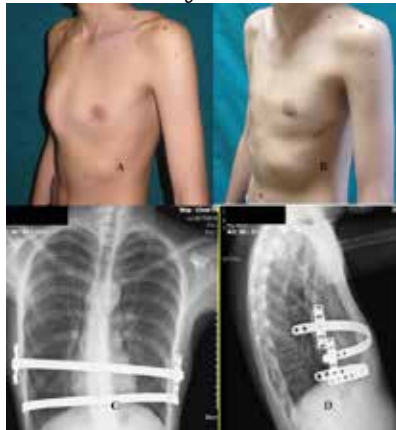
**2**Department of Thoracic Surgery, Faculty of Medicine, Bilim Demiroglu University, Istanbul

**Background and Aim:** As the experiences of the surgeons increased, new modifications were developed according to the necessity for specific group of patients. Sandwich technique is used for mixed type of deformities which can be summarized as a deformity having both excavatum and carinatum parts asymmetrically. We, hereby, present our results with Sandwich Technique.

**Method:** Patients who had had Sandwich Technique between 2014 – 2023 were reviewed retrospectively. 55 patients are included into the study. Patient's data regarding demographics, type of the deformity, duration of the operation, perioperative and postoperative complications, length of hospital stay, and patient satisfaction are recorded for each patient.

**Results:** Among 55 patients; 51 (92.7%) were male and 4 were female (7.3 %). Mean age was 18.7 (13-23). 8 (14.5%) of them had symmetric deformity and 47 (85.5%) had asymmetric deformity. All patients were operated with one MIRPE bar and one MIRPE bar. Mean duration for the operation was 76 minutes (60-180 minutes) and mean length of hospital stay was 4.1 days (2-6 days). Pneumothorax (3.6%, 2 patients) was the leading early complication and none of the patients needed intervention for the treatment. Additionally, wound infection (1.8%, 1 patient), chronic serous drainage (1.8%, 1 patient) and stabilizer displacement (1.8%, 1 patient) were the other early complications. Two of the patient's bar removed because of unbearable pain at the end of the first month and was the leading long-term complication. Bars of 22 patients were removed as scheduled so far with quality-of-life questionnaire revealing %97 patient satisfaction.

Figure-1



A- Preoperative image of the patient with mixed type deformity B- Postoperative image of the patient C- Postoperative P/A view chest X-Ray of the patient D- Postoperative lateral view Chest X-Ray of the patient

**Conclusions:** Sandwich technique is the preferred surgical option in the management of this complex deformity called mixed type. It can be safely used as a successful combination of both Nuss and Abramson procedures with high patient satisfaction and less early and late complication rates.

**Keywords:** Pectus Excavatum, Pectus Carinatum, Mixed type deformity, Chest wall deformity

**YIA-05 THE SHORTENING OF MINIMUM ANTERIOR-POSTERIOR DIAMETER OF THE THORAX IN THE UPRIGHT COMPARED WITH THE SUPINE IN PATIENTS WITH PECTUS EXCAVATUM**

Takahiro Suzuki<sup>1</sup>, Keisuke Asakura<sup>1</sup>, Yoshitake Yamada<sup>2</sup>, Kyohei Masai<sup>1</sup>, Minoru Yamada<sup>2</sup>, Yoichi Yokoyama<sup>2</sup>, Tomohiro Imoto<sup>1</sup>, Yu Okubo<sup>1</sup>, Kaoru Kaseda<sup>1</sup>, Tomoyuki Hishida<sup>1</sup>, Jinzaki Masahiro<sup>2</sup>

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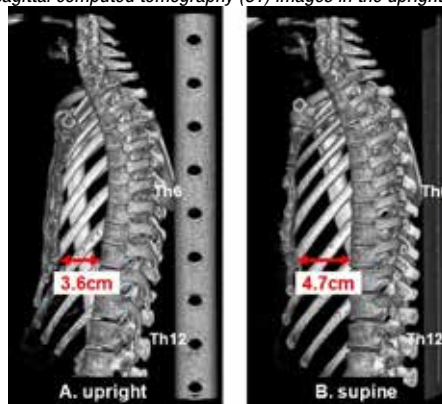
<sup>2</sup>Department of Radiology, Keio University School of Medicine, Tokyo, Japan

**Background and Aim:** Patients with severe pectus excavatum (PE) presenting worsening cardiopulmonary symptoms in the upright position have been reported. However, its underlying mechanism is unknown. We aimed to evaluate posture-related changes in chest depression and organ morphology in patients with PE using the newly developed upright computed tomography (CT) and a conventional supine CT.

**Method:** We analyzed preoperative CT scans obtained in the upright and supine positions for 21 surgical candidates with PE. The minimum anterior-posterior diameters of the thorax on horizontal sections, and the distances between the Th6 and Th12 plumb lines on sagittal sections, indicating the degree of spinal curvature, were compared between upright and supine CT.

**Results:** The minimum anterior-posterior diameter of the thorax was smaller in the upright position than in the supine position (mean: 4.9 cm vs. 5.5 cm,  $p < 0.001$ ). The distance between the Th6 and Th12 plumb lines was longer in the upright position than in the supine position (mean: 2.4 cm vs. 0.8 cm,  $p < 0.001$ ), suggesting the anterior shift of the lower vertebrae in the upright position. The degree of spinal curvature increased in the upright position owing to the anterior shift of the lower vertebrae, resulting in the shortening of minimum anterior-posterior diameter (Figure. 1). One patient with dyspnea presented only in the upright position exhibited compression of the right inferior pulmonary vein only on upright CT, accompanied with the shortening of the minimum anterior-posterior diameter (Figure. 2).

Figure 1. Representative sagittal computed tomography (CT) images in the upright (A) and supine (B) positions



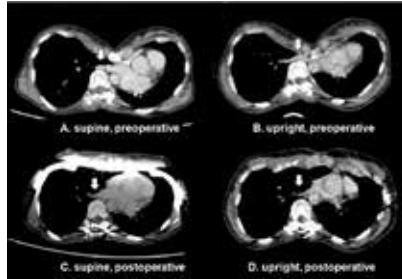
In this patient, switching from the supine to the upright position resulted in a 1.9 cm shift of the Th12 plumb line anteriorly to the Th6 plumb line. The minimum anterior to posterior diameter on the sagittal image (arrow was shorter in the upright position than in the supine position (3.6 cm vs. 4.7 cm).

Figure 2. Horizontal computed tomography (CT) sections from a 49-year-old patient with pectus excavatum presenting with dyspnea taken at the level of maximum chest depression



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*Images were captured at deep inspiration in (A) the supine, preoperative, (B) the upright, preoperative, (C) the supine, postoperative, and (D) the upright, postoperative. The right inferior pulmonary vein was compressed between the sternum and vertebra in the upright position preoperatively (B).*

**Conclusions:** The minimum anterior-posterior diameter of the thorax shortens in the upright position compared with the supine position. The phenomenon might be the underlying mechanism of worsening of cardiopulmonary symptoms in the upright in patients with severe PE.

**Keywords:** pectus excavatum, postural changes, upright CT



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## YIA-06 CROSS-BAR FOR NUSS PROCEDURE IN A PEDIATRIC PRACTICE

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<sup>1</sup>*Moscow Regional Research and Clinical Institute named after M.F. Vladimirovskiy ("MONIKI"), department of pediatric surgery, department of thoracic surgery, 129110, Moscow, Russia.*

**Background and Aim:** Report the results of treatment patients with pectus excavatum by the cross bar method in pediatric practice

**Method:** 392 pectus excavatum using the Nuss procedure were performed in department of pediatric surgery MRRCI from 2006 to 2022. The age of the patients was 14±2. For the first time correction was applied in cross-bar modification in 2017. 34 (8.7%) thoracoplasty according to Nuss procedure in the cross-bar modification was performed. The selection criterion was a deep local pectus excavatum with a Haller Index >5 with combination of the rib flare, in which the standard straight position of the correcting bar did not lead to proper elevation of the sinking and reduction of the protrusion ribs

**Results:** 34 (100%) cases of treatment of patients with deep local type of deformation in combination with protrusion ribs were analyzed. Satisfactory result was achieved in 31 (91%) patients, in 1 (3%) case hypercorrection was obtained. Retrospectively in 1 (3%) case, a reversal of the lower bar was delayed, without loss of correction. In 1 (3%) case, erythema was obtained, the bar's were removed in stages over 2 years with the survive of the result.

**Conclusions:** Using X-bar's expands the possibilities correction of PE, but has rather narrow indications for use and is not suitable as a method of choice for all patients with PE in pediatric practice's.

**Keywords:** pectus excavatum, Nuss procedure, cross-bar





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## YIA-07 ECHOCARDIOGRAM DOES NOT ADEQUATELY PREDICT CARDIOPULMONARY IMPAIRMENT IN PEDIATRIC PECTUS EXCAVATUM

R Scott Eldredge<sup>2</sup>, Brielle Ochoa<sup>1</sup>, Daniel Ostlie<sup>1</sup>, Justin Lee<sup>1</sup>, Craig Egan<sup>1</sup>, Jae-O Bae<sup>1</sup>, Mark Molitor<sup>1</sup>, David Notrica<sup>2</sup>, Benjamin Padilla<sup>1</sup>, Lisa McMahon<sup>1</sup>

<sup>1</sup>Phoenix Children's

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**Background and Aim:** Pectus excavatum (PE) can lead to cardiac compression and may result in decreased cardiopulmonary function. Prior to repair, cardiopulmonary function is commonly evaluated by echocardiogram (Echo), cardiopulmonary exercise stress testing (CPET,) and patient-reported symptoms. The primary aim of this study was to determine if abnormal Echo results correlated with abnormal CPET results and patient symptoms.

**Method:** A single-center retrospective review was conducted of pediatric patients aged 12-21 years who underwent surgical repair for PE from January 2016 and June 2022 who had preoperative resting Echo and CPET. Haller index (HI) and Correction index (CI) were recorded. Echo was reviewed for tricuspid and mitral valve regurgitation, right ventricle size and function, and left ventricle size and function. A percent predicted VO<sub>2</sub> and O<sub>2</sub>pulse < 80% were considered abnormal for CPET. Echo results were compared to demographics, CPET findings and patient symptom survey response using Chi-square and Student-t tests.

**Results:** 338 patients meeting study criteria were identified; 81% (274/338) were male with a median age of 15 years [IQR 14-16], BMI 18.4 kg/m<sup>2</sup> [IQR 16.7-19.6], HI 4.7 [IQR 3.9-5.8], and CI 33.1% [IQR 25.0-44.0]. 18% (62/338) patients had an abnormal Echo, the most common abnormality was tricuspid regurgitation occurring (61.6% (32/62)). Patients with abnormal Echo findings compared to those with a normal Echo had no significant difference in age, BMI, HI, CI, abnormal CPET results, or reported symptoms, Tables 1 and 2.

Table 1

	Abnormal Echo	Normal Echo	p-value
Age, years	15.1±1.8	15.2±1.9	0.683
BMI	18.4±2.4	18.4±2.6	0.856
Haller index	6.8±8.7	5.5±5.6	0.93
Correction index	39.4±17.6	35.2±14.0	0.126
% Predicted Peak VO <sub>2</sub>	73.9±14.2	72.8±14.2	0.558
% Predicted Peak O <sub>2</sub> pulse	83.0±19.4	79.9±18.2	0.298

Comparison of continuous variables between patients with abnormal (n=62) and normal (n=276) echocardiograms. Values are mean +/- standard deviation.



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Table 2

	Abnormal Echo % (n)	Normal Echo % (n)	p- value
Male	77.4 (48)	85.1 (235)	0.136
Precent predicted peak V02 < 80%	66.1 (41)	70.3 (194)	0.52
Precent predicted peak O2pulse < 80%	47.5 (29)	55.4 (148)	0.265
Shortness of breath at rest	17.7 (11)	20.3 (56)	0.649
Shortness of breath with exercise	50.0 (31)	59.8 (165)	0.158
Lack of endurance	45.2 (28)	52.5 (145)	0.294
Chest pain at rest	19.4(12)	23.2 (64)	0.514
Chest pain with exercise	27.4 (17)	36.2 (100)	0.187

*Comparison of categorical variables between patients with abnormal (n=62) and normal (n=276) echocardiograms.*

**Conclusions:** Patients with normal right and left ventricular size and function and without tricuspid or mitral valve regurgitation on Echo were just as likely to have abnormal CPET result, shortness of breath and chest pain as those with an abnormal Echo. Worsening PE severity as represented by HI and CI did not correlate with Echo results. Echo is a poor predictor of cardiopulmonary performance and symptomology in patients with PE.

**Keywords:** Pectus Excavatum, Cardiopulmonary function, Echocardiogram, CPET



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## YIA-09 USEFULNESS OF ULTRASONOGRAPHIC GUIDANCE FOR ACCURATE BAR FORCE APPLICATION IN PECTUS EXCAVATUM

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**Background and Aim:** In the Nuss procedure, it is important to precisely apply bar force to the target points of the deformed area to obtain the ideal thoracic morphology. From this standpoint, the insertion point of the bar is critical. This position is ordinarily determined with reference to the most concave point of the sternum, usually at the caudal end. However, we have encountered cases in which the sternum was not elevated to a sufficient height during the operation, and a localized concave deformity later appeared in the epigastric area. Since the caudal portion of the sternum is routinely determined by palpation only, we evaluated the usefulness of preoperative ultrasonography (US) examination of the epigastric area to assess the target point of the sternum for obtaining the intended thoracic morphology.

**Method:** We prospectively enrolled 42 patients who underwent the Nuss procedure at our hospital. Mean age at surgery was 11.8 years (range: 11-18 years). After positioning the patient for surgery, the caudal end of the sternum was first marked as identified by palpation, and next was identified by US. The distance between the two points was then compared.

**Results:** The points determined by palpation and US were different in all cases. US revealed that the part of the sternum considered to be the caudal end by palpation was frequently composed of cartilaginous tissues. The mean distance between the two points was 12.5±5.3 mm (range: x-y mm).

**Conclusions:** During the Nuss procedure, the position at which the bar was placed as determined by palpation was inadequate in many cases, even considering bar width (12 mm). US guidance may be useful to apply bar force to target points more accurately.

**Keywords:** Nuss procedure, ultrasonography, surgical treatment

**YIA-10 SURGERY IN PRIMARY TUMORS OF THE CHEST WALL: A SINGLE CENTER EXPERIENCE**

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**Background and Aim:** Primary chest-wall tumors are rare and include a large group of neoplasms that can arise from bone or cartilage of the chest wall. In this study, surgical outcomes of patients who were operated for CW primary tumors were analyzed on the institutional experience our center.

**Method:** Between January 2010 and December 2023, 28 patients who were operated for primary chest wall tumor in our clinic were retrospectively analyzed. Synthetic grafts and/or plates were used for reconstruction. Ten patients with malignant chest wall tumors were operated with free margins of 4 cm from the tumor. 18 patients with undiagnosed or benign chest wall tumors were operated with free margins of 2 cm from the tumor.

**Results:** Ten (35.7%) of the patients were female and 18 (64.3%) were male. The mean age was 38.7+/-12.63 years. Of the patients, 9 (32.1%) were malignant and 19 (67.9%) were benign. The tumor was localized in the ribs in 26 (92%) patients, and in the sternum in two (8%) patients. The most common malignant tumor was chondrosarcoma in 9 (32.1%) patients, and the benign tumor was fibrous dysplasia in 6 (21.4%) patients. The average hospital stay was found to be 3.42 +/- 2.65 days. No postoperative death was observed in our cases. Considering the negative surgical margin in the pathology reports, our patients with malignancy were not given adjuvant or radiotherapy. One of our patients (3.5%) who underwent clavicle and multiple rib resections had pulmonary and pleural metastases one year after the operation, and wedge resection and pleurectomy were performed. The mean follow-up period of the patients was 60.45 +/- 35.4.

Picture



**Conclusions:** Successful results with acceptable morbidity and mortality can be achieved with resections performed with safe free margins in primary chest wall tumors.

**Keywords:** chondrosarcoma, fibrous dysplasia



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## YIA-11 ABRAMSON PROCEDURE OR BRACE SYSTEM FOR THE TREATMENT PECTUS CARINATUM IN PEDIATRIC PRACTICE.

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**Background and Aim:** Background: Pectus carinatum is considered the second-most common cause of thoracic malformations. The condition is often asymptomatic, with patients seeking treatment for cosmetic reasons. Management alternatives have shifted from open resective to minimally invasive strategies, and finally, to reshaping the chest using both surgical and non-surgical modalities. The first report on non-resective extrathoracic treatment of pectus carinatum, was by Abramson. In 2008, Martinez-Ferro published an 8-year review on the use of a specially designed dynamic compression system. The analysis of the experience of foreign colleagues in the field of PC, presented at the XXI International Congress of CWIG (Seoul, South Korea, 2018), forced us to reconsider our attitude to the correction method in favor of non-surgical treatment. This study examines our experience in the treatment of children with pectus carinatum.

**Method:** retrospective review of 69(N) patients who underwent minimally invasive repair of pectus carinatum deformity between 2011 and 2022 was performed. We applied two different techniques, the original Abramson procedure (22patients-31,9%) and from 2018 brace system (47 patients-68,1%).

**Results:** Abramson procedure: the mean age of the patients was  $15 \pm 2$  years. The mean operative time was 118min. The mean hospital stay was  $7 \pm 1$  day. The bars were removed at a median of  $30 \pm 6$  months in 10 of 22 patients with the following results: 8 excellent, 2 good. Brace system: the mean age of the patients was  $13 \pm 3$  years. Mean utilization time was 16 hours daily for 18 months  $\pm 1$  month. Recurrence of pectus carinatum after removal of the compressive brace occurred in 2 (4,3%) of the total 47 patients. These patients stopped wearing the compressive brace against our advice. Total of 45 (95,7%) of 47 had good to excellent results scoring.

**Conclusions:** brace system is a safe and effective alternative to both invasive surgical correction and no treatment for PC in children. Compliance is critical to the success of this management strategy.

**Keywords:** pectus carinatum, Abramson, brace system.



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## YIA-12 CRYOABLATION VERSUS SUBCUTANEOUS CATHETERS VERSUS EPIDURAL: AN ANALYSIS OF >10 YEARS UTILIZING DIFFERENT ANALGESIC MODALITIES AFTER ADULT PECTUS EXCAVATUM REPAIR

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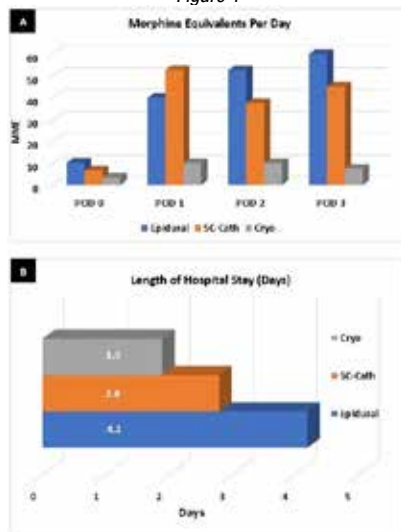
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**Background and Aim:** Pain control following minimally invasive repair of pectus excavatum (MIRPE) in adults has been challenging. We present our experience and results over >10 years utilizing different analgesic modalities including epidural, elastomeric continuous infusion subcutaneous catheters (SC-Cath), and intercostal nerve cryoablation (Cryo).

**Method:** Medical records of adults (>18 years old) who underwent only primary MIRPE at Mayo Clinic Arizona from October 2010 to December 2021 were retrospectively reviewed. Excluded were cases with the potential of additional pain stimulus as well as open, hybrid, revision procedures or those with concurrent procedures. Patients were classified into 3 groups for analysis based on pain control method utilized: Epidural, SC-Cath, and Cryo. Outcomes analyzed included duration of surgery, length of hospital stay, use of narcotics in-hospital, and 30-days complications. The majority of patients participated in a standardized enhanced recovery pathway. Continuous data was reported as mean  $\pm$  standard deviation or median (interquartile range) according to distribution, and categorical variables were reported as count (percentage).

**Results:** In total, 729 patients were included (67.1% males, mean age 30.9  $\pm$  10.3 years old, Haller Index 4.8  $\pm$  3.0). Overall, the Cryo cohort required significantly lower doses of morphine equivalents ( $p < 0.001$ ) during hospitalization. They also had the shortest hospital stay (mean 1.9  $\pm$  1.5 days,  $p < 0.001$  for the comparison) with <17% staying  $\geq 2$  days (versus Epidural 94% and SC-Cath 48%,  $p < 0.001$  for the comparison). A lower incidence of complications related to constipation and ileus ( $p < 0.001$ ) was observed in the Cryo group however, a higher incidence of pleural effusions requiring thoracentesis occurred ( $p = 0.024$ ). There were no other significant differences found regarding complications.

Figure 1



Panel A: Morphine equivalents per day used by every group from post operative day (POD) 0 till 3. Panel B: Mean length of hospital stay of each group.



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Table 1: Major Findings

	Group 1 (Epidural) N=90	Group 2 (Subcutaneous catheters) N=428	Group 3 (Cryoablation) N=211
spital stay, days (mean $\pm$ SD)	4.2 $\pm$ 1.2	2.8 $\pm$ 1.2	1.9 $\pm$ 1.5
stayed >2 days, n (%)	85 (94.4%)	206 (48.1%)	35 (16.6%)
urgery, minutes (mean $\pm$ SD)	149.9 $\pm$ 50.6	157.9 $\pm$ 60.2	155.7 $\pm$ 45.1
illigram equivalents per day, median (IQR)			
e day 0	10.2 (21.1) (N=90)	6.6 (11.9) (N=428)	3.4 (6.4) (N=211)
e day 1	39.8 (58.8) (N=90)	52.7 (41.4) (N=428)	10.0 (17.1) (N=211)
e day 2	52.5 (51.4) (N=90)	37.5 (37.5) (N=426)	10.0 (20.6) (N=116)
e day 3	60.0 (52.5) (N=85)	45.0 (50.0) (N=206)	7.5 (22.5) (N=35)
ns (significantly different across groups), n (%)			
ion requiring thoracocentesis	5 (5.6%)	19 (4.4%)	21 (9.9%)
	6 (6.7%)	9 (2.1%)	0 (0.0%)
g ER visit or affecting oral intake	5 (5.6%)	5 (1.2%)	0 (0.0%)
nificant constipation	23 (25.6%)	105 (25.5%)	11 (5.2%)
requiring ER visit or prolonging discharge	9 (9.0%)	9 (2.1%)	4 (1.9%)

**Conclusions:** Intercostal nerve Cryoablation for postoperative pain control along with enhanced recovery pathways showed significant benefits in postoperative pain control with less opioid use and a lower incidence of ileus and constipation when compared to other analgesic modalities.

**Keywords:** Pectus excavatum, Nuss procedure, Cryoablation

**YIA-13 PECTUS REPAIR SMALL MONTENEGRO SERIES**

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<sup>2</sup>*Marmara University Pendik Training and Research Hospital*

**Background and Aim:** Most common deformities of the sternum are pectus excavatum and carinatum. The aim of this study is to assure an overview after pectus repair with minimally invasive and open technique .

**Method:** In Clinical center of Montenegro we underwent correction of 9 pectus patients . The mean age of the patients was from 12-18 years old. All patients was with estetic problems. We analyzed, esthetic result, post-operative pain, operative technique and time , length of hospital stay and complications.

**Results:** After the operative procedure, we achieved satisfactory esthetic results in all patients after bar placement in 93-98 % . We operated 5 Nuss cases, 3 Abramson cases, and one modified case. Post-operative pain was not significant. The operative time was on average from 45 min to 75 min. The mean hospital stay was 5 days. We don't have postoperative complications

*MIRPE sec NUSS Cross bar*



*MIRPE sec NUSS*



**Conclusions:** Pectus repair through Nuss and Abramson procedure is effective and safe. Its efficacy is demonstrated by the excellent to satisfactory results from 93% to 98.% of patients after correctional bar placement. The pectus repair has low morbidity and excellent cosmetic results in the treatment of pectus deformities in selected patients.

**Keywords:** Chest wall deformity, Pectus, Pectus repair





## YIA-14 RECONSTRUCTION OF THE CHEST WALL USING 3D-PRINTED POLYETHYLENE ESTER KETONE (PEEK) PROSTHESIS

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**Background and Aim:** Chest wall reconstruction using 3D-printed (3DP) implants is a relatively new frontier. In majority of such cases, metal implants such as titanium are used. Non-metallic 3DP implants have been rarely used in chest wall reconstruction. We describe our experience using 3DP Polyetheretherketone (PEEK) implants in 2 patients.

**Method:** Patient 1: A 65-year-old male, with history of diabetes, COPD, and rheumatoid arthritis on immunosuppressive medications, underwent 3-vessel coronary bypass surgery. This was complicated by sternal infection, requiring multiple sternal debridements and partial sternectomy. He developed a wide midline gap with unstable sternum, lung herniation, and severe dyspnea requiring supplemental oxygen. After wound vac therapy and IV antibiotics for 6 weeks, the chest wall was reconstructed using customized 3DP PEEK sternal prosthesis, bilateral pectoralis major and right rectus muscle advancement flaps, and split-thickness skin graft. Patient 2: A 44-year-old male with a history of head and neck cancer, treated with resection and chemoradiation. He developed right lower lobe lung oligometastatic squamous cancer with chest wall invasion and pathological fractures. He underwent elective thoracotomy with en-bloc segmental resection of 3 (6th to 8th) ribs using customized 3DP cutting guides and bilobectomy. The chest wall was reconstructed with ovine rumen-derived composite permanent tissue matrix, 3DP PEEK individual rib prostheses and latissimus dorsi flap.

Figure 1



Intraoperative image of Patient 1 showing midline sternal defect (left) and reconstructed chest wall with 3D Printed prosthesis (Right)

Figure 2



Intraoperative image of Patient 2 showing post-resection chest wall defect (left) and after reconstruction with 3D Printed customized rib prosthesis (Right)



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**Results:** Patient 1 was discharged on POD 21 to rehabilitation and followed for over a year with no complications related to the chest wall surgery. His supplemental oxygen was eventually discontinued. Patient 2 underwent surgery on POD 14 to evacuate a loculated pleural effusion and was discharged on POD 21 to home. He was followed postoperatively for 4 months, at which time he developed spinal metastases and deceased soon after.

**Conclusions:** PEEK, a non-metallic, MRI-compatible material with bone-like mechanical properties, can be used as an alternative to metals for customized 3DP chest wall reconstruction.

**Keywords:** Chest wall, PEEK, 3D-Printing, Pectus, Reconstruction, Prosthesis



## YIA-15 OUR EXPERIENCE CORRECTION ACQUIRED PECTUS CARINATUM (APC) AFTER OPEN HEART SURGERY.

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**Background and Aim:** APC is a violation of the chest frame after sternotomy, and formed asymmetry of the sternum, no fusion or no healing of the sternum. This study Aim is Estimate the effectiveness of correction APC using an orthosis after sternotomy in children.



**Method:** We have examined 36 children ages 3 to 14 of APC. We divided the patients into two groups depending on the beginning of the correction after sternotomy: 1 group: 27 (75.0%) from 6 to 18 months, 2 group: 9 (25.0%) from 18 months to 2,5 years. According to types of deformation: symmetrical in 23 (64.0%) and asymmetrical - in 13 (36.0%). All patients underwent EchoCG, ECG, X-ray, MRI of the chest, the value was determined degree of deformity and "reaction of heart" to the procedure. Cardiac reactions were assessed before and after bracing under control EchoCG, then every 2 weeks. The treatment takes about 15 months.

**Results:** We noted positive results within 12 months in 24 (66.7%) from the first group (almost complete correction of the chest wall visually and according to MRI), 3 (8.3%) of this group continued the bracing for a longer period (about 15 months), their correction was incomplete. In the 2 of group, result is positive in 4 (11.1%) but in a longer period more than 15 months, in 2 (5.6%) of this group treatment continues about 2 years, their correction was incomplete. In 3 (8.3%) of patients were unsatisfactory.

**Conclusions:** The conservative method for correcting APC after sternotomy by bracing can be effective if it is used early in 6-18 months. After 6 months opening heart surgery is complete healing of the skin and cardiac scar. The healing of the chest bone takes longer periods, so the correction of deformity is possible. At more 2 years after sternotomy is unadvisable to start chest correction, this time already formed callus, therefore, in the 2nd group was less effective.

**Keywords:** Acquired Pectus Carinatum (APC) after open heart surgery., using an orthosis after sternotomy, "reaction of heart" to the procedure, At more 2 years after sternotomy is unadvisable to start chest correction



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## YIA-16 RECENT ADVANCEMENT IN PECTUS SURGERY: CRANE LIFTING, MULTIPLE-BAR, BRIDGE STABILIZATION, AND SANDWICH TECHNIQUE

Rajkamal Vishnu Sudha Krishnagopal<sup>2</sup>, Gongmin Rim<sup>1</sup>, Seung Keun Yoon<sup>1</sup>, Hyung Joo Park<sup>1</sup>

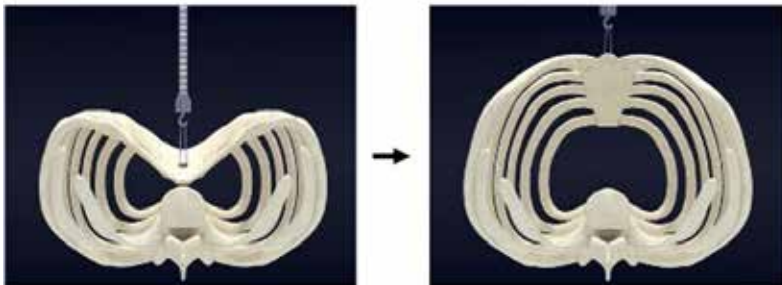
<sup>1</sup>Seoul St. Mary's Hospital, The Catholic University of Korea and Nanoori Hospital, Seoul, South Korea

<sup>2</sup>SRM Institutes for Medical Science, Chennai, India

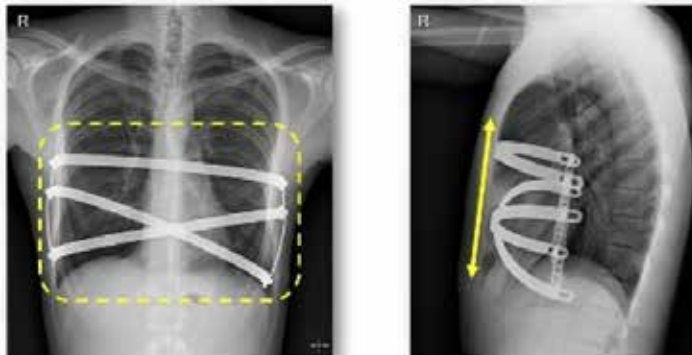
**Background and Aim:** This study aims to demonstrate how recent developments to the procedure have made it safer and more efficient. The most current procedure is known as “crane- powered entire chest wall remodeling,” employing the techniques of crane lifting, multiple-bar, bridge stabilization, and sandwich techniques. This approach resulted in shifting the paradigm of pectus deformity repair from merely lifting the sunken bone to remodeling the chest wall to normal anatomy.

**Method:** Between March 2018 and January 2022, we operated on 649 patients with pectus deformities who had pectus excavatum, pectus carinatum, or complex combined deformities. The crane was used to lift fully without using the pectus bar’s turning power. This was done by sternal wiring or sternal screwing. Multiple-bars were placed with bridge connections to form a secure cage structure. The sandwich techniques are applied to remodel carinatum deformities and to relieve the lower costal flare (flare-buster) and the focal protuberance (magic string).

*Total Crane Pre-lifting( Screw Crane)*



*Entire Chest Wall Remodeling( XI Technique)*





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**Results:** The mean age of patients was 12.2 years (range: 3-45 years). A single bar was used in 196 patients until 2021. For the multiple-bars technique, the cross bars (n = 178), parallel bars (n = 140), and crossbar plus upper horizontal bar (the XI pattern, n = 135) were used. The overall complication rate was 16%. There was no case of bar displacement, but other minor complications occurred were pneumothorax (n = 21, 3.3%), pleural effusion (n = 11, 1.7%), and wound infection (n = 3, 0.47%). Three patients required reoperation (infection 2, hemorrhage 1).

**Conclusions:** The crane-powered entire chest wall remodeling technique utilizing total crane lifting, multiple-bars, bridge stabilization, and sandwich techniques seems a safe and effective approach to all varieties of pectus deformities. We have resolved the issues of bar displacement and insufficient repair resulting in residual deformity after surgery, leading to more aesthetically pleasing and functionally improved outcomes.

**Keywords:** Pectus Surgery, Crane Lifting, Sandwich Technique, Multiple-Bar, Bridge Stabilization, XI Technique

**YIA-17 PECTUS REPAIR AFTER PRIOR STERNOTOMY: CLINICAL PRACTICE REVIEW AND PRACTICE RECOMMENDATIONS BASED ON A 2200 PATIENT DATABASE**

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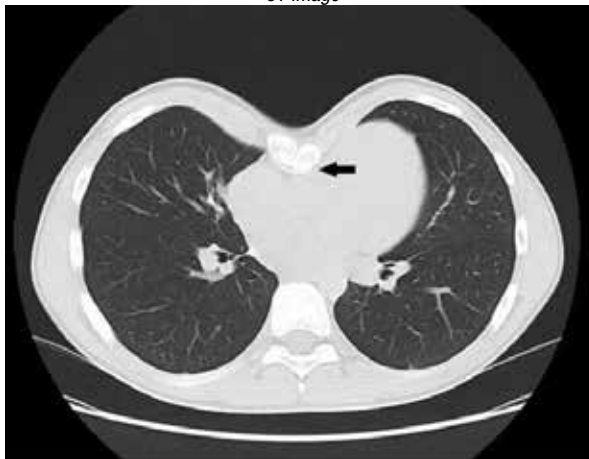
<sup>2</sup>*Eastern Virginia Medical School*

**Background and Aim:** The minimally invasive repair of pectus excavatum (MIRPE) is widely accepted as a method of pectus excavatum (PE) repair. Repair is rarely performed in patients with a history of median sternotomy. A feared complication of this procedure is iatrogenic cardiac injury; the risk of injury in patients with prior sternotomy is especially high due to the development of post-surgical retrosternal adhesions, which obscures the “critical view” during MIRPE. A 14-center review reported the incidence to be as high as 7% after analyzing 75 patients with history of sternotomy who underwent MIRPE.

**Method:** A review of the literature and a retrospective review of over 2200 patients who underwent MIRPE at our institution was performed to analyze 9 patients who underwent MIRPE after prior sternotomy. An IRB-approved (01-05-EX-0175-HOSP) retrospective review was performed from 1/1/1997 to 9/1/2022 to query these patients (Table 1).

**Results:** A total of 9 patients were found to have undergone MIRPE after previous median sternotomy. The age of patients ranged from 9 to 24 years of age. Most of the patients underwent previous sternotomy for repair of various cardiac conditions, while 2 of the 9 patients underwent sternotomy for non-cardiac reasons, including one who had previously undergone a Ravitch procedure. Iatrogenic cardiac injury occurred in 2 patients. Evaluation of the preoperative CT scans in these cases demonstrates the location of sternal wires on cross-sectional imaging of a patient who suffered iatrogenic cardiac injury (Figure 1).

*CT image*



*Figure 1. Pre-operative axial non-contrasted CT image of a patient who suffered intra-operative cardiac injury during MIRPE, with history of prior sternotomy. The arrow highlights the sternotomy wire.*

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**Table 1. MIRPE Patients with History of Median Sternotomy at Single Institution, 1997 – 2022**

Age of MIRPE (years)	Age of prior sternotomy	Reason for Sternotomy	# of bars placed	EBL (mL)	Thoracoscopy	Method of Sternal Elevation	Grain prepped	CT Surgery present	Cardiac injury	Noted details of MIRPE procedure
13	4 years	ASD repair	2	5	yes	manual elevation with retractor	no	no	no	DSRD <sup>vi</sup> was performed by the pediatric surgeon for retrosternal dissection.
9	3 days	sternal cleft repair	2	< 5	yes	vacuum bell	no	no	no	
17	4 months, 6 months	VSD <sup>vii</sup> repair, aortopexy	2	< 5	yes	manual elevation with retractor	no	yes	no	DSRD was performed by CTS <sup>iii</sup> for retrosternal dissection.
17	newborn	TGA-IAA <sup>viii</sup> repair	2	10	yes	manual elevation with retractor	no	yes	no	DSRD was performed by CTS for retrosternal dissection.
15	3 years	VSD and ASD repair	1	2000	yes	none	no	yes, after injury	yes	Cardiac injury occurred during passage of a second bar. Median sternotomy was performed by CTS for repair of right ventricular injury. MIRPE was not completed.
14	9 months	atrioventricular canal defect repair	2	5	yes	none	yes	yes	no	CTS was present for retrosternal dissection.
24	20 years	Rawitch procedure	1	100	yes	N/A, elevation was performed	no	no	no	Rawitch repair was opened, sternum was dissected down to include a sub-xiphoid window, DSRD was performed.
17	1 years	pericardial patch closure of an ASD	2	15	yes	crane retractor	yes	yes	no	CTS performed DSRD.
19	newborn, 2 years	BT <sup>ix</sup> shunt ligation, RVOT <sup>x</sup> reconstruction with transannular patch and ASD closure	1	25	yes	crane retractor	yes	yes	yes	CTS performed DSRD, cardiac injury occurred during this dissection and was repaired without re-sternotomy.

*i – atrial septal defect; ii – Direct sub-xiphoid retrosternal dissection; iii – ventricular septal defect; iv – cardio-thoracic surgery; v – transposition of great arteries and interrupted aortic arch repair; vi – Blalock-Taussig shunt; vii – right ventricular outflow tract*

**Conclusions:** Given the infrequency in our experience and the low numbers reported in the literature, statistical conclusions cannot be drawn. However, prudent strategies based on this experience include use of thoracoscopy, routine sternal elevation, direct sub-xiphoid retrosternal dissection, coordination with cardio-thoracic surgeons, preparation for cardio-pulmonary bypass, and massive transfusion protocol availability to optimize surgical outcomes in patients undergoing MIRPE with a history of sternotomy.

**Keywords:** Median Sternotomy, Minimally Invasive Repair of Pectus Excavatum, Nuss Procedure, Pectus Excavatum



**YIA-18 OUTCOMES ASSOCIATED TO CUSTOM-MADE 3D-PRINTED SILICON PROSTHESES FOR PECTUS EXCAVATUM REPAIR**

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**Background and Aim:** Optimal pathways for Pectus Excavatum (PE) treatment have not been standardised and indications among trusts can differ significantly. The use of custom-made silicon prostheses (CmSP) is now a recognized feasible option for those who don’t suffer from severely impacted cardiopulmonary function (CPf). Nonetheless, it suffers from poorly known Morbidity&Mortality (M&M) outcomes.

**Method:** All consecutive patients undergoing CmSP insertion between 2019-2022 at a single centre were included. Primary outcomes were short- and long-term M&M (TM&M Ottawa system), postoperative length of stay (pLOS), pain score on day1, antibiotics usage, need for reintervention and recurrence. A homogenous Nuss population has been employed for comparison.

**Results:** 43 CmSP patients were included. Median age was 17 years (15-25) and 81.4% (35/43) were male. 88.3% (33/43) had PE, 4.65% (2/43) pectus arcuatum and, 9.3% (4/43), pectoralis muscle agenesis in Poland syndrome. N=14 Nuss patients with unimpacted CPf were included. In Table 1 results are reported. No intraoperative complications, no need for transfusion and no returning to theatre within 30 days were encountered. No difference was found concerning pain score. Need for postoperative antibiotics was significantly higher for Nuss. Interestingly, TM&M registered a complication rate of 81.4% (35/43) and 92.8% (13/14) in CmSP and Nuss (p=0.42). 95.8% (46/48) of them were grade 1-2 (minor complications). Interestingly, Nuss’s median grade was I (apical pneumothorax), whereas CmSP’s median grade was II (100% (34/34) seroma requiring needle aspiration).

*Table 1: Short-term and long-term surgical outcomes after custom-made silicon prosthesis for Pectus Excavatum*

	Custom-made silicon prostheses	Nuss	p
Mean operative time (min)	87.8 (±32.8)	78.3 (±35.3)	0.35
Mean anaesthesia time (min)	125 (±34.5)	179 (±53.5)	0.024
Mean pLOS (days)	2.21 (±0.94)	7.29 (±5.88)	<.0001
Median visual analogue scale for pain on Day 1	4 (IQ 1-5)	3 (IQ 1-6)	0.928





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	Custom-made silicon prostheses	Nuss	p
Postoperative antibiotic therapy (%)	18.6% (8/43)	71.4% (10/14)	0.0005
TM&M postoperative complications (%)	81.4% (35/43)	92.8% (13/14)	0.42
TM&M postoperative complications (grade I-V)	II (I-IIIa)	I (I-IIIb)	<.0001
Mean Follow-Time (months)	8.6 (±7.4)	10.3 (±5.4)	0.51
Need for reintervention (%)	9.3% (4/43)	100% (14/14)	
Recurrence (%)	2.3% (1/43)	0	

**Conclusions:** CmSP and Nuss procedures are commonly performed for PE. They can be used for different typed of PE and sometimes can be used jointly to achieve optimal results. Interestingly, TM&M reported a reduced median grade of complications following Nuss. Being CmSP a custom-made implant, it may provide superior cosmetic outcomes and higher patients' satisfaction. Body uneasiness is now being tested for further comparison with validated questionnaires.

**Keywords:** Custom-made implants, Pectus excavatum, Poland syndrome, Silicone Implants, Outcomes in thoracic surgery, Sternal prosthesis



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## **YIA-2 AUTOMATIC IMPLANT SHAPE DESIGN FOR MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM USING DEEP LEARNING AND SHAPE REGISTRATION**

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<sup>2</sup>*Department of Thoracic Surgery, Beijing Children's Hospital, Capital Medical University, National Center for Children's Health*

**Background and Aim:** NUSS procedure is an effective method for correcting pectus excavatum (PE). In NUSS procedure, a long, thin, curved stainless plate is placed across the thoracic cage to correct the deformity. However, the implant curvature depends on the surgeon's expert knowledge and experience and lacks objective criteria in most cases.

**Method:** A novel three-step end-to-end automatic framework is proposed to determine the implant shape during preoperative planning in our study: (1) The deepest depression point (DDP) in the sagittal plane of the patient's CT volume is automatically determined using Sparse R- CNN-R101, and the axial slice containing the point is extracted. (2) Cascade Mask R-CNN- X101 segments the anterior intercostal gristle of the pectus, sternum and rib in the axial slice, and the contour is extracted to generate the PE point set. (3) Robust shape registration is performed to match the PE shape with a healthy thoracic cage, which is then utilized to generate the implant shape. The framework was evaluated on a CT dataset of 90 PE patients and 30 healthy children.

**Results:** The experimental results show that the average error of the DDP extraction was 5.83 mm. The end-to-end output of our framework was compared with surgical outcomes of professional surgeons to clinically validate the effectiveness of our method. The results indicate that the root mean square error (RMSE) between the midline of the real implant and our framework output was less than 2 mm.

**Conclusions:** Using deep learning and shape registration can be one of the methods for the automatic implant shape design for minimally invasive repair of pectus excavatum.

**Keywords:** Pectus excavatum, Surgical planning, Object detection, Instance segmentation, Shape registration



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**VIDEO  
PRESENTATIONS**



**VA-1 RECONSTRUCTION OF CHEST WALL WITH A DYNAMIC 3D PROSTHESIS**

Jose Ramon Cano<sup>1</sup>, Donato Monopoli<sup>2</sup>, Wolker Tavares<sup>1</sup>, Belinda Mentado<sup>2</sup>, Ricardo Medina<sup>1</sup>, Michelle Leung<sup>1</sup>, David Pérez<sup>1</sup>

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<sup>2</sup>*Biomedical Engineering Department. Instituto Tecnológico de Canarias*

**Background and Aim:** We present a 73-year-old woman with a history of breast prosthesis, tumor in the right breast that after removal of the prosthesis is reported as undifferentiated pleomorphic sarcoma. We describe the chest wall resection and reconstruction con dynamic 3D prosthesis.

**Method:** The CT scan showed a right breast mass with involvement of the 4th to 8th right costal arch. She was treated with preoperative chemotherapy with poor response. 3D CT reconstruction was performed to assess resection. With biomedical engineers we designed a dynamic prosthesis to cover the wall defect. A titanium prosthesis was 3D printed and fixed to the sternum with 4 movable ribs. A block resection of the right breast, pectoral muscles, serratus major and partially the latissimus dorsi together with the costal arches from 4th to 8th to the sternal border was performed. Reconstruction of the wall is performed with 3D prosthesis that is fixed to the sternum with self-locking screws and ribs with Dall Miles braided wire system and gore-tex mesh. A muscle flap was made with the rest of the latissimus dorsi muscle by plastic surgery. After 48 hours flap necrosis was observed, the patient was reintervened and a new flap was made with anterior rectus abdominis muscle and anastomosis of the inferior epigastric vein of the flap to cephalic vein was performed to improve venous drainage.

**Results:** The patient was discharged after 10 days with good mobility and ventilatory mechanics.

**Conclusions:** Personalized 3D printed dynamic prostheses provide a good correction in large chest wall defects, while not limiting the patient's ventilatory mechanics and facilitating surgery.

**Keywords:** Chest wall reconstruction, Dynamic prosthesis, Custom 3D prosthesis



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## VA-2 SIZE SELECTION AND SHAPING OF PECTUS BARS AIDED BY FREE SOFTWARE - A STEP-BY- STEP GUIDE FOR THE MIRP NOVICE.

Tibor Krajc<sup>1</sup>, Michal Benej<sup>1</sup>, Thomas Klikovits<sup>1</sup>, Vladyslav Getman<sup>1</sup>, Stefan Watzka<sup>1</sup>, Clemens Aigner<sup>1</sup>

<sup>1</sup>*Department of Thoracic Surgery, Klinik Floridsdorf, Vienna Health Network*

**Background and Aim:** Selecting the proper size and shape of the pectus bars can be challenging without sufficient experience, despite the use of bending templates. Free software allows for 3D modeling of the deformity, accurate shaping and positioning of bars within the model, as well as production of 2D printouts of corresponding bar outlines to scale.

**Method:** DICOM data are imported into 3D Slicer (slicer.org) and a surface model of the bony and cartilaginous chest is created by using the threshold method. The smoothed model is decimated to a face count of <100.000 in Surf Ice (nitrc.org/projects/surface) to increase processing speed in following steps. In Blender (blender.org), bar models are positioned at the level of appropriate intercostal spaces in orthographic view to create corresponding skeletal cross sectional slices. A Bézier curve is molded and used as a modifier for bar shaping, using most anterior parts of given bony ribs as the supporting points. Final adjustments of bars, including overcorrection and planning of fixation points, are possible. Final bar outlines are exported (Outline To SVG, makertales.gumroad.com) into a vector image, in turn converted to PDF in Inkscape (inkscape.org) and printed along with an integrated ruler for scale verification, and sterilized for intraoperative use.

**Results:** Creating surface models of bars of most sizes as well as pre-shaped Bézier curves, and establishing a sequence of defined steps helped reduce the manual input and time needed to achieve a printable result. Our initial intraoperative experience was surprisingly satisfying in terms of bar shaping and fixation, without need for readjustment or reinsertion.

**Conclusions:** Preoperative 3D planning of MIRP to appropriately define bar size and shape can be achieved with freeware on standard hardware (PC/Mac/Linux). Including 3D planning helps patients better understand their surgery, has the potential to improve surgeon's comfort, reduce operating time, and contribute to a satisfactory final result.

**Keywords:** pectus deformity, MIRP (Minimally Invasive Repair of Pectus), 3D planning, bar shaping, freeware



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## VA-3 MODIFY NUSS OPERATION

ARİF NURİ GÜRPINAR<sup>1</sup>, AYŞE PARLAK<sup>1</sup>, FATİH ÇELİK<sup>1</sup>, AMAR SHARBAJİ<sup>1</sup>

<sup>1</sup>Bursa Uludağ University Department of Paediatric Surgery

**Background and Aim:** To present the Modified Nuss Surgery technique, which we have been using in 120 patients since 2006 in our clinic.

### MODIFIED NUSS SURGERY

**Method:** The highest intercostal distance on both sides of the deepest part of the deformity was marked. The slots of the stabilizers were prepared with bilateral incisions from the lines drawn perpendicular to these points from the anterior axillary line. 5 mm trocars were inserted through the right and left intercostal space for optics so that the deepest part of the deformity could be seen directly from the front. The first attempt was always made from the left side. An endoscopic dissector was inserted through a lower space of the trocar. Vacuum was applied to the deformity. Then, the porous tissue between the sternum and the pericardium was dissected with an endoscopic dissector under direct vision, and a tunnel was created under the sternum and entered on the right side. A Nylon tape was inserted into the thorax with a clamp at the highest intercostal point previously determined on the right side as a gayt. This gayt was retained by the dissector in the thorax. It was pulled out from the intercostal space on the left side. Then, a clamp was inserted into the thorax from the highest left intercostal space and this gayt was taken out from the left upper intercostal space. The bar opening prepared according to the patient was placed upwards, with the help of a nylon tape. Then, the bar stabilizers were attached and fixed to the chest wall by inverting.

**Results:** we presented the video of this surgery.

**Conclusions:** It can be said that the Modified Nuss Surgery performed with this technique is both easy and safety.

**Keywords:** MODIFIED NUSS SURGERY

## VA-4 HAMMOCK TECHNIQUE DURING MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM OF THE RIGID ADULT CHEST WALL: PRELIMINARY FINDINGS

Daniela Sanjurjo<sup>1</sup>, Luzia Toselli<sup>1</sup>, Gaston Bellia-Munzon<sup>1</sup>, Vallee Maxroxia<sup>1</sup>, Marcelo Martinez- Ferro<sup>1</sup>

<sup>1</sup>*Clinica Mi Pectus, Buenos Aires, Argentina*

**Background and Aim:** Tearing of the intercostal muscles after Minimally Invasive Repair of Pectus Excavatum (MIRPE) might lead to recurrence, particularly in adult patients with stiff chest walls. To avoid this, a novel technique, the Hammock Technique (HT), has been reported recently by Dr. Jaroszowski et al. We aim to share our initial experience with HT and assess pectus recurrence using the Lower Vertebral Index (LVI).

**Method:** Retrospective analysis of a cohort of adult patients who underwent MIRPE and HT between October 2020 and March 2023. This technique comprises passing a polyethylene tape including the upper and lower rib of the intercostal space at the emerging point of the transthoracic implant (Figure 1). To evaluate postoperative recurrence objectively, we calculated the LVI from a lateral chest X-ray, as defined by Dervaux et al. in 1989 (Figure 2), performed 7 days postoperative (7dLVI) and 4 months postoperative (4mLVI). Variables analyzed included age, the Haller, Correction, and Titanic indexes, the number of hammocks per patient, intraoperative complications, and LVI.

Figure 1

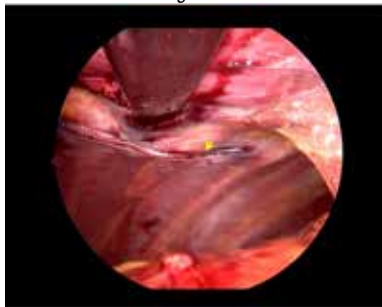


Figure 2



*The Hammock technique. Note the polyethylene tape in the shape of an eight (arrow) including the upper and lower rib of the intercostal space where the transthoracic implant is located.*

*The Lower Vertebral Index was defined as the ratio between the sagittal diameter of the vertebral body at the level of the xiphisternal junction and the minimum sagittal diameter of the chest measured from the posterior surface of the vertebral body to the posterior aspect of the xiphisternal junction.*

**Results:** Eight male patients, with a mean age of  $28.8 \pm 6.3$  years, were included. The mean Haller Index was  $4.9 \pm 1.5$ , the Correction Index was  $40.2\% \pm 16.1$ , and the Titanic Index was  $82.7\% \pm 14.4$ . Regarding the number of hammocks per patient,  $2.5 \pm 0.7$  were made. There were no intraoperative complications. Analyzing the LVI, the mean 7dLVI was  $0.23 \pm 0.04$ , and the 4mLVI was  $0.24 \pm 0.05$  ( $p=0.49$ ).

**Conclusions:** The Hammock Technique was a safe and effective technique to avoid recurrences due to the tearing of the intercostal muscles. The LVI proved to be a simple, efficient strategy to determine PE recurrence.

**Keywords:** Pectus Excavatum, Adults, Recurrence, Hammock

**VA-5 NUSS SURGERY IN A 51-YEAR-OLD PATIENT**

Viktor Markushin<sup>1</sup>, Rustem Hayaliev<sup>2</sup>, Sharif Rakhimiy<sup>2</sup>

<sup>1</sup>*the clinic "Chalet-Sante" (Krasnodar, Russia).*

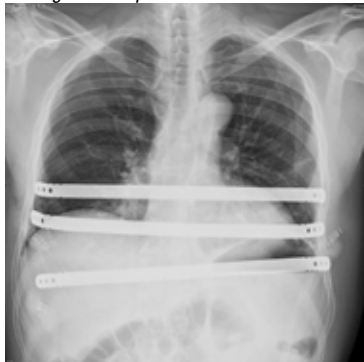
<sup>2</sup>*Multidisciplinary international clinic "Surgemed", Urgench, Uzbekistan*

**Background and Aim:** Pectus excavatum (PE) is the most common congenital chest abnormality, and affects males 5 times more frequently than females. PE results from improper fusion of the ribs with the sternum during embryologic development. The cardinal presenting sign is chest depression. There are limited data on the outcome of Nuss surgery for plastic funnel-shaped chest deformity in adults. For example, Sakamoto Y, et al. (2021) operated on six patients aged 24 to 43 years. After the Nuss operation, the funnel shape of the chest improved in all cases, the thoracic spine of the patients also shifted forward, and the chest shifted forward, and the stoop of the patients decreased. Our goal was to determine the possibility of performing the Nassa operation after 50 years

**Method:** Patient R.O., 51 years old, male, chest changes have been noted since birth. He was operated on as a teenager in a hospital at his place of residence, Ravich's operation was performed with an attempt to correct PE, however, a relapse occurred quite quickly in the postoperative period. In December 2022, an ulcer of the duodenum was detected, treatment was carried out under the supervision of a gastroenterologist under EFGDS control. Continues receiving treatment recommended by a gastroenterologist.

**Results:** The established diagnosis is a PE, symmetrical focal type A 1, after a previously performed Ravich operation, a form not combined with connective tissue dysplasia. Video- assisted installation of metal plates under the sternum was performed (Nuss operation). Plates: support plate CREA-Bar-P KIMPF 34 sm, 34 sm, 34 sm. (fig. 1). Photos before and after the operation clearly show a good functional and cosmetic result (Fig. 2).

*Fig 1. Metal plates under the sternum*



*Fig 2. Foto before and after Nuss operation (51 year old male).*



**Conclusions:** Thus, it can be argued that in the absence of connective tissue dysplasia, the Nuss operation can also be performed in patients over 50 years old.

**Keywords:** Nuss operation, pectus excavatum, correction





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**POSTER  
PRESENTATIONS**

A stylized, glowing blue illustration of a human ribcage is centered in the lower half of the poster. The ribs are depicted as concentric, glowing lines, giving it a three-dimensional, wireframe appearance. The background is a light blue gradient with abstract, curved lines.



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## PA-01 CHEST WALL TUMORS REQUIRING RIB RESECTION: IS RECONSTRUCTION ALWAYS NECESSARY?

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**Background and Aim:** The chest wall is a structure with muscle, connective tissue, bone, and cartilage components. Therefore, tumors of this structure present a great variety. The purpose of this study was to present the results of cases in which a prosthesis was used for chest wall stabilization and primary repair in cases with rib resection.

**Method:** Between 2009 and 2022, patients who presented to our department, with only a mass in the chest wall and underwent chest wall resection were included in the study. Resections due to trauma and congenital deformities, as well as cases with simultaneous chest wall resection, were excluded from the study. Cases were retrospectively evaluated and were statistically compared for length of hospital stay, use of synthetic material, and complications between groups with one and more ribs removed and between groups with tumor size less than 3 cm and 3 cm or more.

**Results:** Thirty-nine cases (11 female, 28 male) with a mean age of 39.02±20.6 years were included in the study. The size of the lesion removed was found to be related to the length of hospital stay, and the number of ribs removed was related to the length of hospital stay. The length of hospital stay and complication rates were similar in patients who underwent reconstruction compared with those who underwent primary repair ( $p>0.05$ ).

**Conclusions:** In cases with a single rib resection, a primary repair is usually sufficient. In this study, the results of primary repair in cases with two and three rib resections were found to be comparable to the results of reconstruction with synthetic materials, and it was considered an option to be considered in selected cases. However, it should be predicted that the length of hospital stay increases with the number of ribs resected and the size of the lesion.

**Keywords:** chest wall tumor, resection, surgery

**PA-02 STERNAL RESECTION AND SEMI RIGID RECONSTRUCTION TO ISOLATED BREAST CANCER METASTASIS TREATMENT**

Máira Kalil Fernandes<sup>1</sup>, Camilla Matos<sup>1</sup>, Caio Chalhoub<sup>1</sup>, Sérgio Tadeu Lima Fortunato Pereira<sup>1</sup>, Ricardo Oliveira<sup>1</sup>

<sup>1</sup>Hospital Santa Izabel

**Background and Aim:** The treatment of isolated sternal metastasis from breast cancer is controversial, and sternal resection may be considered as a form of disease control. In the following case report, the patient with breast cancer underwent thoracectomy with resection of the sternal body and costal arch segments.

**Method:** Case report

**Results:** Female patient, 67 years old, with a history of breast carcinoma treated with neoadjuvant therapy, followed by left breast quadrantectomy and adjuvant treatment with chemotherapy and radiotherapy in 2011. In 2022, the patient had a recurrence of the disease, a single metastasis in the sternum. The patient underwent en bloc thoracectomy covering the tumor, body of the sternum, segments of the 3rd, 4th, 5th and 6th costal arches bilaterally. (Figures 2 and 3). An incision was made with margins of approximately 3 cm, irregularly shaped to preserve subcutaneous tissue. Reconstruction of the chest wall was performed using a 30x30cm polypropylene mesh in a double layer with a 45-degree angle between them in the sternum region. (Figure 4) The plastic surgeon prepared a latissimus dorsi flap and a myocutaneous "Z" flap. (Figures 5 and 6) The patient was extubated in the operating room. Hospital discharge on 8DPO.

Figure 3



Figure 4



**Conclusions:** Isolated sternal metastasis in patients with breast cancer is rare, and thoracectomy is a curative surgical treatment to be offered to these patients. There is no consensus. The ideal materials for reconstruction must be malleable, in order to sculpt the size and shape of the defect, and rigid in order to avoid paradoxical breathing. In the case described, it was not possible to use rigid material to rebuild the wall, and the choice was made to use a double mesh positioned at an angle of 45 degrees between them. This way of using polypropylene screens, fixed to the costal arches without slackness, provides a semi-rigid wall.

**Keywords:** thoracectomy; breast metastasis; sternal metastasis; chest wall reconstruction



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### THE RECONSTRUCTION OF THE CHEST WALL WITH OVITEX™ REINFORCED TISSUE MATRIX AND RIBFIX BLU™ THORACIC FIXATION SYSTEM

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<sup>1</sup>*Department of Pediatric Surgery University Hospital of Hamburg Eppendorf*

**Background and Aim:** Chest wall reconstruction in sarcoma surgery can be challenging, especially when treating children and adolescents. Many different methods of chest wall reconstruction have been described.

**Method:** We report on two cases of extensive chest wall resection in infants with Ewing's Sarcomas and the reconstruction of the pleura using ovine tissue matrix and subsequent fixation using RibFix osteosynthesis

**Results:** After extensive thoracic wall reconstruction in 2 children with Ewing's sarcoma starting from the ribs, a large-area reconstruction of the pleura and stabilization of the surrounding ribs became necessary. We used an ovine tissue matrix to replace the pleura and the RibFix Thoracic Fixation System for stabilization and fixation. In both cases, a complete tumor removal and an adequate reconstruction of the thorax wall were successful. Both children could be discharged from the hospital after about 7 days and found in good conditions in the follow-up

**Conclusions:** In some cases, extensive tumor resections are necessary for complete tumor removal in the case of sarcomas of the chest wall. This poses particular challenges for those treating children and adolescents. The reconstruction using ovine tissue matrix and subsequent RibFix thoracic fixation has given us very good results so far

**Keywords:** Sarcoma, chest wall reconstruction



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## DOES NUTRITION EDUCATION AFFECT ADOLESCENTS WITH PECTUS EXCAVATUM'S NUTRITIONAL STATUS, GROWTH, AND DEVELOPMENT?

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<sup>1</sup>*Acibadem University*

<sup>2</sup>*Istanbul Sabahattin Zaim University*

<sup>3</sup>*Chest Wall Deformities and Pectus Association*

**Background and Aim:** Pectus deformity is thought that abnormalities in the gastrointestinal systems of patients cause growth and developmental retardation. The study aimed to follow the nutritional status and development of growth after nutritional intervention in patients with moderate pectus excavatum.

**Method:** At the beginning of the study, a questionnaire form was applied to the participants using a questionnaire form, in which demographic information, nutritional habits, and physical activity levels were questioned. Food consumption frequency form and 24-hour food consumption record were taken at the beginning of the study to determine nutritional habits. Nutrition education was given to the child and his family by the researcher. At the end of the study, anthropometric measurements and food consumption were taken.

**Results:** Results show that 40 adolescents (77.5% male, 22.5% female), 31 males and 9 females, diagnosed with pectus excavatum and moderate deformity severity participated in the study. At the study's end, the height and weight increases were statistically significant ( $p < 0.001$ ). It was found that the reflux symptoms defined at the beginning of the study decreased, and the increase in the total amount of energy, protein, and fat in the daily diet was significant ( $p < 0.001$ ).

**Conclusions:** This study suggested that nutritional intervention in adolescents diagnosed with moderate pectus excavatum could increase height and body weight. Therefore, referring the patients to a dietician to apply longer-term and improved training models would be beneficial.

**Keywords:** pectus excavatum, medical nutrition therapy, mild deformities

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## RESULTS OF ORTHOSIS APPLICATION IN PEDIATRIC AGE GROUP PECTUS CARINATUM PATIENTS

Esra Yamansavcı Şirzai<sup>1</sup>, Fatih Aydoğan<sup>1</sup>, Serkan Yazgan<sup>1</sup>, Ahmet Üçvet<sup>1</sup>

<sup>1</sup>Health Sciences University Dr.Suat Seren Chest Diseases and Chest Surgery Training and Research Hospital

**Background and Aim:** Pectus carinatum (PC) is a chest wall deformity, known as pigeon chest, characterized by varying degrees of anterior protrusion of the sternum and sternocostal cartilages. It is the most common chest wall deformity after pectus excavatum. This study presents the results of patients under the age of 18 who underwent orthotic treatment for PC.

**Method:** Between September 2021 and March 2023, orthotic treatment was applied to 63 patients due to PC. The orthotic results of 63 pectus carinatum patients under the age of 18 were evaluated retrospectively. First week, patients were recommended to start with low compression pressures at least 12 hours per day. At the end of 1 month, the targeted compression level of orthosis adjustment was reached.

**Results:** 12 (19%) of the patients were male and 51 (81%) were female and the mean age of the patients was  $13.5 \pm 2.78$ . Asymmetric/mixed excavatum deformity was present in 25 (39.6%) patients. Carinatum pressures were recorded on average  $6.72 \pm 2.35$  kg/cm at baseline. After an average of  $4.7 \pm 2.81$  months in 42 patients, the carinatum pressure control decreased to an average of  $2.32 \pm 1.67$  kg/cm. 2 (3.1%) patients could not complete the treatment protocol due to irregular use, and 1 (1.5%) patient decided to get operated. We have 21 (33.3%) patients who are still under treatment. The only morbidity of the treatment was ecchymosis in the application area in 3 (4.7%) patients.

Picture



14 years old Male (pressure 6.5---2.5 kg/cm2) 4th month control

**Conclusions:** Orthotic treatment has entered our daily practice and replaced surgical treatment of PC in children under 18 years of age who has PC. We believe that this method, which has high treatment compliance and successful results, is a technique that can be used safely in the treatment of carinatum.

**Keywords:** Pectus carinatum, Orthotic treatment



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## COMBINED MINIMAL INVASIVE REPAIR OF PECTUS CARINATUM AND LIMITED STERNO-COSTO-CHONDROPLASTY FOR CORRECTION OF COMPLEX AND RIGID DEFORMITY

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**Background and Aim:** The Abramson-Yüksel technique is a widely used minimal-invasive approach for correcting pectus carinatum (PC). However, wire cutout, rib fractures or implant failure with loss of correction were reported for PC with high reduction pressure. In order to use the minimal invasive repair of pectus carinatum (MIRPC) in these patients, we complemented a limited sterno-costo-chondroplasty (LSCC) technique, former used in the open repair.

**Method:** Patients with asymmetric PC not suitable for standard MIRPC due to high initial correction pressure were operated with a combined MIRPC-LSCC. Pre-operative thoracic MRI was performed to evaluate the type of deformity including sternal rotation and location for LSCC. Anterior correction pressure was measured in Newton (N) using a force-measuring device before and during intervention after each level of bilateral LSCC completed. LSCC was only performed on the anterior cartilage maintaining the stability of the chest wall.

**Results:** A total of 3 male patients median age 15 yrs. were operated between 11/2022 and 04/2023. Mean rotation of sternum was 8.6° (SD 2.76). Mean pre-operative correction pressure was 78.7 N (SD 1.16, 95% CI: 75.8–81.54). LSCC was performed parasternal at 4 levels in 1 patient and 3 levels in 2 patients. This resulted in a significant intraoperative reduction of correction pressure of 67 % to 29 N (SD 7.21, 95% CI: 11.1–46.9). In one patient with dysplastic rib formation 2 STRATOS bar were additionally used.

**Conclusions:** This combined technique of MIRPC and LSCC expands the application of a minimal invasive correction for complex and rigid PC avoiding the disadvantages of the open repair and maintaining integrity of the anterior chest wall. Moreover, this minimal-invasive concept is not limited to the application of a pectus bar, but also offers the possibility to for further development of implants keeping the idea of remodeling the chest wall minimal invasively.

**Keywords:** Pectus carinatum, MIRPC, sterno-costo-chondroplasty, LSCC, minimal invasive

**PREOPERATIVE IMAGING OF CLINICALLY RELEVANT INTRATHORACIC ABNORMALITIES IN PECTUS EXCAVATUM PATIENTS**

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**Background and Aim:** Preoperative radiological imaging in pectus excavatum sometimes coincidentally yields additional intrathoracic abnormalities. In the context of a larger research project investigating replacement of CT scans by 3D-surface scanning as routine preoperative work-up for pectus excavatum, this study aims to quantify the incidence of clinically relevant intrathoracic abnormalities found incidentally using conventional CT in pectus excavatum patients.

**Method:** A single-center retrospective cohort study was conducted including pectus excavatum patients, receiving CT between 2012 and 2021 as part of their preoperative evaluation. Radiology reports were reviewed for additional intrathoracic abnormalities and scored into three subclasses: non-clinically relevant, potentially clinically relevant or clinically relevant findings. Also, two-view plain chest radiographs reports, if available, were evaluated for those patients with a clinically relevant finding. Subgroup analysis was performed to compare adolescents and adults.

**Results:** In total, 382 patients were included, of whom 117 were adolescent. Although in 41 patients (11%) an additional intrathoracic abnormality was found, only two patients (0.5%) presented with a clinically relevant abnormality requiring additional diagnostics, postponing surgical correction. In only one of the two patients, plain chest radiographs were available, which did not show the abnormality. Subgroup analyses revealed no differences in (potentially) clinically relevant abnormalities between adolescents and adults.

**Conclusions:** The prevalence of clinically relevant intrathoracic abnormalities in pectus excavatum patients was low, supporting the notion that CT and plain radiographs can be safely replaced by 3D-surface scanning in the preoperative work-up for pectus excavatum repair.

**Keywords:** Pectus Excavatum, Funnel Chest, Diagnostic imaging





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### **RELATIONSHIP BETWEEN 3D IMAGING-DERIVED MORPHOLOGICAL FEATURES AND PSYCHOSOCIAL DISTRESS IN PECTUS EXCAVATUM PATIENTS; PRELIMINARY RESULTS.**

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**Background and Aim:** Pectus excavatum, or funnel chest, is the most common congenital anterior chest wall deformity. While the Haller index, obtained from CT or plain chest radiographs, is widely used as a measurement to quantify its severity, it comes with several limitations, including the absence of a direct relationship with psychosocial distress, often seen in pectus excavatum patients. Three-dimensional optical surface imaging, on the other hand, provides information on all morphological features of the deformity. Hence, the objective of the current study was to determine whether there is a relationship between morphological features derived from three-dimensional optical surface imaging and psychosocial distress, aiming to expand our understanding of this complex deformity.

**Method:** Consecutive records from all pectus excavatum patients who received three-dimensional optical surface imaging between August 2019 and April 2021 were retrospectively reviewed and assessed for eligibility. Data on morphological features were collected and compared between patients with or without psychosocial distress (indicated by patient during assessment of psychosocial functioning at first outpatient clinic appointment). Univariable and multivariable logistic regression analysis was performed to determine whether psychosocial distress was associated with any morphological feature.

**Results:** Preliminary data from 87 patients were analyzed. Significant differences in the following morphological features derived from three-dimensional optical surface imaging: depth, width, length, volume, start position, right side steepness, external Haller index, lateral diameter, and torso length were found between the group with (n=39) and without psychosocial distress (n=48). Multivariable analyses revealed that only a smaller width of the deformity was significantly correlated with psychosocial distress.

**Conclusions:** Our preliminary findings suggest that a smaller width of the deformity is associated with psychosocial distress in pectus excavatum patients.

**Keywords:** Pectus Excavatum, 3D optical surface imaging, Psychosocial Functioning, Morphological Features

**CARDIO-RESPIRATORY INVESTIGATION & MANAGEMENT OF ADOLESCENTS WITH PECTUS EXCAVATUM**

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<sup>1</sup>*Royal Hospital for Children, Glasgow*

**Background and Aim:** Pectus excavatum (PEX) is a congenital chest wall abnormality presenting in childhood, with a male: female ratio of 4:1. Severity has traditionally been quantified by cross sectional imaging using the Haller index (> 3.25 considered moderate to severe), and the correction index may be more useful in asymmetrical cases. The Haller Index has been challenged since first publication, with concerns regarding age or gender related differences, however an index greater than 2.7 is considered severe. Not only cross sectional imaging but symptomology, both physiological and psychological, aid decision making towards surgical repair.

**Method:** The Scottish National Chest Wall Service reviews around 100 PEX per year, with 20- 25 patients listed for a Nuss operation annually. Aim to develop a guideline to ensure equity of cardiorespiratory investigations of adolescent PEX and ensure appropriate surgical intervention. Previously surgical decision making was influenced by psychological factors, severity of defect and objective markers of severity such as cardiopulmonary exercise testing (CPET) and CT scan. However, CT is limited in the inability to provide a measure of the physiological impact of the pectus defect. Transthoracic echocardiography (TTE) is used to ensure normal cardiac anatomy, in particular the absence of mitral or tricuspid valve prolapse, but more importantly to assess for evidence of RV compression. Unlike the left ventricle (LV), assessing right ventricular function is challenging by TTE. However cardiac MRI provides detailed assessment of the anatomy and function of the RV.

**Results:** This guideline brings together the multidisciplinary team involved in the care of teenagers with pectus excavatum: chest wall deformity team, including paediatric surgical team and specialist physiotherapists; paediatric cardiology; radiology and paediatric respiratory team. (Figure 1)

**Conclusions:** This national guideline rationalises cardiorespiratory investigations and management of patients presenting with marked PEX. Identifying impairment of the cardiorespiratory function which may influence timing of surgical repair.

**Keywords:** Pectus Excavatum, Cardio-respiratory, Guideline



## AWAKE MINIMALLY INVASIVE REPAIR OF PECTUS CARINATUM PATIENTS: RESULTS OF 14 PATIENTS - FIRST REPORT IN THE LITERATURE

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**Background and Aim:** Pectus Carinatum (PC) is the second most common congenital chest wall deformity. Minimally invasive repair of Pectus Carinatum (MIRPC) have become the treatment of choice in recent years due to high patient satisfaction. Thoracic epidural anesthesia has been recently employed to perform awake thoracic procedures for avoiding the adverse effects of general anesthesia. We hereby report, first time in the literature, the results of 14 cases who underwent awake MIRPC.

**Method:** Patients who had had awake MIRPC were reviewed retrospectively according to demographics, type of the deformity, duration of the operation, perioperative and postoperative complications, length of hospital stay and patient satisfaction.

**Results:** Among 14 patients; 10 (71.4%) were male and 4 were female (28.6 %). Median age was 15 (10-19). 9 (64.2%) of them had symmetric deformity and 5 (35.7%) had asymmetric deformity. All patients were operated with single bar and bilateral stabilizers. Median duration for the operation was 82 minutes (60-120 minutes) and median length of hospital stay was 3.6 days ( 2-9 days). Pneumothorax (14.2%, 2 patients) and wound infection (7.14%, 1 patients) were the most frequent early complications. None of pneumothoraces needed chest tube drainage and wound infection patient was treated conservatively. Metal allergy (7.14%, 1 patient) and over-correction (7.14%, 1 patient) were the leading late complications. Quality of life questionnaire revealed 95.2 % patient satisfaction.

Figure-1



Picture of the patient before transferring from OR to the floor Figure-2



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*Preoperative and postoperative images of the patient*

**Conclusions:** MIRPC with awake anesthesia is a reliable and promising technique for repair of PC. Based on the technological developments in recent years, novel approaches like minimally invasive surgery and awake anesthesia should be preferred, thus the well-being of the patient should be protected by reducing the rate of complications.

**Keywords:** Chest Wall Deformities, Pectus Carinatum, Pectus Excavatum, Minimally invasive, Awake Surgery

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## PA-12 PECTUS EXCAVATUM AND CARINATUM- TREATMENT WITH ORTHOSE( BRACE), VACUUM AND BANDAGE

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**Background and Aim:** The purpose of this project is treating patients with pectus carinatum and excavatum by detecting it at an early age and treating it with non invasive methods and avoiding later surgical treatment which is much more traumatic, painful and expensive.

**Method:** The tools and methods which are used for the treatment of a group of patients with anterior chest wall deformities are orthosis( brace), vacuum and bandage. For the treatment of pectus excavatum in patients from the age of 6 months old to 15 years old we use the vacuum bell. It starst with wearing it 5 minutes a day and the time is gradually increased until 1 hour, then the patient wears it every day for 1 hour morning and 1 hour evening .For the treatment of pectus carinatum in patients from the age of 13 years old to 17 years old we use orthosis( brace) for a duration of 23 hours a day for the first 6 weeks. After the 6th week, it is recommended to apply 16 hours a day for 2 months. If the improvement is complete in the control after 2 months, orthosis application is terminated within 2 months after 8 hours of application per day.

*Pressure test*



*The pressure test determines which treatment is going to be used to fix the deformity.*

**Results:** For the group of patients who were treated by vacuum and orthosis the results were noticeable after the first week thanks to their dedication of wearing the device consistently despite the pain that may have been caused by the pressure of pulling and pushing that the device caused.



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*Pectus carinatum in 17 years old girl*



*Before and after orthoses treatment of pectus carinatum in 17 years old girl*

**Conclusions:** This non invasive treatment should encourage us in detecting the patients with these deformities in an early age so they can be treated as soon as possible. It will help many people and their families avoid the unnecessary trauma and cost of going through the surgical treatment of this deformity.

**Keywords:** chest wall deformity, vacuum, orthosis, non invasive treatment



## PA-13 CORRECTION OF PECTUS EXCAVATUM

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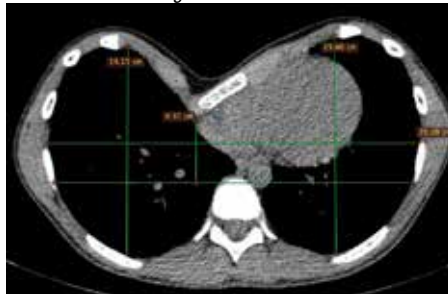
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<sup>2</sup>the clinic "Chalet-Sante" (Krasnodar, Russia).

**Background and Aim:** Pectus excavatum (PE) is an indentation in the anterior chest wall resulting from a dorsal deviation of the sternum and third to seventh rib or costal cartilage and is the most common chest deformity accounting for 90% of all cases. 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.

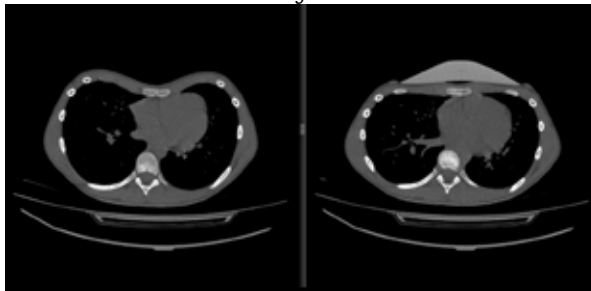
**Method:** 2002 patients with PE were corrected for the period 2019-2022. 156 patients of them were citizens of Uzbekistan. There were 1352 males and 650 females. The age of patients ranged from 3 to 52 years. 250 (12.48%) patients were performed the Nuss surgery, in the remaining 1752 (87.52%) cases, 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 metal plate that will be used during the Nuss surgery (Fig. 1).

fig. 1 MSCT of PE



**Results:** The duration of wearing the bell varied from 9 months to 36 months. 14 patients who refused to wear the bell from the first days were excluded from observation. Figure 2 shows dynamic MSCT scans of the patient before and after applying the bell.

fig.2



MSCT-scans before wearing the bell and during the procedure



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**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 3.5; older age group ( $\geq 22$  years); lack of efficiency from Vacuum Bell.

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





## **TREATMENT RESULTS OF THE COMBINED RAVITCH AND NUSS PROCEDURE FOR SEVERE PECTUS EXCAVATUM**

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<sup>1</sup>*Division of Thoracic Surgery, Department of Surgery, Keio University School of Medicine, Tokyo, Japan*

**Background and Aim:** Pectus Excavatum (PE) is a congenital thoracic deformity. Since 1998, the Nuss method, which corrects the chest wall with a pectus bar, has been widely used as a standard surgical treatment. In 2014, we established a PE outpatient clinic at our institution, and have been actively performing surgical treatment using the Nuss procedure. In the process, some cases have become clear that adequate thoracic correction cannot be obtained only with the simple Nuss procedure. In particular, in the case of PE with a severe depression, the conventional Nuss method alone cannot achieve satisfactory chest elevation, and the surgical method needs to be devised. We introduced a new treatment method (Combined Ravitch and Nuss procedure: CRN procedure) in which costal cartilage transection was added to the Nuss method.

**Method:** We examined the usefulness of CRN procedure. The clinical data of the patients were retrospectively reviewed, based on the following variables: age, sex, family history, symptoms, radiological findings, cardiopulmonary function, detailed operative record, and perioperative complications.

**Results:** The patients consisted of 40 men and 14 women with a median age of 22 years. Thirty patients (57.7%) had cardiopulmonary symptoms such as dyspnea and palpitations. The median Haller index on computed tomography scans (HI-CT) was 4.58. 34 patients (65.4%) had asymmetrical depressions. The median operating time was 165 minutes, the blood loss was 40.0 g, and the postoperative hospital stay was 7 days. Postoperative Grade 3 or higher adverse events were observed in 6 patients (11.5%). The postoperative HI-CT was 3.02, and the postoperative sternum torsion angle was 6.9 degrees.

**Conclusions:** The CRN procedure can be used in various cases such as severe depression, asymmetric depression, the elderly, and recurrent cases, and can be a useful technique in cases where it is difficult to raise the sternum with the Nuss procedure alone.

**Keywords:** Pectus Excavatum, Combined Ravitch and Nuss Procedure, Nuss procedure, Ravitch procedure



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## DEPRESSION, SOCIAL ANXIETY, QUALITY OF LIFE AND PERSONALITY TRAITS IN PATIENTS WITH PECTUS EXCAVATUM

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**Background and Aim:** The quality of life (QOL) and psychological states of patients with pectus excavatum (PE), is not well understood. This study aimed to evaluate the health-related QOL, psychological status, and personality tendency and their associations in patients with PE who undergo repair surgery.

**Method:** A cross-sectional evaluation was performed in patients with PE before repair surgery in a tertiary medical center. The primary outcome was the patients' health-related QOL (the 12- Item Short Form Health Survey: SF-12), and the secondary outcomes were depression, social anxiety, self-efficacy and personality tendency, which were assessed with the Patient Health Questionnaire 9, Liebowitz Social Anxiety Scale, General Self-Efficacy Scale, and NEO Five- Factor Inventory, respectively.

**Results:** The patients had significantly lower health-related QOL overall (mean±standard deviation: 41.8±12.8, range: 39.5–44.0,  $p < 0.001$ ) and in role-physical (45.6±12.0, 43.5–47.7,  $p < 0.001$ ) and role-emotional (44.9±13.1, 42.6–47.2,  $p < 0.001$ ) domains compared with general population control. They had significantly higher scores for bodily pain (51.9±9.6, 50.2–53.5,  $p = 0.029$ ), general health (55.8±10.1, 54.0–57.5,  $p < 0.001$ ), physical component summary score (54.0±10.4, 52.1–55.8,  $p < 0.001$ ), and mental component summary score (53.3±8.8, 51.8–54.8;  $p < 0.001$ ) than the control.

**Conclusions:** Our study showed that patients with PE had a decrease in social QOL and that chest deformity causes depressive tendencies, social phobia, lower self-efficacy, and introverted personalities. In the future, it will be necessary to conduct a longitudinal study on how psychosocial tendencies change with treatment.

**Keywords:** Pectus excavatum, QOL, Depression, Social Anxiety, Nuss procedure

## MINIMALLY INVASIVE REPAIR OF PECTUS ARCUATUM WITH MODIFIED SANDWICH TECHNIQUE

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**Background and Aim:** Pectus arcuatum - also known as “Roman breastplate, pouter pigeon breast” - is a rare and complex chest wall deformity characterized by a deep depression in the body of the sternum with a raised and arched manubrium. It is usually asymptomatic but can cause respiratory and cardiac symptoms in severe cases. The aim of this case report is to present a novel minimally invasive repair technique for pectus arcuatum.

**Method:** A literature search was performed to identify existing surgical techniques for repairing pectus arcuatum. Several reports that described radical open techniques were founded. However, We found no mention of repairing this type of deformity by minimally invasive intervention. In this report, a 20-year-old male with moderate pectus arcuatum deformity underwent a minimally invasive repair using an innovated modified sandwich technique.

**Results:** The new minimally invasive repair technique was successfully performed on the patient, resulting in satisfactory cosmetic outcomes. The patient experienced no complications during or after the procedure. To the best of our knowledge, here we report the first case of an innovative minimally invasive repair for pectus arcuatum.

*Preoperative Image*



*Preoperative Image Postoperative Image*

*Postoperative Image*

**Conclusions:** This case report demonstrates the possibility of applying a minimally invasive repair technique for pectus arcuatum using a modified sandwich technique. Further reports and studies are needed to assess the effectiveness and safety of this approach and establish its place among existing surgical techniques for pectus arcuatum repair.

**Keywords:** Pectus arcuatum repair, Minimally invasive repair of pectus arcuatum, Sandwich technique for pectus arcuatum

**PA-17 PHYSIOTHERAPY FOR CHEST DEFORMITIES**

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**Background and Aim:** With a slight deformation of the chest, conservative treatment is possible – massage, physiotherapy, respiratory gymnastics, swimming, the use of corsets. Physiotherapy plays an important role and is aimed at restoring the bioelectric activity of the muscles of the thoracic and lumbar spine. Treatment with physical factors has a beneficial effect, creating prerequisites for the formation of proper posture skills in the future and subsequent correction of the spine position within the possible limits under the supervision of an orthopedist. Our goal is to relax the trapezius muscle to induce a sedative effect.

**Method:** Conducting complex physiotherapy, manual massage of the muscles along the spine is carried out, paying active attention to the chest and lumbar region using relaxing techniques. To do this, stroking, circular rubbing with fingers, continuous vibration are performed. Next, relaxing massage techniques are performed - stroking, rubbing, continuous vibration. In the area of thoracic kyphosis, low-frequency pulse therapy ("Amplipulse" therapy) is used in the transverse, alternating with the longitudinal method (fig. 1):

Fig. 1. low-frequency pulse therapy



**Results:** 1) For metabolic purposes, the 1st and 4th types of work are used with a modulation frequency of 30-60 Hertz and a modulation depth of 50-75%, daily, a course of 10 procedures; 2) For the purpose of electrostimulation of weakened back muscles (external oblique, square and long on the side of the spine protrusion): use the 2nd kind of work with a duration of 15-20 minutes, the frequency of modulation is 50-75 Hertz, the depth of modulation is 100% and higher. Our patients also underwent a course of low-frequency magnetotherapy paravertebral, for the purpose of trophic effects, the intensity of magnetic induction 10-15 MT, duration 15-20 min.

**Conclusions:** Conservative treatment is not able to correct the deformity, but it allows you to stop the progression of deformity and preserve the functionality of the chest organs.

**Keywords:** physiotherapy, chest deformities, conservative therapy, low-frequency pulse therapy

## PA-18 PRELIMINARY RESULTS OF THE TREATMENT OF PECTUS EXCAVATUM WITH THE VACUUM BELL IN URUGUAY

Maria Celina Sienra<sup>1</sup>, Martín Ormaechea<sup>1</sup>

<sup>1</sup>*Pectus Uruguay*

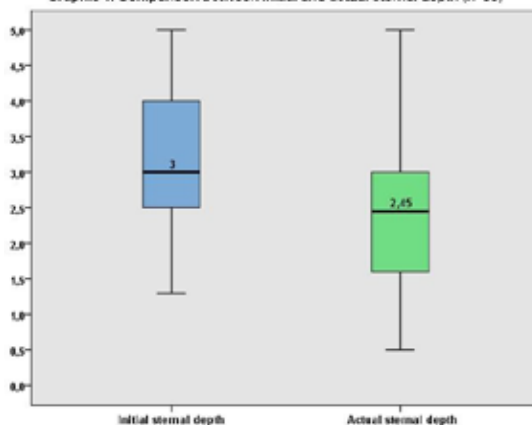
**Background and Aim:** The aim of this study is to describe the first experience in Uruguay with the use of the Vacuum Bell for the treatment of patients with pectus excavatum.

**Method:** An analysis of the preliminary results of patients treated with the Vacuum Bell for pectus excavatum in Uruguay in the period 2017-2023 was carried out. The results were analyzed in terms of sex, age at the start of treatment, type of defect, sternal depth, treatment time, improvement of sternal depth, and treatment abandonment. The data was analyzed in SPSS version 22 for Windows, using distributions of frequencies for the qualitative variables and summary measures for the variables quantitative. The comparison of means was carried out with a t test, using a level of significance of 5%, considering prior verification of application assumptions.

**Results:** 30 patients diagnosed with pectus excavatum in treatment with the Vacuum Bell were analysed; 26 male (87%) and 4 female (13%). The average age was 16.3 years (8-32 years). The median treatment time was 9 months. The initial sternal depth had an average of 3.12, while the actual sternal depth had an average of 2.41. The comparison of both means shows a significant decrease in the sternal depth ( $p < 0.001$ ). It is important to note that 10 patients (33%) abandoned treatment.

*Graphic 1: Comparison between initial and actual sternal depth.*

Graphic 1. Comparison between initial and actual sternal depth (n=30)



*Graphic 1: Comparison between initial and actual sternal depth. Box plots.*

**Conclusions:** There was an improvement in the sternal depth in all of the patients treated with the Vacuum Bell, which means that the treatment is effective. This improvement was greater in patients with sternal depressions of less than 3cm. A significant percentage of treatment abandonment was identified, which must be addressed to achieve better results with these patients. A longer follow up and larger number of patients are required in order to make more conclusions.

**Keywords:** pectus excavatum, Vacuum Bell



## **15 YEARS OF EXPERIENCE WITH MODIFICATIONS OF THE NUSS TECHNIQUE IN YOUNG ADULT PATIENTS WITH PECTUS EXCAVATUM**

Horia Sirbu<sup>1</sup>, Moustafa Higaze<sup>1</sup>, Mohamed Haj Khalaf<sup>1</sup>, Koblandy Khamitov<sup>1</sup>, Denis Trufa<sup>1</sup>

<sup>1</sup>University of Erlangen, Germany, Department Thoracic Surgery

**Background and Aim:** Since Nuss published the minimally invasive correction technique (MIRPE) in children in 1998, it has become the most commonly used technique worldwide. The aim of our study was to investigate changes in patient characteristics and technical MIRPE modifications over time

**Method:** During the period 2008-2023, MIRPE was used in our Department. N=705 patients were studied and n=208 (30%) patients received MIRPE with various modifications over the time period. Age was 20.8±6.1 (median 19 (14-51)), CT-HI was 4.34±1.46 (median 3.9 (1.97- 13.8)). Analgesia was provided in close collaboration with our pain unit and was planned for an additional 4-5 weeks. Patients were routinely assessed at 2 weeks, 6 months, and then once a year after surgery until explantation.

**Results:** One bar was implanted in 78 (37%) patients, two bars in 120 (57.6%) patients, and three bars were implanted in 8 (3.8%) patients. After the introduction of tensiometry to quantify the required corrective force 165±35 N, the median length of the bars decreased to 11±2 inches vs. 13±2 before the modifications. Surgical time decreased over the time from 80±25 min. to 60±15min. Median postoperative stay shortened to 7±4 vs 8±4.5 days. No deaths or deep infections occurred. Complications (6 (2.8%) bar rotation/dislocation, 9 (4.3%) pneumothorax, 2 (0.9%) pleural effusion, 6 (2.8%) pain syndrome, 1 (0.4%) hemothorax, 3 (1.4%) superficial infection, 1 (0.4%) deep infection) occurred in 28 (13%) patients. Bar explantation occurred in 127 (60%) patients after 3.67±1.07 years.

**Conclusions:** After introduction of tensiometry for correction force quantification and together with technical modifications of the initial MIRPE with implantation of multiple shorter bars and their multipoint fixation, we minimized the complication rate, achieved better cosmetic results associated with lower analgesia consumption, accompanied by shorter operative time and inpatient stay. However, due to restrictive health insurance regulations of our country, only 30% of PE patients received surgical correction.

**Keywords:** nuss modifications, mirpe, tensiometry, pectus excavatum



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JUNE 22-24, 2023 TURKEY *Istanbul*

## RESULTS OF VACUUM THERAPY IN PEDIATRIC AGE GROUP PECTUS EXCAVATUM PATIENTS

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<sup>1</sup>*Health Sciences University Dr.Suat Seren Chest Diseases and Chest Surgery Training and Research Hospital*

**Background and Aim:** Pectus excavatum (PE) is the most common deformity of the chest wall and is mostly operated for cosmetic reasons in young adults. This study presents the results of patients under the age of 18 who underwent vacuum therapy for PE.

**Method:** Between September 2021 and March 2023, vacuum therapy was recommended for 57 patients due to PE. Vacuum therapy was started in 45 of these patients. Patients are recommended to use the vacuum for 15 minutes in the mornings and 15 minutes in the evenings during the first week. The application duration was increased to 30 minutes in the mornings and 30 minutes in the evenings in the second week. The ultimate application duration was reached at the first month as 1 hour in the mornings and 1 hour in the evenings.

**Results:** There were 32 (71.2%) male and 13 (28.8%) female patients. The mean age of the patients was 10.65 years (6 months - 17 years). The mean depth of the deformity was recorded as 2.56 +/- 0.95 cm at the beginning of the treatment. In 17 patients, a 50,17% reduction in pectus depth was detected during controls after an average of 9.8 (6 - 20 months) months. In 10 (22.2%) patients, there was not enough change in depth despite 9 months of use. Follow-up continues with routine outpatient clinic controls. We have 18 patients who are still under treatment (Picture). Petechiae and pain in the application area were observed in 2 (4.4%) patients.

Picture



**Conclusions:** In patients with pectus excavatum presenting for cosmetic and psychological reasons in childhood, it is possible to achieve satisfactory results by eliminating surgical risks with vacuum therapy.

**Keywords:** Pectus excavatum, Vacuum therapy



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## PA-21 PRELIMINARY RESULTS OF DYNAMIC COMPRESSION THERAPY FOR CHILDREN WITH PECTUS CARINATUM

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**Background and Aim:** One of the most common anterior chest wall deformities is pectus carinatum. In these patients, surgery or brace treatments are applied as a treatment method. In this study, it is aimed to examine the treatment results in patients treated with pectus carinatum using brace without surgery.

**Method:** Retrospective review of patient records was conducted for children with pectus carinatum who received brace treatment with dynamic compression therapy in 2023. Statistical analysis was performed using demographic data, patient complaints, family history, symmetry, correction pressure, clinical symptoms, side effects, initial treatment pressure, and recovery period duration.

**Results:** Demographic data and treatment outcomes are presented in Table 1. All patients reported cosmetic problem as their main complaint. No symptoms were reported during exercise or rest. During brace use, one patient experienced back pain, one had chest pain, one developed a wound, and two had erythema.

*Demographic data and Treatment Results of the Patients*

Gender	Male 20 (95.2%)	Female 1 (4.8%)	
Age (years)	13.47 ± 1.56 (mean ± sd)	(11 - 17) (min-max)	
Height (cm)	166 ± 8.59 (mean ± sd)	(148-178) (min-max)	
Body weight (kg)	50 ± 1.03 (mean ± sd)	(33-67) (min-max)	
Family History	Yes 8 (38.1%)	None (61.9%)	
Presence of symmetry	Yes (47.6%)	None (52.4%)	
Degree of deformity	Mild (4.8%)	Moderate (81%)	Serious (14%)
Posture disorder	Yes ( 33.3% )	None (66.7%)	
Correction pressure	6.27 ± 2.27 (mean ± sd)	(2.5-11.2) (min-max)	
Orthosis wearing time (month)	3.65 ± 2.89 (mean ± sd)	(1-10.5) (min-max)	
Post-orthotic pressure	2.98 ± 2.43 (mean ± sd)	(0-6.3) (min-max)	
Recovery time (month)	2.65 ± 1.35 (mean ± sd)	(1-5) (min-max)	

**Conclusions:** Brace applications, as a non-invasive technique, have shown successful results in children with pectus carinatum, particularly when performed during the prepubertal and early pubertal years. Patient compliance during treatment is generally high, and the occurrence of symptoms is minimal.

**Keywords:** pectus carinatum, dynamic compression therapy, brace treatment, non-invasive technique





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## PECTUS BAR FEATURES

Figen Türk<sup>1</sup>

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**Background and Aim:** Bar usage started with Nuss. Depending on the content of the bar, the choice of bar to be preferred may change. Although steel-nickel and titanium bars have similar properties, there are also differences.

**Method:** In this study, steel-nickel, titanium and nitinol contents were investigated.

**Results:** Titanium bars are preferred in cases with a history of nickel allergy. Titanium is an element while stainless steel is an alloy. Titanium occur naturally in the metal but stainless steel is a metal alloy of chromium, iron, nickel, and other things. Titanium is found in igneous rocks, sedimentary layers and is eventually mined. Stainless steel is a material obtained by combining with nickel, silicon, molybdenum, vanadium and body elements after being taken out from under the frame of the chromium element, which is the main material, and then boiling and liquefying after separating into sections. Nitinol is a metal alloy containing approximately equal amounts (50%) of nickel and titanium.

**Conclusions:** In this presentation, the features and differences of the bars will be researched and presented.

**Keywords:** steel-nickel, titanium, nitinol



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## LATE PECTUS BAR INFECTION AFTER NUSS PROCEDURE: WHEN TO REMOVE THE BAR?

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**Background and Aim:** Background Despite placement of a metal bar behind the sternum, infections after minimally invasive repair of pectus excavatum (MIRPE) are rare and reported to be 1.5 – 6.9%. Thus, their treatment strategy is not well standardized. Objectives To describe a case of infectious complication after MIRPE and to review the evidence regarding its management and the bar preservation rate.

**Method:** Method We report on an 18-year-old patient who underwent uncomplicated MIRPE with excellent functional and aesthetic results and review studies of infection after MIRPE.

**Results:** Results Our patient complained of neuropathic pain on both sides of the pectus bar three weeks after MIRPE. Intercostal cryoneurolysis dorsal to the midaxillary line improved symptoms on the left side but only by 50% on the right side. At 5 months postoperatively, painful redness with swelling over the left thoracic wound without other systemic signs of infection appeared. Skin test for metal allergy was negative. Treatment with oral clindamycin did not improve the situation. Surgical wound drainage revealed purulent secretions, which prompted us to remove the pectus bar.

**Conclusions:** Conclusion Persistent pain after MIRPE may be a harbinger of a complication. There is limited evidence on how to manage infection postoperatively and how long to wait before removing the pectus bar. Bar preservation rates during an infectious episode vary from 25% to 80%.

**Keywords:** Infection, neuropathic pain after MIRPE, Nuss procedure, Pectus excavatum, bar removal



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## TENSION REDUCTION OF LARGE CHEST WALL RECONSTRUCTION BY FRAMEWORK SEGMENTATION

Julia Strauchmann<sup>1</sup>, Jens Carsten Rückert<sup>1</sup>, Aron Elsner<sup>1</sup>

<sup>1</sup>Charité

**Background and Aim:** Large chest wall defects result from resection of advanced staged lung cancer with chest wall infiltration. These large defects are still a challenge for reconstructions. Apart from contemporary MIS approaches, the bony defect requires permanent tension free robustness avoiding stress-fractures of the material. Modern approaches aim at complete chest wall motility. A solution might be an adaptive reconstruction framework.

**Method:** A 74-year-old patient presented with an advanced lung carcinoma of the left upper lobe invading the chest wall. Neoadjuvant chemotherapy led to MPR with downstaging (stage IIIA) of the lung cancer. Indication for surgery with curative intention was decided upon the tumor board. A large chest wall defect after oncologic resection had to be anticipated. Due to the extensive defect the adequate system by MedXpert was evaluated. The solution appeared to be a large size-framework, but experience showed a high risk of tension-fractures in such reconstructions. To reduce the tension, it was separated into a dorsolateral and ventrolateral segment. The bendable titanium components allowed adjustment according to the natural shape of the chest wall. Tension free placement of all components had to be guaranteed by fine surgical adjustment.

**Results:** The patient was mobilized rapidly under initial pain management with peridural catheter. With coherent implementation of oral pain medication, it was possible to remove PDA after 6 days. The oral pain medication could be further reduced to a combination of nonsteroid, antipyretic and pregabalin-medication. Two weeks after reconstruction the patient was discharged fully mobilized.

**Conclusions:** The case demonstrates the possibility of R0-resection even with extensive chest wall involvement by lung cancer. Almost hemi-thoracic reconstructions create special functional demands due to high mechanical forces and require high flexibility of these reconstructions. The actual case shows the feasibility to reduce material fractures by independent elements of a complex planned construction. Further dedicated investigations should follow.

**Keywords:** chest wall reconstruction

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## POSTPREMATURITY THORACIC DYSPLASIA: IS THERE MORE THAN MEETS THE EYE?

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**Background and Aim:** Postprematurity thoracic dysplasia (PPTD) has been recently described, but no other reports have been published since. Therefore, we aimed to explore and identify patients with a compatible morphology with PPTD within a large cohort of patients with chest wall malformations (CWM).

**Method:** Retrospective analysis of our pectus clinic database, following the subsequent steps: 1. Analysis of medical photographs of 2030 consecutive patients with non-excavated CWM. 2. Selection of patients with bilateral inward curvature of the 6th to 8th ribs. 3. Review of their medical records. 4. Patients were contacted by phone for additional data. Variables analyzed included a history of preterm birth, ventilatory support, age of deformity onset, respiratory comorbidities, and family history of CWM.

**Results:** We identified 23 patients (1.1%), whereas 11 were excluded due to a lack of perinatal records. Thus, 12 patients (91.7% male) were included in the analysis with a median age of CWM onset of 18 months (IQR 9, 48). Only 7 (58%) patients had a positive history of prematurity. In this group, all but one (86%) required invasive ventilation, 4 (57%) presented with bronchopulmonary dysplasia, and their median age of presentation was 12 months (IQR 3, 12). Of the remaining 5 term patients (42%), 4 (80%) had respiratory comorbidity (1 diaphragmatic hernia, 1 cystic fibrosis, and 2 asthma), one requiring ECMO and invasive ventilation. The median onset of their CWM was 24 months (24, 108). Fourteen% of the preterm and 40% of the term patients had a positive family history of CWM.

Figure 1



*This figure shows the peculiar chest wall of the 7 patients included in the study who shared a history of prematurity.*

Figure 2



*This figure shows identical chest walls of 5 patients who do not have history of prematurity.*

**Conclusions:** Our cohort's prevalence of a compatible chest wall morphology with PPTD was 1.1%. While 91% had respiratory comorbidity or required ventilatory support, almost half were not preterm, suggesting that this peculiar deformity might be more related to respiratory disorders than prematurity.

**Keywords:** Postprematurity thoracic dysplasia, mixed pectus, chest wall deformity, pectus carinatum



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## PA-26 INITIAL EXPERIENCE WITH NEW MODIFIED RAVITCH APPROACH COMBINING NUSS AND ABRAMSON TECHNIQUES FOR PECTUS ARCUATUM CORRECTION IN ADULT PATIENTS.

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**Background and Aim:** Pectus arcuatum is a complex and, also, a rare chest wall deformity, caused by premature obliteration of the sternal sutures in combination with an abnormal growth of the costal cartilages. Methods of surgical correction are still aim of debate nowadays. In order to try to improve previous reported approaches, we report about two consecutive patients treated on an open way through a clamshell incision with a new modified Ravitch technique. One male patient, previously operated at the age of 5, currently 33 years old; and a 39 years old female presented with pectus arcuatum diagnose.

**Method:** For the “carinatum part of the deformity” large chondrotomies were carried out bilaterally at the level of 2nd, 3rd and 4th cartilages; also small limited fractures were performed laterally at those ribs with the oscillating saw, and a pectus bar in “Abramson position” was placed. After two manubrial osteotomies, this bar was fixated at the 2nd and 4th ribs bilaterally with “Abramson type stabilizers” using sternal cable system for this purpose. For the correction of lower part of the deformity, the “excavatum part”, one or two pectus bars “in Nuss position” were used. Prior to the positioning of such bar(s), also limited chondrotomies were performed around the sternal bone, together with one more sternal osteotomy. Nuss bars were also fixated bilaterally using sternal cable system without the need of stabilizers (in one patient in crossed position)

*Intraoperative view*



*Modified Ravitch approach*

**Results:** Both patients were discharged at the 8 th postoperative day. Good cosmetrical and functional result was achived. Further control is needed to evaluate long term results.

**Conclusions:** Clamshell incision gives optimal surgical exposure to correct complex deformities in adult patients. Modified Ravitch approaches decrease tension and allow low analgesic regimes in postoperative period. Further follow up of both patients is needed to evaluate long term results.

**Keywords:** Pectus Arcuatum, Nuss, Abramson, Ravitch



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## SINGLE CENTER EXPERIENCE ON CROSS-BAR TECHNIQUE FOR PECTUS EXCAVATUM

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**Background and Aim:** There are limited data on the clinical experience of cross-bar technique in the treatment of children with pectus excavatum (PE). This study summarized the clinical experience used cross-bar technique in the treatment of PE in our centre.

**Method:** We reviewed the clinical data of 96 patients admitted, Beijing Children's Hospital Affiliated to Capital Medical University, Beijing, China, from January 2017 to December 2022 for the treatment of PE by used cross-bar technique.

**Results:** A total of 96 children with PE were treated by cross-bar technique, including 94 males and 2 females. The median age was 14 years (10-17 years); haller indices ranged from 3.2 to 22.9 (median was 4.11). The median ratio of longitudinal diameter to transverse diameter of the depression is 1.142 (range 0.46 to 1.69). In appearance, the sternal depression range was limited but deep in 25 cases. The center of the depression was located under xiphoid process in 34 cases; The depression range was extensive in 37 cases. All patients had different degree of costal eversion. In addition, 11 cases had flat chest. All patients had good postoperative appearance.

**Conclusions:** Cross-bar technique is safe and effective, and the appearance of the chest is fuller after correction, which can achieve better cosmetic effect. Cross-bar technique can be selected to treat children of large age with PE, according to the following types of appearance: (1) the scope of sternal depression is limited, but the depth is deep and the chest wall is stiff; (2) The center of the depression is located under xiphoid process; (3) The smaller the ratio of longitudinal diameter to transverse diameter of the sag; (4) the presence of costal eversion; (5) flat chest; (6) The lower segment of the sternum was severely depressed with a wide range of depressions.

**Keywords:** pectus excavatum, Cross-bar technique, Indications, Treatment

## THORACIC AUGMENTATION SURGERY FOR JEUNE SYNDROME

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**Background and Aim:** Jeune syndrome is a syndrome with short ribs and small chest cavity, accompanied by autosomal recessive inherited multiple system anomalies which causes dyspnea in patients due to expansion defect. It can be inherited as well as acquired as a complication of open surgeries performed to correct pectus excavatum. The decision for corrective surgery depends on the severity of the dyspnea and frequency of respiratory infections.

**Method:** The patients who were diagnosed with congenital Jeune syndrome (n=3) were followed up by pediatricians and consulted for any thoracic expansion possibility. The patients who were diagnosed with acquired Jeune syndrome (n=2) had corrective chest wall deformity surgeries.

**Results:** Between January 2013 and April 2023, all 5 cases except one who were diagnosed as Jeune syndrome underwent bilateral surgical lateral thoracic augmentation surgery. The surgical method included cutting of the 3 or 4 consecutive ribs which are mainly associated with the narrowed thoracic cage and reuniting them using plates and screws after adequate expansion. The interval between staged surgeries for left and right chest cavities was 6 to 12 months. There was one mortality. The 6 month old baby who underwent right sided thoracic augmentation passed away on postoperative day 7 due to septic shock and multiorgan failure. The other 2 pediatric patients did not have any morbidities following the staged surgeries. The associated dyspnea has resolved and they did not have any pneumonias following the surgeries. These two patients underwent rethoracic expansion surgeries 4 years after the first surgeries with the increasing age. The 22 year old patient who was diagnosed as the acquired Jeune syndrome following an open surgery for pectus carinatum had an uneventful staged thoracic augmentation postoperative period. The 44 year old man who had acquired Jeune syndrome underwent staged thoracic augmentation surgeries. Both patients were free of dyspnea.

### Radiological images



Preop and postoperative radiological images of 44 yo male patient Radiological images



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*Radiological images of 22 year old patient*

**Conclusions:** Staged thoracic augmentation surgery can be offered to selected patients with Jeune syndrome to relieve their respiratory symptoms.

**Keywords:** Jeune syndrome, augmentation surgery





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## PA-29 MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM

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**Background and Aim:** Pectus excavatum(PE) is the most common type of anterior chest wall deformities. Although most commonly the prominent symptom is cosmetic which causes psychosocial symptoms,-cardiopulmonary symptoms such as palpitations,early fatigue,exercise intolerance can be the cause of the outpatient visit.This study presents the surgical results of our prospective pectus excavatum database.

**Method:** Between September 2018 and April 2023, 295 patients (250 M,45 F,mean age:17,1,range 9-46) underwent minimally invasive repair of pectus excavatum.Preoperative assessment included physical examination,posteroanterior and lateral chest X-rays and ECG.Only patients with deep PE had a chest computed tomography.Patient demographics,presenting symptoms,type of deformity,previous surgery data, number and length of the inserted bars,operation duration and hospitalisation duration were evaluated.All patients underwent single lung ventilation with carbondioxide insufflation.Analgesia control was achieved by intercostal nerve block and iv PCA

**Results:** PE deformity was asymmetric in 40 (13.5%) patients.11 of the patients had prior Ravitch surgery. Eighteen patients had cardiac symptoms(mitral regurgitation in 2,sinus tachycardia in 5,right ventricle compression in 5,arythmia in 6)and 20 had dyspnea.In 257 (87.1%)patients, symptom was only cosmetic deformity.Single bar was placed in 151(51.2%) patients,two bars in 130(44.1%) and three in 14 (4.7%). Mean operation duration was 68 minutes(range: 30-180),mean hospitalisation was 4,17 days(range:2-11). Peroperative complications included diaphragm laceration(n=2),postoperative complications included venous insufficiency in both hands (n=1)(solution: revision with a shorter bar),brachial plexus injury due to arm stretching (n=1)(treatment:physical therapy)and incision infection (n=4).Four patients needed early bar removal due to overcorrection resulting in pectus carinatum(n=2)and increase in scoliosis(n=2).In 98 patients, bars were removed at a mean of 26 months.Five patients(1.7%)were not satisfied with the result.

**Conclusions:** In clinics where videothoroscopic applications were performed with successful results,-minimally invasive repair of pectus excavatum can be applied with short operation duration,minimal blood loss,short hospitalisation,low morbidity and high patient satisfaction.The decision for appropriate bar length and number of bars during the surgery can be provided easily after reaching a certain experience.

**Keywords:** pectus excavatum, minimally invasive surgery, videothoracoscopy



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## PA-30 THE USE OF PATIENT SPECIFIC 3 DIMENSIONAL MODELING AND PRINTING IN CHEST WALL INSTABILITY WITH STERNO-COSTAL PSEUDO-ARTHROSIS FOLLOWING A MODIFIED RAVITCH PROCEDURE: A CASE REPORT

Pieter Jan Van Huijstee<sup>1</sup>, Jesse Romsom<sup>1</sup>, Ali Keyhan-Falsafi<sup>1</sup>

<sup>1</sup>Haga Teaching Hospital of the Hague

**Background and Aim:** Correction for chest wall deformities was first described by Mark M. Ravitch in 1949, subperichondral resection of costo-chondral cartilage, a transverse sternal osteotomy and securing the sternum in a slightly over corrected position, multiple modifications of the procedure were described. Chest wall instability as a result of sterno-costal non-union is a rare complication but can give rise to invalidating pain and breathing problems. This case presents complicated course after a modified Ravitch procedure and a patient-specific 3D printed implant used for chest wall reconstruction

**Method:** Case-report

**Results:** A 46-year old woman with a prior history of polycythemia vera, cardiac arrhythmias and cardiopulmonary resuscitation due to ventricular fibrillation possibly triggered by her chest wall deformity (pectus excavatum) causing a dissection of a coronary artery for which she received a stent at age 35, was referred to us with complaints of anterior chest wall pain and instability. She had undergone a modified Ravitch procedure, after an initial attempted Nuss-bar procedure had failed due to per-operative retrosternal bleeding. In subsequent years she underwent multiple surgeries attempting to stabilize the anterior chest wall, reduce pain and increase quality of life, all failing to succeed for different reasons. A patient specific 3D modeled and printed Titanium prostheses, mainly anterosternal, but partially retrosternal (image 1) was used in a hybrid operation (VATS/OPEN) to both lift the sternum for pectus correction. As well as re-connecting the sternum and the sternal costal junction and the lower costal margins on both sides to each other to regain anterior chestwall stability (image 2 and 3).

*X-Thorax AP post-op*



*Post-op X-ray of the result after the operation OR View AP*



*Result of implantation for closure*



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**Conclusions:** Technological advancement together with proven surgical techniques can aid in the treatment of very specific pathology in which current golden standard fails to succeed. In the future we hope that patient specific 3D modeling and printing could help solve specific problems as technological possibilities further increase.

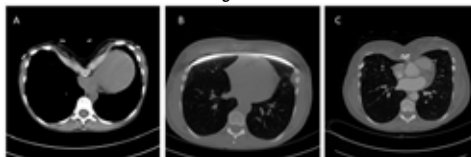
**Keywords:** Ravitch-procedure, complications, anterior chestwall instability, 3D printed implant, patient specific implant, Pectus Excavatum

**PA-31 RAPID ENLARGEMENT OF ASCENDING AORTIC ANEURYSM AFTER NUSS PROCEDURE**Mohammad Alomari<sup>1</sup>, Jennifer Morin<sup>1</sup>, Si Pham<sup>1</sup>, Mathew Thomas<sup>1</sup><sup>1</sup>Department of Cardiothoracic Surgery, Mayo Clinic in Florida

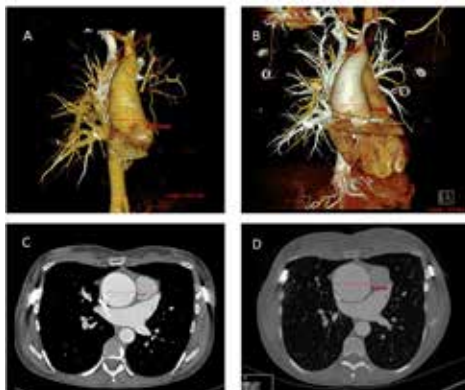
**Background and Aim:** Pectus excavatum (PE) may be associated with other genetic disorders but can occur in isolation. Aortic aneurysms can present concurrently with PE in patients with connective tissue disorders (CTD). Although simultaneous repair of PE and aortic aneurysm in patients with proven CTD has been reported, the optimal management of concurrent PE and aortic aneurysm in those without genetic or clinical evidence of CTD is unclear. We report a case of rapid expansion of aortic aneurysm after Nuss minimally invasive repair of pectus excavatum (MIRPE) in a patient without evidence of CTD, and the subsequent management.

**Method:** A 36-year-old female patient presented with shortness of breath. Evaluation showed severe PE and a 4.7cm aortic aneurysm (Figure 1A and 2 A&C); Haller index was 12.7 and Cardiac Compression Index, 3.9. Extensive clinical and genetic testing panel were negative for CTD. Following Nuss MIRPE using 2 bars, she was monitored with CT angiograms at 3, 6 and 12 months post-operatively. The pectus repair was stable (Figure 1B), but her aortic aneurysm rapidly enlarged to 5.7 cm within a year (Figure 2 B&D) meeting criteria for surgical repair. Under general anesthesia, the pectus bars were removed first through lateral axillary incisions and with thoracoscopic visualization. This was immediately followed by repair of the aortic root and ascending aorta using a Dacron graft via midline sternotomy. The sternotomy was closed using sternal plates and interrupted sternal wires (Figure 1C).

Figure 1



CT chest Axial views showing: A) Severe pectus pre-repair, B) 12-month post pectus repair, and C) Post-aneurysm repair and sternal fixation with sternal plates Figure 2



CT chest angiogram images showing rapid enlargement of ascending aortic aneurysm: from 3 months after pectus repair (A&C), to 12 months after repair (B&D).



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**Results:** The patient recovered uneventfully after her second operation. She has been followed for 2 years without any obvious recurrence of pectus or aneurysm.

**Conclusions:** Unidentified CTD and increased cardiac output after pectus repair could explain the rapid enlargement of the aortic aneurysm in our patient. Aortic aneurysms presenting concurrently with pectus excavatum and negative genetic testing should be considered for concomitant repair, or otherwise closely monitored.

**Keywords:** Pectus excavatum, Aortic aneurysms. Connective tissue, Nuss, aorta



**PA-33 NUSS SURGERY FOR PECTUM EXCAVATUM**

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**Background and Aim:** Pectum excavatum (PE) and keel-shaped chest deformity are the most common chest deformities. Ravitch performed an advanced open intervention technique in 1949. In 1998, Nuss et al. presented a minimally invasive technique as an alternative to standard open plastic surgery, the so-called minimally invasive plastic surgery of funnel-shaped deformation or minimally invasive plastic surgery of funnel-shaped deformation of the chest. Our goal was to improve the results of surgical treatment of PE by a differentiated approach and optimization of tactics with the choice of an invasive or non-invasive method of correction, depending on the degree of deformation.

**Method:** 2002 patients with PE were adjusted for the period 2019-2022. Of these, 156 patients were citizens of Uzbekistan. 250 (12.48%) patients underwent Nuss surgery - with a Haller index of more than 3.3-3.5; older age group (≥22 years); lack of efficacy from Vacuum Bell. MSCCT allows to calculate the Haller index and provides information about the size and shape of the necessary corrective metal plate.

*Haller index on MSCCT*



**Results:** In the early postoperative period, 13 (5.2%) patients had complications: pleurisy – 7 (2.8%), wound suppuration – 1 (0.4%), periimplantitis – 1 (0.4%), postoperative pneumonia – 3 (1.2%), plate detachment with displacement in 1 (0.4%) patient, in the latter case, a second operation was needed. No fatal cases were noted. Good results were observed in 237 (94.8%) patients. It should be noted that pleurisy is noted in 5% of patients older than 30 years.

*view of chest before and after Nuss procedure*





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**Conclusions:** A competently performed Nuss operation gives not only good functional and cosmetic results in the form of improving the functioning of the cardiovascular and pulmonary systems due to the return of the physiological shape of the chest walls and diaphragm, but also improves the quality of life due to better psychological and social adaptation of the individual in society.

**Keywords:** correction, pectus excavatum, plastic surgery, the Nuss surgery, Haller index



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## PA-34 SHORT TERM QUALITY OF LIFE IMPROVEMENT FOLLOWING THE MINIMALLY INVASIVE REPAIR OF PECTUS EXCAVATUM WITH CRYOABLATION

R Scott Eldredge<sup>1</sup>, Brielle Ochoa<sup>1</sup>, Kristin Mihalcin<sup>1</sup>, Emily Khoury<sup>1</sup>, Daniel Ostlie<sup>1</sup>, Justin Lee<sup>1</sup>, David Notrica<sup>1</sup>, Lisa McMahon<sup>1</sup>, Benjamin Padilla<sup>1</sup>

<sup>1</sup>Phoenix Children's

**Background and Aim:** Pectus excavatum is defined as a concave depression of the sternum and is associated with lower self-esteem and diminished quality of life. Improvement in long term physical and psychosocial quality of life is associated with the minimally invasive repair of pectus excavatum (MIRPE). The aim of this study was to determine the short term effect that MIRPE with cryoablation (MIRPE-C) has on patient reported quality of life.

**Method:** A single center prospective study was conducted from March 2021 to December 2022 of pediatric patients ≤ 21 years undergoing the MIRPE-C. Patients completed the validated Modified Pectus Excavatum Evaluation Questionnaire (MPEEQ) preoperatively and at two months post operatively. Responses used a Likert-type scale from 1 – 4; where 4 was more favorable or positive. Preoperative and postoperative responses were compared using paired- sample t-test.

**Results:** Sixty patients were enrolled with 81.2% (49/60) completing the 2-month MPEEQ; 88% (53/60) were male, with a median age of 14 years [IQR:13.3 – 16.0], BMI 17.7 [IQR: 16.3 – 19.1], Haller index 4.5 [IQR:3.7 – 5.5], and Correction index 29.9% [IQR:24.6 – 40.0]. All patients underwent MIRPE-C. The median time of postoperative survey completion was 2.1 months [IQR:2.0 – 2.3]. Compared to preoperative survey responses patients were significantly more satisfied in their appearance (Q1-Q3 and Q6-Q9) following MIRPE. Patients also reported improvement regarding chest pain, shortness of breath and fatigue related to PE (Q10-Q12). Patients had no change in feelings of sadness or depression (Q15), Table 1.

**Conclusions:** The improvements in pediatric physical and psychosocial quality of life occur within two months of MIRPE-C.

Table 1. MPEEQ Survey responses

	Mean Preoperative	Mean Postoperative 2 months	P-value	Cohen's correction
Q1. How satisfied are you with the way you look in general?	3	3.4082	0.024***	-0.334
Q2. How satisfied are you with the way you look without your shirt on?	2.6531	3.3469	<0.001***	-0.573
Q3. How satisfied are you with spending the rest of your life as your chest looks now?	2.102	3.5918	<0.001***	-1.063
Q4. How often do other people make fun of you because of your chest?	3.75	3.875	0.057	-0.282
Q5. How often do you avoid doing things like spending the night at a friend's house, going exercising or swimming, because of the way your chest looks?	3.5306	3.6939	0.185	-0.192
Q6. How often do you try to hide your chest to keep people from looking at it?	2.9796	3.5306	<0.001***	-0.603





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	Mean Preoperative	Mean Postoperative 2 months	P-value	Cohen's correction
Q7. How often are you bothered because of the way your chest looks?	3	3.7347	<0.001***	-0.906
Q8. How often does your chest make you feel shy or self-conscious?	3.2449	3.7347	<0.001***	-0.564
Q9. How often do you feel bad about yourself because of the way your chest looks?	3.5102	3.898	<0.001***	-0.606
Q10. How often has your chest caused you problems with chest pain while exercising?	2.5306	3.2041	<0.001***	-0.619
Q11. How often has your chest caused you shortness of breath?	2.2041	3.3061	<0.001***	-1.016
Q12. How often has your chest caused you to feel tired?	2.8367	3.4694	<0.001***	-0.637
Q13. How often has your chest caused you to feel irritable?	3.3469	3.5714	0.117	-0.228
Q14. How often has your chest caused you to feel frustrated?	3.3265	3.6939	0.005***	-0.416
Q15. How often has your chest caused you to feel sad or depressed?	3.7959	3.9388	0.051	-0.286
Q16. How often has your chest caused you to feel restless?	3.5714	3.6327	0.652	-0.065

*Responses from MPEEQ by Likert scale (1-4); larger number are associated with positive responses. Paired samples T test (n=49) was performed. Mann-Whitney test was also performed and revealed the same statistical findings. Cohen's Correction is provided to demonstrate effect size.*

**Keywords:** Pectus Excavatum, Quality of Life, Cryoablation

**THE EFFECT OF RIB OSTEOTOMY ON SEVERE ASYMMETRIC PECTUS EXCAVATUM: CASE STUDIES**

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<sup>1</sup>*Nishinomiya Watanabe Cardiovascular Center*

**Background and Aim:** Severe asymmetric pectus excavatum (PE) is a chest wall deformity characterized by deep depression on the affected side compared to the contralateral side. In this condition, the ribs at the costochondral junction of the affected side bend towards the dorsal side. Rib osteotomy has been reported to correct adult PE with rigid chest wall. This study aims to evaluate the effectiveness of rib osteotomy in repairing asymmetric chest deformity in patients with severe PE.

**Method:** Four female patients aged 25 to 35 years with severe asymmetric PE were included in the study. Pre- and postoperative CT images were used to measure the angle and height of the affected ribs at the costochondral junction, as well as the Haller index (HI) and sternal torsion angle (STA).

**Results:** All four patients had high-grade asymmetric deformity on the right side with an average HI of 7.5 and STA of 40.2. Following the rib osteotomy procedure, these parameters improved to 2.8 and 23.7, respectively. The average rib angle of the right 4th and 5th ribs was -29.7 and -25.0 degrees, respectively, before the surgery, and improved to 34.8 and 36.6 degrees postoperatively. Similarly, the average rib height of the right 4th and 5th ribs was 93.4 and 96.6 mm before the surgery, and increased to 126.4 and 123.6 mm postoperatively. No surgical complications were observed, and all patients had uneventful postoperative recovery. After the procedure, the ribs at the osteotomy sites were fractured and flexed but fused properly.

**Conclusions:** Rib osteotomy is an effective technique for repairing severe deformities associated asymmetric PE. This procedure can be performed with minimal invasiveness and has shown promising outcomes in the cases presented.

**Keywords:** pectus excavatum, asymmetric deformity, Nuss procedure, rib osteotomy



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## PECTUS EXCAVATUM AND SCOLIOSIS DOES ORDER OF REPAIR MATTER? A CASE REPORT

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<sup>1</sup>*The Mayo Clinic - Arizona*

<sup>2</sup>*Phoenix Children's*

**Background and Aim:** Pectus Excavatum (PE) results in a concave depression of the sternum. Concomitant postural abnormalities such as scoliosis and kyphosis occur in approximately 15- 20% of cases. Order of repair of these conditions has not been clearly defined. We present a case of PE with concomitant scoliosis with attempted scoliosis repair prior to PE repair.

**Method:** A 14-year-old boy with known PE and BMI of 17.7 was evaluated for repair of scoliosis. A 3-view spinal x-ray demonstrated severe scoliosis with 70 degrees, Sander's score of 8 and Risser stage 3. He was schedule for a posterior spinal fusion (PSF).

**Results:** In the OR the patient was induced with general anesthesia; an arterial line was placed with systolic blood pressures (SBP) 80 - 90 mmHg. After proning, the patient became acutely hypotensive with SBP <50 mmHg and mean arterial pressure <40 mmHg. The patient was returned to a supine position with subsequent hemodynamic improvement. The case was canceled, and the patient was transported to the PACU. One month later the patient was evaluated for PE. On chest MRI he was found to have a Haller index of 5.2 and Correction index of 19%. Echocardiogram demonstrated sternal compression of the right ventricle with normal function. Cardiopulmonary exercise stress testing was pertinent for a percent predicted peak VO<sub>2</sub>/kg and O<sub>2</sub>pulse of 67% and 61%, respectively. He underwent repair of PE without complication. Three months later he underwent PSF without incident.

**Conclusions:** Surgical timing of PE and scoliosis is critical in providing safe patient care. Cardiopulmonary performance can be compromised due to sternal compression with reduced function in the prone position. Evaluation with 3-D imaging should be done prior to PSF to evaluate for risk of further cardiac compression with scoliosis compression and consideration should be made to repair the PE first.

**Keywords:** Pectus Excavatum, Scoliosis, Minimally Invasive Repair of Pectus Excavatum



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## PRESENTATION OF TWO CASES WITH SEVERE PECTUS EXCAVATUM

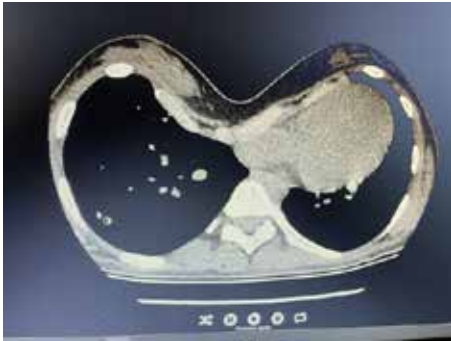
TUBA APAYDIN<sup>1</sup>, MURAT AKKUŞ<sup>1</sup>

<sup>1</sup>S.B.U. İSTANBUL MEHMET AKİF ERSOY THORACIC AND CARDIOVASCULAR SURGERY TRAINING AND RESEARCH HOSPITAL

**Background and Aim:** Pectus excavatum, also known as funnel chest or trichterbrust, is a congenital chest wall deformity characterized by concave depression of the sternum, resulting with cosmetic and radiographic alterations. We aimed to present two cases with severe pectus excavatum which were treated with minimally invasive repair of pectus excavatum(MIRPE).

**Method:** Case 1:A 13 year old female was admitted to our clinic with severe pectus excavatum for surgery. She didn't benefit from vacuum treatment of 1 year follow up. She had fatigue and palpitation. In computed tomography scans, sternum depressed the heart and great vessels(Photo 1). We performed Nuss surgery using two parallel bars. She underwent an unevenful recovery and we discharged her after 5 days.case 2:An 16 year old male was admitted to our clinic with severe pectus excavatum for surgery. He had chest pain. In computed tomography scans, sternum depressed the heart and lung(Photo 2). We performed Nuss surgery using two parallel bars. He underwent an unevenful recovery and we discharged him in 6 days.

Photo 1



Preoperative computed tomography scan of case 1

Photo 2



Preoperative computed tomographic scan of case 2

**Results:** Adequate correction of thoracic silhouette improved both cardiac and respiratory disorders in the early term follow-up.Neither complication nor recurrence were seen in the 1 year follow up.

**Conclusions:** Successful surgical correction of pectus excavatum cases is achieved with MIRPE improving cardiopulmonary symptoms.As there are many different techniques available,even treatment of complex cases as in our patients can be achieved with MIRPE with adequate correction of the thoracic deformity and reduced recurrence rates.

**Keywords:** pectus excavatum, Nuss, surgery



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## MIRPC-PROCEDURE AND SANDWICH-TECHNIQUES FOR ASYMMETRIC PECTUS CARINATUM AND COMBINED EXCAVATUM/CARINATUM COMPLEX

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**Background and Aim:** Open procedures have been replaced by minimally invasive techniques in the correction of pectus excavatum and pectus carinatum. But particularly in the repair of asymmetric pectus carinatum or excavatum/carinatum complex, simple external compression seems to have its limitations. Accordingly, a new technique, called the sandwich-technique, was developed. This fairly new procedure combines the MIRPE/MIRPC technique, whereas external and internal bars are simultaneously applied (press molding) to remodel the entire chest wall. Herein, we report our experiences with the Abramson procedure (MIRPC) for pectus carinatum correction and the sandwich technique for repair of excavatum/carinatum-complex.

**Method:** Between October 2019 and May 2023 11 patients (all male; mean age 15,9 years) with pectus carinatum received a MIRPC-procedure and 4 patients (all male; mean age 15 years) underwent a sandwich-repair for combined PE/PC-complex (“mixed type”). For all MIRPE-repairs the short-bar-technique was used.

**Results:** All 15 patients tolerated the procedure well. Mean operation time for the MIRPC-procedure was 121 minutes and 164 minutes (including 45 minutes for cryoablation) for the sandwich-technique. Median hospital stay length was 3 days for patients with MIRPC-repair and 4 days for the sandwich-group. The sandwich-repair using 1 external MIRPC- and 1 internal MIRPE-short bar were applied to 3 patients and 1 patient received a correction using 2 MIRPE short-bars and 1 MIRPC bar. No intraoperative complications were recorded. 1 patient who underwent a sandwich repair developed postoperative Dressler’s-Syndrome with pericardial effusion as an early complication. It was treated with a single substernal puncture. No late complications were observed. No bar dislocation or rotation occurred.

**Conclusions:** The MIRPC-procedure and the sandwich-technique are safe and effective procedures in the treatment of pectus carinatum and its variants, in particular in the repair of asymmetric pectus carinatum or combined excavatum/carinatum-complex. Both procedures provide excellent aesthetic results as well as subjective satisfaction with the outcome of surgical treatment.

**Keywords:** MIRPC; Sandwich; Pectus Carinatum; mixed-type-deformity; minimally invasive;



**SURGICAL AND LOCAL TREATMENT OF PAIN IN TIETZE SYNDROME: OUR EXPERIENCE IN UNIVERSITY HOSPITAL “SHEFQET NDROQI”**

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<sup>1</sup>University Hospital “Shefqet Ndroqi”

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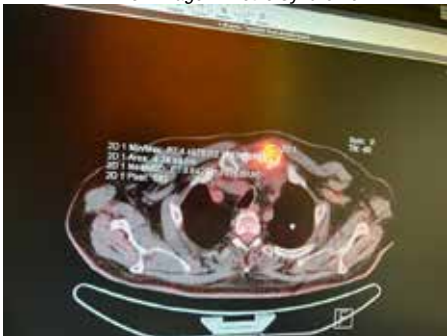
**Background and Aim:** In this study, we present our experiences with local treatment and surgical treatment in patients diagnosed with Tietze syndrome

**Method:** Between January 2008 and January 2023, a total of 17 patients (6 males, 11 females; median age: 33 years; range, 27 to 67 years) who were diagnosed and treated with TS in our clinic. Pain killer were injected into painful joints. Pain was also assessed at several weeks after injections qualitatively and based on physical examination. All patients were medically treated. Only one patient, aged 47. In 2008, a resection of the II-III sternocostal segment was performed. The patient was doing well until the end of 2011. She relapsed and the IV-V sternocostal segment was involved. Intervention is performed by resecting the IV-V sternocostal segments and covering the defect with PPTe mesh and soft tissues. In 2014, she had infection and underwent re-intervention by cleaning the infection and replacing the mesh. Post-intervention pain dominated, but presented in 2016 with redness and edema and erosion of the skin at the level of the medial corner of the operative wound. In the other 16 patients, they were treated medically. Steroids and local anesthetic were used. In 8 patients, oral or i/m and i/v antibiotics were also used, systemic anti-inflammatory drugs were also used. The patients felt calmer and performed better. good 2 weeks after treatment.

**Results:** At two weeks, The patients felt calmer and performed better. The pain severity before the local injection treatment was above average the pain-related discomfort rates, and the response was quite favorable after the treatment. A statistically significant rating was observed for treatment response and success. Twelve patients experienced reduction in pain level after the injection.

**Conclusions:** Patients diagnosed with Tietze syndrome and local steroids or anesthetic injection provides a rapid relief from pain, or employment status. Surgical treatment was used only in selected case.

*PET CT image in Tietze Syndrome*



*PET CT image in Tietze Syndrome Tietze syndrom under medical treatment.*



*Tietze syndrom under medical treatment*

**Keywords:** Arthralgia; Tietze syndrome; chest pain



## PA-41 EXPERIENCE IN THE MANAGAMENT OF PECTUS EXCAVATUM WITH PROCEDURE OF NUSS IN CHILDREN IN AT PEDIATRIC HOSPITAL IN MEXICO.

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<sup>1</sup>*High Specialty Medical Unit, Pediatric Hospital, National Medical Center of the West, Mexican Social Security Institute*

**Background and Aim:** Pectus excavatum (PE) is the most common malformation of the anterior wall of the thorax managed at the High Specialty Medical Unit, Pediatric Hospital, National Medical Center of the West, IMSS. Since 2013, the surgical technique for its correction selected is that described by Dr. Donald Nuss. The aim is describe the experience ans results f in the northwestern region of Mexico. Currently, the assessment of the severity of PE is based on the Haller index by computed tomography (CT).

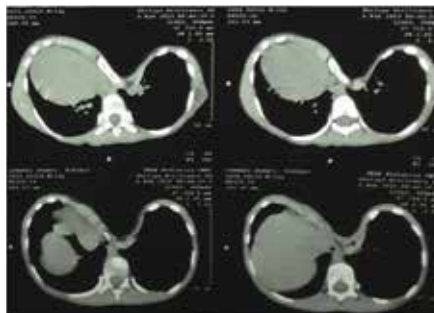
**Method:** Descriptive study of consecutive cases with PE since August 2013-April 2023, who underwent surgical correction with the NUSS technique and thoracoscopy. Ethical aspects were respected, study did not receive external funding.

**Results:** A total of 78patients have been managed, 58 were male(74.3%) and 20 female(25.6%). The age range was 8 to 17years, mean age was 13.9(SD3.2). The average Haller Index was 5.65(SD1.6). 4 patients had history of thoracic surgery due to congenital pulmonary malformation, decortication was performed in the same surgery. A total of 108bars have been placed in 78patients, an average of 1.4with a range of 1 to 2. The average hospital stay was3.8 days(3-17days). The most frequent complications were:displacement of the bar 8patients (10.25%), 1required its removal; granulomas 6patients(7.6%), pneumonia 3patients (4%), exposure of the bar patients (4 %), rejection due to pain, 2 patients, its removal was necessary(2.5%), pericarditis and massive bleeding, 1 patient(1.2%), 0% mortality. The duration of the bars was 25-40months (average 30 months). In 20patients have been removed the bars with satisfactory results for the patients.

*patien with PE and grand cayon*



*He was our firt patient trated in our hospital TAC*



*Study of elecction for surgery*

**Conclusions:** The NUSS technique is adequate and safe for PE correction in children treated in our Hospital. The Mexican Social Security Institute is the most important health care institution in Mexico and our hospital is a reference center for patients with PE from all over the West of our country.

**Keywords:** Pextus excavatum, complicatips, children, Pextus excavatum, complications, children, Pextus excavatum



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## PA-42 A RETROSPECTIVE ANALYSIS OF CHEST WALL DEFORMITIES INCIDENTALLY DETECTED IN EMERGENCY DEPARTMENT PATIENTS: AN OBSERVATIONAL STUDY

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<sup>1</sup>İzmir Katip Çelebi Üniversitesi

<sup>2</sup>İzmir Atatürk Training and Research Hospital

**Background and Aim:** The most frequently observed chest wall deformities are pectus excavatum and pectus carinatum. The purpose of this observational study was to examine the prevalence of chest wall deformities in adult patients presenting for various reasons to the emergency department in our institution, a regional reference center for chest deformities, the demographic characteristics of patients with such malformations, emergency presentation symptoms, and the effects of deformities on patients' psychological state.

**Method:** Two hundred forty cases presenting to the İzmir Katip Çelebi University Atatürk Training and Research Hospital tertiary emergency department and meeting the inclusion criteria were investigated retrospectively. The cases' demographic data, presence of family histories of similar deformities, presentation symptoms, deformity depths, Haller indices, and patients' psychological deformity levels were determined and subjected to statistical analysis.

**Results:** The prevalence of pectus excavatum among the patients presenting to our center was 1/308, while the prevalence of pectus carinatum was 1/698. The patients' mean age was 24.75 years, and 84.6% were men. Accompanying psychological deformity was present in only 28.33% of cases. The presence of family history was determined at 38.8%. The patients' mean Haller Index value was 3.16, and the mean depth of deformity was 2.5 cm. Haller Index values were significantly higher among patients with moderate or severe psychological deformity than in the other patients ( $p < 0.001$ ). The Haller Index exhibited a high correlation with depth of deformity ( $p < 0.001$ ) and negative correlation with patients' body mass index values ( $p = 0.024$ ).

Table 1.

Table 1. Descriptive values.		
Variables	Values	Patients with pectus excavatum
<b>Group, n (%)</b>	175 (72.9)	
Pectus excavatum	29 (12.1)	
Pectus carinatum	36 (15)	
Other		
<b>Age, years</b>		
x±SD	24.75±6.14	25.17±6.22
M (min-max)	24 (18-55)	24 (18-55)
<b>Gender, n (%)</b>	37 (15.4)	
Female	203 (84.6)	25 (14.28)
Male		150 (85.71)
<b>Family history, n (%)</b>		
Yes	93 (38.8)	56 (32.00)
No	147 (61.2)	119 (68.00)





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<b>Table 1. Descriptive values.</b>		
<b>Structural anomalies, n (%)</b>		
ASD	6 (2.50)	2 (1.14)
Aortic insufficiency	6 (2.50)	4 (2.28)
Dextrocardia	3 (1.25)	2 (1.14)
Mitral valve insufficiency	8 (3.33)	3 (1.71)
Scoliosis	20 (8.33)	10 (5.71)
VSD	3 (1.25)	2 (1.14)
<b>Psychological deformity, n (%)</b>		
None	68 (28.33)	62 (35.43)
Minimal	97 (40.41)	58 (33.14)
Mild	41 (17.08)	31 (17.71)
Moderate	26 (10.83)	17 (9.71)
Severe	8 (3.33)	7 (4.00)
<b>Emergency presentation Symptom, n (%)</b>		
Dyspnea		
Palpitation	12 (5.00)	10 (5.71)
Effort dyspnea	15 (6.25)	12 (6.85)
Chest pain	19 (7.91)	11 (6.28)
Syncope	16 (6.66)	9 (5.14)
Back pain	3 (1.25)	1 (5.20)
Other reasons for presentation	23 (9.58)	17 (9.71)
	152 (63.33)	115 (65.71)
<b>BMI</b>		
x±SD	21.51±3.07	
M (min-max)	21 (15-35)	21.71±3.13 21 (15-35)
<b>Haller Index</b>		3.16±0.54
x±SD		3.00 (2.60-5.60)
M (min-max)		
<b>Depth of deformity</b>		
x±SD		2.50±0.83
M (min-max)		2.40 (1.00-5.60)

Abbrev.; %: Row percentage, M: Median, x: Mean, SD: Standard Deviation  
Descriptive values.

Table 2

	Haller Index	Test statistics	
	M (min-max)	H value	p value
Psychological deformity None	2.9 (2.6-3.6) <sup>a</sup>	84,279	<0.001
Minimal	3.0 (2.6-3.8) <sup>b</sup>		
Mild	3.2 (2.7-4.3) <sup>c</sup>		
Moderate	3.9 (3.2-4.7) <sup>d</sup>		
Severe	4.9 (3.8-6.0) <sup>d</sup>		

Abbrev.; M: Median, H: Kruskal Wallis test,

The letters a b c d represent multiple comparisons. There is no statistical difference between groups containing the same letter; there is a statistically significant difference between groups containing different letters.

A comparison of psychological deformity and Haller Index values.



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**Conclusions:** Chest wall deformities are a very common societal health problem, one that exhibits psychological effects and familial predisposition, and that can lead to various physiological problems. Familial disposition levels may vary among societies. Adult patients begin to tolerate the presence of low body mass index and psychological deformity. Prospective studies are now needed for a greater clarification of these issues.

**Keywords:** pectus excavatum, pectus carinatum, chest wall anomalies, psychological deformity, Haller Index

**TREATMENT OF EXTRA DEEP LOCAL PECTUS EXCAVATUM (CASE REPORT).**

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**Background and Aim:** pectus excavatum (PE) is the most common congenital anterior chest wall deformity, present in 85-90% of patients with chest wall deformities and occurs in approximately 1:1000 to 3:1000 of all live births, with a male predominance (4:1). PE with extra deep local deformity due to significant sternal angulation is rare, and methods of surgical correction are not standardized. We present our first experience of hybrid correction of the extra deep local PE combining sternal incision with osteosynthesis and substernal Nuss bar.

**Method:** 16y male patient was electively admitted to the department of pediatric surgery with PE with extra deep local deformity. Given the identified type of deformity and the absence of contraindications, we decided to perform a surgical treatment using hybrid Nuss-Ravitch procedure. Was a V-shape horizontal partial sternal resection at the top of deformity with preservation of posterior cortex and Nuss procedure was done as it is done in primary cases after sternal incision. After completion of Nuss procedure sternal osteosynthesis was done by parallel vertical low profile titanium bars.

**Results:** The duration of the surgery was 260 minutes. Starting from the first day after surgery, the patient proceeded to respiratory physiotherapy. The patient was discharged in satisfactory condition on the 6th day. On follow-up 3 months after surgery, sternotomy wound consolidated. We plan to remove the Nuss bar 36 months after the surgery, sternal osteosynthesis plates can be left for the lifetime.

**Conclusions:** the presented case demonstrates treatment of a rare type of pectus excavatum in pediatric surgical practice. The use of the hybrid surgery technique significantly improved the cosmetic result and reduced the traumatic nature of the intervention, which contributed to the speedy motion activity of the patient and reduced the postoperative rehabilitation period.

**Keywords:** pectus excavatum, chest wall deformity., Nuss procedure, Ravitch procedure



# 23<sup>RD</sup> ANNUAL CONGRESS OF THE CHEST WALL INTERNATIONAL GROUP

JUNE 22-24, 2023 TURKEY *Istanbul*

## IMPACT OF RECURRENT SPONTANEOUS PNEUMOTHORAX ON THE TREATMENT OF CHEST WALL DEFORMITIES

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**Background and Aim:** Patients with chest wall deformities, particularly those related to syndromes, can have pulmonary bullae and recurrent spontaneous pneumothorax (RSP). While the relationship between Pectus Excavatum and pneumothorax has already been reported, there is a lack of information on the management of chest wall deformities with concomitant spontaneous pneumothorax and the impact on their treatment.

**Method:** This study presents a descriptive analysis of the management and results of a cohort of patients with subpleural blebs with RSP and severe chest wall deformities from 2016 to 2021.

**Results:** Six cases are described in this study, including 2 with Pectus Excavatum (PE), 3 with Pectus Carinatum (PC), and 1 with a hybrid malformation. The median age of the patients was 15 (range 13 to 17), and 5 were male and 1 was female. 50% of the patients had Marfan syndrome or other connective tissue diseases. All patients had recurrent spontaneous pneumothorax with apical blebs (50% bilateral). The PC patients were all under brace treatment when RSP occurred. Two of them refused to continue with the brace after bleb resection with pleurodesis, and one was corrected by Abramson technique 6 months later. Of the PE patients, one had bilateral RSP with surgery prior to evaluation of the chest wall deformity and was treated non-operatively with a vacuum bell, rejecting surgical correction. The other patient underwent the Nuss procedure and bleb resection in the same procedure. The patient with the hybrid malformation had RSP 1 month after the Sandwich technique. CT showed a left bullae that had not been present in the initial CT, and thoracoscopic resection was performed.

**Conclusions:** The association of chest wall deformities and RSP due to subpleural blebs is not rare, particularly in patients with connective tissue diseases. RSP can have an impact on the treatment of chest wall deformities.

**Keywords:** chest wall deformities, spontaneous pneumothorax, blebs, treatment management, thoracoscopic pleurodesis

## 3D MODELLING AS A TOOL TO IMPROVE ASYMMETRIC PECTUS CARINATUM SURGICAL REPAIR

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**Background and Aim:** Protruding sternum deformities greatly affect self-image, especially in female adolescents who seek plastic repair. Published techniques and approaches allow a very good structural repair through a sub-mamarian or a midline anterior incision while transverse wedge sternal resection with chisel and hammer, usually straight forward, is imprecise. For asymmetry, however, wedge dimensions and angle are manually tailored intraoperatively, having only one opportunity for the bone resection. The aim of this presentation is to show a way to design cutting guides before surgery to plan this asymmetric sternal wedge resection choosing the best angle and dimension from serial options. This methodology is novel and reproducible, using available software and 3D printing devices.

**Method:** We present the retrospective review of two patients in which preoperative digital planning and osteotomy simulation using computer-assisted planning platform. [3-matic], permitted the surgical strategy to be simulated and later chosen from several possibilities. Sternal bone incisions were done using a 3D printed cutting guide as template for the piezoelectric bonesaw. The plastic guide matches the outer surface of the sternum fitting in position with holes in its margin that allow screw fixation, avoiding twisting or dislodgement giving precise wedge cuts. Sternal fixation was completed with titanium plate and screws reaching excellent stability. Regional blocking for postoperative anesthesia, NSAIDs and oral acetaminophen gave good pain control as to be discharged both patients on postoperative day 3.

*Cutting guide simulation*



*Sideview of sternum and simulated cutting guide in place  
(green color) 3D printed cutting guide in place*

**Results:** Intraoperative bone stability and deformity correction was deemed excellent. Good cosmetic and radiologic postoperative results were observed in both patients. Postoperative follow up of 3 and 4 months show consistent good radiologic bone consolidation.

**Conclusions:** The described methodology permits accurate, reproducible, and precise sternal resection for plate/screw sternal fixation in asymmetric pectus carinatum repair.

**Keywords:** 3D preoperative modelling, asymmetric pectus carinatum, pectus carinatum repair



**PA-46 USE OF FAT TO PROMOTE HEALING TO SAVE NUSS BAR EXPOSURE**

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**Background and Aim:** Among the minor complications reported after the placement of Nuss bars is the dehiscence of the wound and exposure of the bar, this can cause their removal. Adipose tissue transfer have been described since 1893, but was until 1997 that Coleman reported it, that it gain popularity. We present the case of use of fatty tissue for soft tissue regeneration with the usual technique at the bar exposure site,

**Method:** We present the case of a 16-year-old male patient, who 1 month after pectus excavatum correction surgery with 2 bars presents exposure of these. Therefore, in conjunction with the plastic surgery service, we planned to conserve the bars. For what is indicated pre-surgically to improve food intake to promote weight gain, a culture is taken from the bar exposure site. Once counting with negative culture. The patient underwent to surgery under subarachnoid blockade and liposuction was performed in the abdomen and hip, after the the fat tissue was infiltrate t at the bar exposure site. The patient was discharged the following day. It was necessary to perform the procedure on seconoccasions due to the low availability of adipose tissue.

**Results:** With the infiltration of fat tissue t it was possible to conserve the bars. It requires 2 infiltration, for this procedure only required 1 day at hospital. No complications were reported.

*PE patient with bar exposure.*



*Bar exposure*

**Conclusions:** With its filling and regenerative properties, autologous fat transfer provides a reliable minimally invasive procedure for many reconstructive and aesthetic procedures. One of the fundamental limitations is that the amount of tissue transfer is strictly limited by the amount of fatty tissue available in the patient. Therefore, it is an excellent alternative for the dehiscence of wounds and exposure of bars in PE surgery.

**Keywords:** Fat Tissue



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## PA-47 SURGICAL TREATMENT IN A COMPLICATED RECURRING PECTUS EXCAVATUM CASE

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**Background and Aim:** Pectus excavatum is the most common chest wall deformity. Early repair of pectus excavatum using Ravitch surgery in young patients may result in recurrence in adulthood.

**Method:** Here we present a recurring pectus excavatum case who had underwent modified Ravitch sternoplasty at 8 years of age. The minimally invasive repair of pectus excavatum was applied. The developing carinatum deformity at 6th postoperative month was corrected using a modified Ravitch sternoplasty.

**Results:** The patient presented to our clinic at 20 years of age with a Grand Canyon deformity. He underwent minimally invasive repair of pectus excavatum with 2 parallel bars and right sided bullectomy at the same session. He was discharged at 7th postoperative day. Six months after the surgery, his sternum started to change into a carinatum deformity starting from manubriosternal angle. Surgery is scheduled to correct the deformity and he underwent an open modified Ravitch surgery. The convexity of the first bar is decreased and reimplanted and a wedge osteotomy is applied to the manubriosternal angle. 4th, 5th and 6th ribs are separated from the sternum bilaterally, these ribs reconnected to the sternum using plate and screws after bringing the sternum to the same plane as the ribs. His postoperative period was uneventful and was discharged at 6th postoperative day.

*Minimally Invasive Repair of PE*



*Recurring pectus excavatum after Ravitch surgery has been corrected using 2 parallel bars.*

*Correction of Developing Carinatum Deformity*



*Developing carinatum deformity has been corrected using open modified Ravitch sternoplasty.*

**Conclusions:** Minimally invasive repair of pectus excavatum can be safely applied in patients who have previously underwent Ravitch surgery. However one should be prepared for any unwanted complications due to the techniques used in Ravitch surgery. These reoperated patients should be followed up closely. Re-surgery may be needed for any bony deformity.

**Keywords:** recurrence after Ravitch, pectus excavatum, pectus carinatum

**INTERACTIVE CASE REPORT: MANAGEMENT OF PECTUS EXCAVATUM IN AN ADOLESCENT WITH UNDIFFERENTIATED CONNECTIVE TISSUE DISEASE, RECURRENT PNEUMOTHORAX AND INTRAOPERATIVE DIAGNOSIS OF ATRIAL MASS**

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**Background and Aim:** Management and decision-making may be difficult in patients with several comorbidities associated to severe pectus excavatum. Complications after pectus excavatum correction related to thrombus migration have been reported in literature.

**Method:** We hereby describe a case of an adolescent with an incidental and intraoperative diagnosis of a right atrial mass during pectus excavatum correction.

**Results:** Case report: Sixteen-year-old patient with the following medical background: undifferentiated connective tissue disease, recurrent retinal detachments and visual acuity of 5%, recurrent right pneumothorax requiring chest drains, exercise intolerance and severe pectus excavatum. Diagnostic workout included transthoracic echocardiography, cardiac magnetic resonance and chest computed tomography (CT). Severity indexes of the chest deformity were: Haller Index 4.6 and Correction Index 42%. Cardiac studies showed mild compression of the right heart chambers and minimal dilatation of the sinuses of Valsalva. Right pulmonary bullae were described in the CT. Clinically the patient referred exercise intolerance and problems regarding his body perception. During Pectus excavatum correction, with sternal elevation by crane technique, a right atrial mass was diagnosed by transeophageal echocardiography.

**Conclusions:** Management, decision-making and outcome of this patient are presented and discussed interactively.

**Keywords:** pectus excavatum, pneumothorax, atrial mass, connective tissue disease





## MODERN TECHNOLOGIES IN THE CORRECTION OF THE PECTUS CARINATUM

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**Background and Aim:** The precise etiology of pectus carinatum (PC) remains unclear. The main hypotheses are developmental disorder, costal cartilage overgrowth, or genetic predispositions. Patients with PC mainly suffer from cosmetic issues, resulting in a reduced self- image and a lower quality of life than patients without this deformity. Both cosmetic and functional impairments are indications for surgical correction. Currently, PC could be repaired with both surgical and conservative methods, which are available. The history of modern treatments for PC dates back to 1949 when Ravitch described his technique of removing the abnormal costal cartilage and sternal osteotomy. But the recurrence rate after the Ravitch procedure could reach even 30%. In growing patients, the compressive external bracing is a high-profile, non-invasive PC treatment method that could succeed and help avoid the operation. In some departments, the results were so favorable that the brace therapy was introduced as a first-line treatment for PC, followed by surgery once the effect was not satisfying. In 2005, Abramson described the minimally invasive surgical technique for correcting PC. Aim - is to improve the results of treatment of the pectus carinatum.

**Method:** 3454 patients with PC were corrected for the period 2019-2022 (fig. 1). 400 patients of them were citizens of Uzbekistan. There were 2824 (81.7%) males and 630 (18.3%) females. The age of patients ranged from 12 to 20 years. 4 (0.116%) patients were performed the Abramson surgery, in the remaining 3451 (99.91%) cases, the PC was corrected using compressive external bracing (fig. 2).

fig 1



pectus carinatum fig 2



external bracing

**Results:** The average period of wearing the corset was  $18 \pm 6$  months for 14-18 hours a day. Good and satisfactory results were obtained in 96% of cases.

**Conclusions:** Overall, the results obtained with bracing are considered better than those obtained with surgical procedures, making this the first treatment of choice for compliant patients with pectus carinatum.

**Keywords:** pectus carinatum, Abramson surgery, correction, external bracing



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