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Chi Seung Lee

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Virtual Reality Application in Surgical Simulation

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INTRODUCTION

Recent advances in technology of medical image have made surgical simulation that is helpful to diagnosis, operation plan, or education. Improving and enhancing the medical imaging have led to the availability of high definition images and three-dimensional (3D) visualization, it allows a better understanding in the surgical and educational field.

The Real human field of view is stereoscopic. Therefore, with just 2D images, stereoscopic reconstruction process through the surgeon's head, is necessary. To reduce these process, 3D images have been used. 3D images enhanced 3D visualization, it provides significantly shorter time for surgeon for judgment in complex situations.

Based on 3D image data set, virtual medical simulations, such as virtual endoscopy, surgical planning, and real-time interaction, have become possible. This article describes principles and recent applications of newer medical imaging techniques and special attention is directed towards medical 3D reconstruction techniques.

1. KINEMATIC IMAGING

Using CT or MRI of various positions of human body, kinematics of movement can be identified. For virtual surgery, information of the anatomy spatial relationships and moment is necessary. This kinematic information can be acquired by using measurements from 3D reconstructed surgical models and computer-aided design software.

As well as CT or MRI, 3D electromagnetic motion capture device was also used to detect the motion of body. 4D CT is also used and it can provide adequate and novel assessment of biomechanics both before and after surgical repair. 4D kinematic MRI datasets allow to view anatomical structure from any viewing perspective in real-time.

2. SURGICAL SIMULATION

For an interactive virtual reality-based simulation, several features such as virtual camera, surgical equipment model, reference patient model, and texturing and rendering are necessary. Each feature must have same display and material properties with real situation. For example, in case of camera, in order to display a screen like the actual surgery, the virtual camera should have same optical angle as an real endoscope view.

In case of soft tissue, it often has elaborate nonlinear material characteristics such as soft tissues that are soft and compliant to small strains. Therefore, to express the material characteristics, a constraint-based finite-element algorithm is used to simulate the nonlinear incompliant tissue materials efficiently for interactive simulation applications.

CONCLUSION

Development of CT, MR and other imaging modalities has ensued in new applications and possibilities of medical imaging. Among them, 3D images are enthusiastic issue on clinical and research field. It can help the clinician to more effectively and shortly understand and decision. In addition, 3D images provide advanced medical related applications, which is considered as a powerful instrument for clinician, students, as well as public health.

Session 1: Pectus Excavatum : Diagnostic Tools & Functional Studies

Effect of Positional Echocardiogram on Right-sided Hemodynamics Based on Pectus Excavatum Severity

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PURPOSE

Patients with pectus excavatum may complain of dyspnea on exertion or decreased exercise tolerance due to right sided cardiac compression. Transthoracic echocardiograms (TTE) are routinely performed in the supine at rest, during no symptoms. The aim was to evaluate the effect of positional change on right-sided hemodynamics using TTE going from supine to sitting position. In addition, we assessed for correlation between Haller index severity and right-sided hemodynamics.

METHODS

A prospective cohort of symptomatic PE patients an undergoing evaluation at Mayo Clinic underwent routine 2-D TTE with Doppler assessment of Right Ventricular Outflow Tract (RVOT) Velocity Time Integral (VTI). Additional assessment of the RVOT VTI was performed in the sitting position (Figure 1). The cohort was split into three groups based on Haller index (<4, 4-5, >5). Paired t-test was performed to assess significant differences in patient's symptoms, peak exercise VO2, and positional right-sided hemodynamics among the three groups.

RESULTS

The proportion of patients with complaints of dyspnea and palpitations increased with increasing pectus severity, although these differences were not statistically significant (Table 1). There were no significant differences amongst three groups regarding peak predicted VO2. There was an inverse relationship between RVOT VTI and Haller index severity in both supine and sitting position. As compared to less severe group (Haller index <4), those patients with most severe pectus abnormality (Haller index >5) had significantly lower RVOT VTI in sitting position (13.9±3.2 vs. 10.6±3.1, P=0.047) consistent with more abnormal right-sided hemodynamics. There was a direct relationship between percent RVOT positional change and Haller index severity, although not statistically significant likely due to sample size.

CONCLUSION

This is the 1st study showing the feasibility and utility of dynamic echocardiography in assessing right ventricular hemodynamics based on pectus excavatum severity.

Table 1	Haller Index <4	Haller Index 4-5	Haller Index >5	P-Value
N	14	9	6	
Haller Index	3.2±0.5	4.5±0.4	5.6±0.5	
Dyspnea (%)	86	89	100	NS
Palpitations	71	78	83	NS
Fatigue	36	33	33	NS
Exercise Intolerance	79	44	67	NS
Peak VO2 Predicted %	76.0±14.9	69.3±2.8	75.3±15.5	NS
Supine RVOT VTI (cm)	17.2±3.2	16.3±2.8	*14.4±2.8	0.08
Sitting RVOT VTI (cm)	13.9±3.2	13.1±2.4	*10.6±3.1	0.04
Change in RVOT VTI %	19	20	26	NS

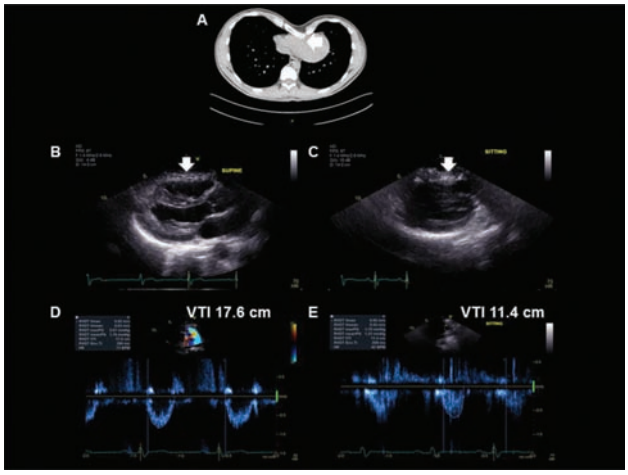

Figure 1. Comparison of Right Sided Hemodynamics based on Position in a Patient with Severe Pectus Excavatum (PE) Deformity. (A) Computed tomography image demonstrating significant PE with significant compression of the right ventricle (RV) (arrow). (B and C) TTE images demonstrating RV external compression in supine and sitting position (arrow), note the decrease in RV size when the patient sits up. (D, E) Significant decrease in RVOT VTI going from supine to sitting position.

• Free Paper: Oral

Is there is Unifying Mechanistic Explanation for Cardio-Respiratory Dysfunction in Patients with Pectus Excavatum?: A Preoperative Prospective Clinical Study

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INTRODUCTION

Patients with pectus excavatum (PE) frequently report compromised exercise ability, the cause of which has been attributed to cardiac compression. This study was undertaken to provide comprehensive examination of the contribution of the respiratory and cardiac systems to exercise dysfunction.

METHODS

Between 2006 and 2017, 65 consecutive patients, with a mean age 20.2 Years (range 14-46 years) completed physiological assessment by cardiopulmonary exercise test (CPET) evaluation. The bicycle ergometer protocol, standardised in accordance with The American College of Chest Physicians was used. Measures of work, oxygen utilisation, lung and cardiac function were recorded as percentage of predicted at peak exercise. Statistical analysis included students t-test, $p<0.05$. Univariate and multi-variate analysis was used to identify primary predictors of exercise dysfunction.

RESULTS:

The work achieved was 88.7% (+/- 14.0) and the O2 Pulse 88.0% (+/- 16.2) of predicted values, whilst VO2 Max and VO2 AT were reduced 78.0% (+/- 15.1%) and 43.5% (+/-10.5) respectively. Breathing Reserve (BR%) and Respiratory rate (RR) that were both elevated showed a correlation of $r=-0.62$, $p<0.001$, and inverse correlation with O2 Pulse (Surrogate of stroke volume) and VO2 Max, each $r=-0.52$, $p<0.001$. Linear regression identified that BR% and O2 Pulse were two of four predictors of VO2Max, R2 being 83.3%. Predictors of O2 Pulse was predicted by BR% and PET CO2, $p<0.001$, which were determined by Respiratory Rate, $p<0.001$.

CONCLUSION

The results confirm that the population of patients with PE have significant reduction in the oxygen delivery capacity during exercise. The limitation has been shown to be causally related to cardiac and respiratory dysfunction, limitation of cardiac function being related to compromised ventilation capacity. We therefore hypothesise that PE causes restricted chest wall movement, reduces respiratory and then secondarily cardiac function, a composite that inhibits exercise capacity.

Severity of Chest Wall Depression is Associated with Cardiac Dysfunction in Pectus Excavatum: Prospective Observation Study in Minimally Invasive Repair

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BACKGROUND

It has been hypothesized that there is impairment of cardiac function in pectus excavatum have visible deformities of the heart on radiological images. This study is based upon the measurement of B-type natriuretic peptide (BNP) secreted by the ventricle of the heart in response to excessive stretching of heart muscles by the severity of the chest wall depression in pectus excavatum.

METHODS

Prospectively, we measured the blood level of BNP at pre/post-operative 1, 3, 5 and 7 days in 50 patients underwent Nuss pectus repair. We investigated the correlation between serial changes of BNP and severity of chest wall deformity (Haller index).

RESULTS

The mean Haller index was 4.2±0.8 (3.3-6.2) in patients with severe chest wall depression (CT index≥3.2 (n=34)). FVC% ($p=0.007$) and FEV1% ($p=0.040$) were impaired and preoperative BNP was more elevated in severe group ($p=0.012$) compared to non-severe group (Table 1). Postoperatively, BNP level in severe group remained higher compared to non-severe group until postoperative 5 days. The BNP level in severe group was normalized at postoperative 7 days (Table 2).

CONCLUSIONS

Our results might provide the objective evidence of cardiac dysfunction and differences of postoperative recovery by the severity of chest wall depression in pectus excavatum.

Table 1. Follow-up data of B-type natriuretic peptide

Group	CT index<3.2 (n=16)	CT index≥3.2 (n=34)
Preop	25.3±17.1	45.4±35.9
POD1	327.3±151.2	423.5±371.2
POD3	134.7±179.6	252.5±303.1
POD5	39.9±28.4	135.9±174.2
POD7	28.9±21.1	55.4±41.7

Is Sternal Rotation a Relevant Factor of Cardiac Compression in Patients with Pectus Excavatum? (Prospective Study in 120 Patients)

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OBJECTIVE

The relationship between Sternal Rotation (SR) and cardiac compression (CC) has never been described in detail. We aim to determine if SR is related to CC in patients diagnosed with Pectus Excavatum (PE).

MATERIALS AND METHODS

Prospective study including 120 consecutive patients with PE. All patients were assessed with Chest Computed Tomography (CCT) and Cardiac MRI (CMRI). SR angle (SRA) and orientation (SRO) were evaluated in the axial plane of CCT while CC was assessed with CMRI in the horizontal long axis plane.

RESULTS

A total of 120 patients were included, 85.8% were male and the mean age was 19.7 +/- 6.5 years. CCT assessment revealed that the most frequent side of SR was to the right observed in 61 (50,8%), followed by left side in 37 patients (30,8%). CMRI analysis denoted that a total of 100 patients (83,3%) presented cardiac compression. Detailed evaluation of CC revealed that left side SRO was related to compression of the free wall of the right ventricle, in addition patients with right side SRO also presented atrioventricular (AV) groove compression (p=0,005). The analyses of the SRA revealed that, at higher angles (17,9º-26,7º) greater CC towards the AV groove were observed (p=0,001).

CONCLUSION

SRA and SRO are related not only to an asymmetric or complex malformation but also to cardiac compression morphology and severity in patients with Pectus Excavatum. We concluded that sternal rotation is a relevant factor of cardiac compression in these patients.

Dimensional Changes of Thorax after Nuss Procedure

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PURPOSE

The Nuss procedure corrects the chest wall deformity by inserting the metal bar in pectus excavatum. We evaluated the thoracic dimensional changes after Nuss procedure.

METHODS

We performed a retrospective review of 141 patients who had undergone the Nuss procedures. The thoracic dimensions were measured using anteroposterior and lateral diameters at three anatomical landmarks (jugular notch, manubriosternal joint and xiphisternal joint) in computed tomographic scan. Preoperative and postoperative Haller index and thoracic dimensions were compared among each group according to the age, type and inserted bars. The paired t-test was used to compare the differences within each group.

RESULTS

Of the 141 patients (115 men, 26 women), 87 patients were symmetric and 54 patients were asymmetric type. The postoperative anteroposterior diameters in manubriosternal and xhiphisternal joint were significantly higher than the preoperative values. The Haller index, lateral diameters in jugular notch, manubriosternal joint and xiphisternal joint were significantly lower than the preoperative values. In age>13, asymmetric type and multiple bar inserted group, the postoperative anteroposterior diameters in manubriosternal joint and xiphisternal joint were significantly higher than the preoperative values. However, postoperative lateral diameters in three anatomical landmarks were significantly lower than the preoperative values.

CONCLUSIONS

The increased anteroposterior and decreased lateral diameter in three anatomical landmarks were noted in pectus excavatum patients after Nuss procedure. These results would be related to the postoperative changes of thoracic cavity volume. Further research would be warranted to determine the relationship between this phenomenon and pump handle action and postoperative changes of total lung volume.

• Free Paper: Oral

A Classification of Sub-types of Pectus Excavatum

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INTRODUCTION

Pectus excavatum a defect of the sternum and anterior chest wall, has varying severity and anatomical characteristics, that are as yet unclassified. In order to facilitate assessment and treatment we have devised a classification that categorises anatomical sub-types. We report the classification, incidence of sub-types and related respiratory function.

METHOD

Between 2006 and 2017, the available scans of 54 patients were investigated by 2D and 3D CT scans were evaluated. We classified observed anatomical findings into 3 categories; Type A - posterior angulation of the of the body sternum, Type B - posterior depression of the whole sternum, with or without posterior angulation of the sternum, Type C - posterior depression and vertical torsion of the sternum, with asymmetrical torsion of the rib cage. We related findings to Haller's index and to dynamic pulmonary function tests.

RESULTS

Of 54 patients who completed CT scan, 19 were type A, 26 type B and 7 type C defects. 1 had congenital defect of the sternum. Haller's index was a mean 3.81 (CI 3.5-4.24), with no significant difference in relation to pectus type. 19 (35%) patients had restrictive flow loop records, and 7 (36.8%), 8 (30.7%) and 4 (57.1%) of types A - C respectively. The FEV1 was 77.4% (CI 74.0-80.8%) in comparison normal flow loop cohort, FEV1 96.4% (CI 93.1-99.9%), $p<0.0001$, however the difference was not significant between pectus type A, B or C.

CONCLUSION

The new classification has aided definition of varieties of anatomy of pectus excavatum. Exercise physiology is significantly and equally deranged in the 3 types. Haller's index is not related to the pectus type and is not predictive of altered dynamic spirometry. It is anticipated the classification will aid current and future planning of surgical strategy.

Are X-rays Sensible Enough to Select Surgical Pectus Excavatum Patients?

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PURPOSE

In the last years studies have been published evaluating the utility of the chest X-ray (Rx) for the measurement of the Haller Index (HI) in the Pectus excavatum (PE). The aim of our study is to evaluate the correlation of 3 different severity indexes measured in the Rx with the CT/MRI, calculating the sensibility and the positive predictive value of the Rx for diagnosis of surgical malformations.

METHODS

A retrospective analysis (2010-2017) of the PE patients evaluated in our outpatient clinic who had CT/MRI examinations close to Rx (AP and lateral) studies (less than 6 months) was done. Measurements of HI, Correction (CI) and Depression index (DI) were done in both (CT/MRI by a paediatric surgeon and a trainee, Rx by paediatric surgeon and a paediatric radiologist).

Using the "statcrunch" software Spearman correlation indexes were calculated. Sensibility and positive predictive values for the Rx to establish surgical indication (IH≥3.25, IC≥20%, ID≥0.2) were also determined.

RESULTADOS

We analyzed 48 patients (medium age 12.48 years). Medium HI was 4.36 in the Rx y 4.46 in the CT/MRI, for CI 34.29% and 35.37%, for DI 0.94 and 0.76. Correlations between the measurements of the different specialists were significant ($p<0.0001$): Rx [HI r=0.963, CI r=0.821,DI r=0.598] and CT/MRI [HI r=0.942, HI r=0.862, HI r=0.762].

Indexes measured on CT/MRI also had a significant correlation with the ones on Rx ($p<0.0001$): HI r=0.72, CI r=0.58, DI r=0.47.

Sensibility of the Rx to detect surgical cases was 0.8 for the HI, 0.91 for the CI and 1 for the DI, with the following positive predictive values: 0.84; 0.95 y 0.93.

CONCLUSIONS

Rx can be used for diagnosis, motorization and severity evaluation of PE patients permitting measurement of HI, CI and DI. With the use of the Rx repeated CTs should be avoided.

Session 2: 3D Scanning

Use of an Optical Scanning Device to Monitor Progress of Non-invasive Treatments for Chest Wall Deformity: A Pilot Study

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INTRODUCTION

Recently, use of vacuum bell therapy for pectus excavatum and external brace treatment for pectus carinatum have gained acceptance for the non-surgical treatment of chest wall deformity. It has proven difficult to monitor progress of treatment. The external measurements of the chest can be assessed by ruler or caliper devices, but these give a limited picture of the entire chest shape. CT scanning, which gives a good three-dimensional picture with 3-D (three-dimensional) reconstruction, subjects the patient to ionizing radiation. Magnetic resonance imaging is expensive and time consuming. We sought a non-invasive way to follow progress of treatment, and to provide positive reinforcement to the adolescent patients who grow tired of the treatment, which often takes more than a year of daily application.

METHODS

An optical scanner was developed from a Kinect TM device by the engineering department at Old Dominion University. This equipment was verified to measure distances from the probe accurately, and its ability to produce a 3D image was confirmed. Accuracy and precision measurements were made, and were found to be more than sufficient for use in a biologic system.

Patients were scanned before, during, and after treatment. Photographs were taken at the beginning and end of treatment. Measurements were taken with a dowel and ruler for the excavatum patients. A computer program was used to digitally subtract the images of the patients. A color map, using the colors which make up visible light, was used to indicate where the chest had changed in shape. This image was then shown to patients and parents to encourage adherence to the regimen of treatment.

RESULTS

A patient who underwent the Nuss procedure as surgical treatment of Pectus excavatum was used for a proof of concept. In patients who undergo the Nuss procedure, the chest wall is elevated to its normal location. A scan taken before operation and one week later in an 18 y.o. patient with Haller index 5.7 and correction index of 34%. Figure 1 shows the digital subtraction of the images, indicating a nearly 19 mm elevation of the deepest part of the chest, and shows the relative elevation of the surrounding area. Subsequently, patients with vacuum bell treatment we monitored with the device, and also patients with brace treatment for carinatum. The interval scanning provided feedback to the patients and their parents for the non-surgical treatments which require months. This encouraged continued adherence to the regimen despite the inevitable slow progress.

CONCLUSION

This technique affords a way to follow patients undergoing nonsurgical treatment of chest wall deformity. It gives much more information about the shape of the chest than single or dual-point measurements. It is inexpensive, done in the office, and practical. Parents and patients immediately see the progress or lack thereof.

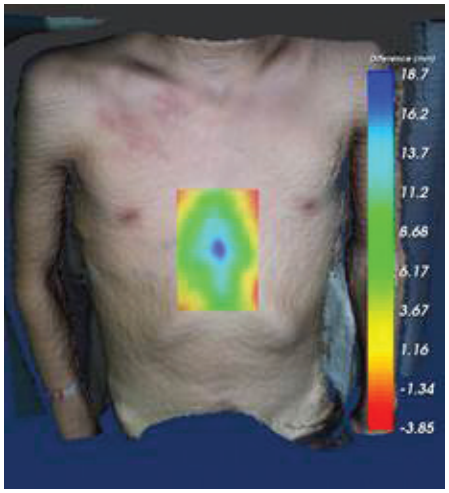

Figure 1. Optical scan of patient before and after Nuss procedure.

A Usefulness of Three-dimensional Body Surface Scanning Images in the Evaluation of Patients with Pectus Carinatum Treated with Compressive Orthotic Brace

Sungsoo Lee, Min Kyun Kang, Duk Hwan Moon

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PURPOSE

Chest wall deformity of patient with pectus carinatum is commonly

evaluated with X-ray and computed tomography (CT) at the present, but they need an ionizing radiation exposure and a related cost. The purpose of our study is to suggest an effective, radiation-free, and objective method to provide 3-D body surface scanning imaging, which can be used to evaluate the improvement of patients with pectus carinatum.

METHODS

15 patients with pectus carinatum underwent serial 3-D body scans, who were treated with compressive orthotic brace between September 2017 and February 2018. Sequential 3-D body scanning images were compared with chest X-ray lateral view images.

RESULTS

The mean protrusion difference was 9.97±6.95 in the 3D scanning images and 10.00±7.16 in the chest X-ray lateral view images with insignificant inter-modality difference (p=0.98). The 3D scanning images measures correlated well with chest X-ray lateral view image measures (r2=0.99).

CONCLUSION

In the evaluation of patients with pectus carinatum treated with compressive orthotic brace, 3-D body surface scanning imaging can be an effective, radiation-free method and an alternative to chest X-ray image.

Table 1. Height difference of maximal protrusion part of chest wall 3D scanning images and chest X-ray lateral view images

No.	3D scan difference (mm)	Chest X-ray difference (mm)	p-value
1	3.20	3.21	
2	12.90	12.83	
3	22.70	23.08	
4	3.64	3.30	
5	5.52	5.31	
6	4.25	4.26	
7	6.95	6.83	
8	4.50	4.99	
9	12.50	12.10	
10	4.56	4.65	
11	15.85	15.88	
12	25.95	26.90	
13	8.65	8.86	
14	9.75	9.68	
15	8.67	8.07	
mean	9.97±6.95	10.00±7.16	0.98

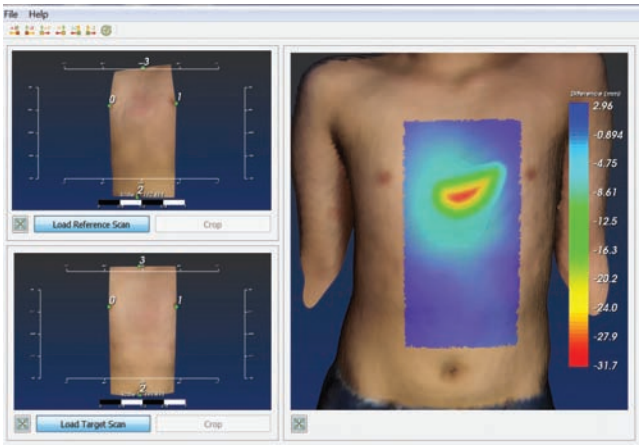

Fig. 1. Developed software used to compare two scans of chest wall: landmark-based alignment and registration (left) and difference color map in mm (right).

Measurement of Chest Figure in Patients with Pectus Excavatum Using 3D Body Scanning before and after the Nuss Procedure

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PURPOSE

CT is the standard modality to evaluate the degree of pectus excavatum (PE), although it has a high dose of radiation exposure for children. We innovated a simple 3D body scanning system to analyze PE non-invasively. The objective is to evaluate this new technique with measuring chest depression, analyzing postoperative effect, and potentially displacing CT image.

PATIENTS AND METHODS

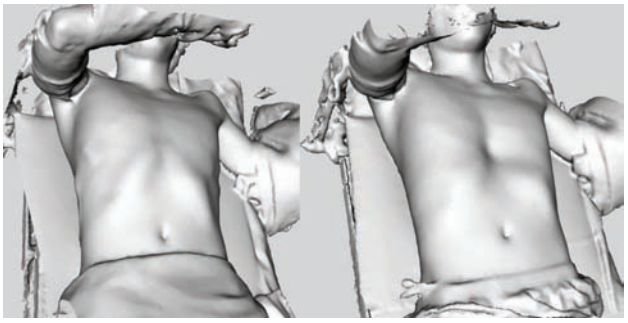
Eleven symmetric PE patients underwent 3D body scanning using Structure Sensor (Occipital Inc, USA) under general anesthesia before and after Nuss procedure. Scanning data were analyzed using 3D-Rugle (Medic Engineering, Japan) imaging software. We measured chest width and the height from the bed to the deepest point to compare Haller index (HI). Body surface depression index (BSDI) was calculated by width divided by height. To evaluate postoperative chest augmentation, we calculated the sternal elevating distance (SED) on the sagittal section through the deepest point. Also, we evaluated the change of sternal angle drawing a sagittal line between the sternal notch and the deepest point against a horizontal line.

RESULTS

All patients were male and mean age was 13±3.2 years old. Average Haller index was 5.2±2.2 and BSDI was 2.2±0.1. A coefficient of correlation was 0.498 and it showed a positive correlation with HI. Mean SED at the deepest point was 38.6±6.1 mm. Furthermore, at 4 cm and 8 cm cranial from the deepest point, SED was 28.4±5.1 mm and 19.4±4.9 mm respectively. Sternal angle improved from 3.9±1.6 to 15.0±1.1 degrees.

CONCLUSION

3D body scanning for evaluating PE is quite revolutionary, radiation-free method. This new technique may have a potential for a standard modality to evaluate PE in the near future.



Evaluation of pectus excavatum by 3D external scan. Is there a correlation between internal and external indexes?

Ana Laín, Paula Jimenez, Laura García, Carles Giné, Manuel López

Hospital Vall d´Hebron, Barcelona, Spain

PURPOSE

3D external scan (3DES) (OrtenBodyOne) is a new radiation-free technique used for diagnosis and treatment monitoring of chest wall deformities. The software of the device calculates external indexes. The aim of our study is to see if internal indexes measured on CT or MRI correlate with external indexes.

METHODS

Retrospective study of PE patients evaluated by 3DES between 2017 and 2018 with a previous CT or RMI. External Haller index (EHI) and external correction index (ECI) obtained by 3DES were compared to Haller index (HI) and correction index (CI) measured on CT/MRI. Patients with a difference of more than 1 year between 3DES and CT/MRI were excluded. Statistical Correlation indexes and their significance were calculated by "statcrunch" software.

RESULTS

Of Twenty-nine PE patients with 3DES scans and CT/RMI, 7 were excluded. Of the remaining 22, 14 were boys and 8 girls (mean age 13). All the patients had severe PE (mean HI 4,55; mean CI 38%). Median time between 3DES and CT/MRI was 6 months.

A significant correlation between CI and ECI was found (r=0,66, p=0,0012). This correlation was stronger in boys (r=0,74) than in girls (r=0,69). However no significant correlation was not found between HI and EHI (r=0,37, p=0,09).

CONCLUSIONS

3DES is a useful tool for objective evaluation and follow up of PE. Internal CI and ECI correlate so that repeated radiologic studies could be replaced by 3DES. This is a preliminary study with a short number of cases limited to severe pectus excavatum forms. We think a prospective study including normal chests and all types of PE is mandatory to define correlations better and establish numeric equivalences between internal and external indexes.

Evaluation of Pectus Excavatum (PE) Severity by Means of a portable 3D body scanner: an evolving appraisal

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BACKGROUND AND PURPOSE

In a previous work, we evaluated chest wall defect severity for PE patients by a portable 3D body scanner, developing a novel optical index that we named CI3D. The aim of the present study was to improve CI3D index integrating the defect depth with asymmetry and eccentricity, in the hypothesis that we could obtain a better evaluation index for PE severity.

METHODS

In an outpatient setting, 189 pediatric PE patients were assessed using an instant 3D optical scanner. For these patients an automatic 3D severity index which included defect severity, grade of asymmetry and eccentricity was calculated. With a correlation analysis we determined cut-offs thresholds to cluster PE patients into six severity classes (from 0 to 5). Lastly, we correlated the results with blind clinical assessment (BCA) of the same PE patients performed by five pectus surgeons using a zero to five score.

RESULTS

Matching the new CI3D indices with the average BCA of PE severity we showed that there was a good correlation among the six severity groups obtained through the two compared evaluation.

CONCLUSION

This innovative approach offers few advantages over existing indices: a) it is fast and repeatable; b) it is easy to use in the outpatient setting; c) it is perfect for follow-up purposes. For these reasons, in our opinion, although conventional imaging remains necessary in the preoperative assessment of PE patients, we consider CI3D a valuable and manageable tool. We plan in the near future to compare CI3D with BCA evaluation from the "most expert PE surgeons" to further improve the strength of such index.

Session 3: Oncology / Resection & Reconstruction

Bio-prosthesis in Chest Wall Repair after Cancer Resection

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IRCCS CROB Referral Oncologic Center Basilicata, Rionero in Vulture, Italy

PURPOSE

We report a combination of complex collected cases after demolition and repaired by biomaterials.

METHODS

Between January 2014 and December 2017 the cases were reviewed after resection, stabilization and repair of the chest wall.

We employed in 22 patients new biomaterials that are remodelable like bovine pericardium patch no- or crosslinked for reconstruction. The patches were used as a single layer and were secured under tension with running and interrupted polypropylene sutures. All tumors had radical resection, consisting of the ribs in 18, a portion of sternum in 12, and transverse processes of the spine in 6. The chest wall defects measured from 4.0×7.0 cm to 15.0×23.5 cm. Muscle flaps were interposed in 19 patients: latissimus in 10, serratus anterior in 3, pectoralis major in 4 and transverse rectus abdominis musculocutaneous in 2 patient. Evaluation at 3 and 6 months included adhesion formation, defect area size and thickness, tensile strength, and histology.

RESULTS

There were no severe complications or operative deaths. Mean adhesion coverage area ranged from 30 to 42%. The cross-linked material showed greater tensile strength. All prostheses had cellular ingrowth and neovascularization by 3 months.

The cost can influence the selection of material to use. PTFE patches range in cost from $800 to $3,000, bovine pericardial patches are the least expensive, ranging from $400 to $1,750.

CONCLUSION

Chest wall reconstruction with biomaterials is a valuable option in the management of patients with chest wall abnormalities. Use of biomaterials will expand the indications for chest wall resection and reconstruction in a contaminated field as well as reduce overall cost.

Chest Wall and Sternal Resection for Primary or Secondary Tumors, Our Experience in Single Unit in Albania, from December 2003 to December 2017

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INTRODUCTION

Chest wall resection involves resection of the ribs, sternum, costal cartilages and the accompanying soft tissues and the reconstruction strategy depends on the site and extent of the resected chest wall defect.

METHODS

From December 2003, to December 2017, 75 patients underwent chest wall resection and reconstruction with prosthetic material at the University Hospital "Shefqet Ndroqi", thorax surgery division. There were 75 patients (46 male and 29 female, rate M/F 2:1). The median age was 57 years and ranged from 16 to 73 years. The indication for resection was primary chest wall and sternal malignancy in 45 patients (60%) (20 (26.6%) patients osteosarcom; 7 (9.3%) patients condrosarcom; 5 (6.7%) solitary plasmocitoma; 4 (5.3%) desmoidal tumor; 2 (2.7%) patient liposarcoma; 2 (2.7%) patients Ewing sarcoma; 2 (2.7%) patient hemangiopericitoma;rabdomyosarcoma 2 (2.7%) patients; (1.3%) patient malignant non Hodgkins limfoma;), secondary (solitary chest wall metastase) and recurrent chest wall malignancy in 11 patient (14.7%), contiguous lung cancer (NSCLC) in 11 patient (14.7%), breast cancer recidive in 8 patients (10.7%).

RESULTS

Skeletal reconstruction was achieved with prosthetic material alone in 35 patients (46.7%) and with Prosthetic materials covered by flaps of myocutaneous or muscle tissue were used (Prolen mesh and methylmethacrylat sandwich plastica)in 26 patients (34.7%), myocutaneous or muscle flaps alone in 14 (18.7%).Soft tissue coverage was achieved with transposed muscle in 48 (64%) patients, local tissue only in 27 (36%) patients.

CONCLUSIONS

Our experience demonstrates that sternal and chest wall resection is a safe and effective treatment, which may improve the patient survival and quality of life.

KEYWORDS

Chest wall resection, Primary and secondary malignancy, Reconstruction

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Surgical Treatment of a Rare Chest Wall Deformity: Jeune Syndrome

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OBJECTIVES

Jeune's Asphyxiating Thoracic Dystrophy is also known as Jeune's Syndrome is a rare disorder characterized by typical dysplasias; such as narrow thorax. It can be congenital or acquired. Congenital form of the disease is an autosomal recessive disorder while acquired form is an iatrogenic deformity following a premature and aggressive open pectus excavatum repair.

We report our series of 4 patients who were treated with bilateral or unilateral thoracic expansion.

METHODS

All of the four patients are diagnosed based on radiological and clinical evidences. Two of the patients were congenital and the other 2 were acquired Jeune's Syndrome. Computerized Tomography (CT) of the chest and two-sided X Rays were performed for all of the cases. Pulmonary Function Tests could only be performed for the acquired patients. Lateral thoracic expansion with titanium plates

was chosen as a surgical technique of treatment in all cases

RESULTS

Two of the patients were congenital and the other 2 were acquired Jeune's Syndrome. Mean age was 13,75 (1-36) and all of the patients were male. Pulmonary Function Tests (PFT) were measured within their individual parameters. Main complaint of the acquired cases were dyspnea on exertion whereas congenital cases have recurrent pulmonary infections causing intensive care unit hospitalizations. 2 of the cases had bilateral operations. Mean number of ribs expanded was 4.5 on the right side and 5.3 on the left side. The mean interval between the first and second operation was 7.5 months. First patient was re-operated on the right side because of insufficient expansion. One of the congenital cases passed away on postoperative 6th day due to septic shock. Other three patients recovered uneventfully.

CONCLUSION

Jeune's Syndrome or Asphyxiating Thoracic Dystrophy is a rare but an important clinical entity. It can be both congenital or acquired so treatment spectrum contains variety of patients both in pediatric and adult group. Lateral thoracic expansion is a satisfactory surgical technique which creates an expansion on thorax of the patient. It relieves the symptoms together with good cosmetic results.

Long Term Outcomes of Surgically Resected Lung Cancer Invading the Chest Wall

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PURPOSE

Lung cancer with chest wall invasion accounted for 5% of all lung cancers. We aimed to identify long term outcomes of patients who underwent en-bloc chest wall resection for lung cancer in a single center.

METHODS

From 2004 to 2017, patients who underwent surgical resection for primary lung cancer with pathologically proven chest wall involvement were identified in the Seoul National University Hospital. We excluded 1) chest wall resection for metastatic or recurred lesion, 2) diaphragmatic, mediastinal pleural, and pericardial invasion rather than parietal pleura following the 7th edition of TNM staging system. Multivariable Cox proportional hazards modeling was used to determine independent predictors for survival and recurrence.

RESULTS

A total of 152 patients were included. Median follow-up was 23.6 months (IQR=9.0-29.5 months). Postoperative complication was developed in 59 (38.8%). 144 (94.7%) achieved R0 resection. The median tumor size was 5.0 cm (IQR=3.6-6.5 cm). Skeletal resection including rib, sternum and spine were performed in 81 (53.3%). 80 (52.6%) and 27 (17.8%) received adjuvant chemotherapy and radiotherapy, respectively. 3-year and 5-year overall survivals for the entire cohort was 52.7% and 41.6%, respectively. 3-year recurrence-free survival was 36.7%. Distant metastasis is the most frequent pattern of recurrence. Adjuvant chemotherapy was a favorable factor for survival in multivariable analysis. The tumor size was a prognostic factor for survival and recurrence.

CONCLUSIONS

We described survival outcomes of patients with lung cancer with chest wall invasion. The tumor size affected both of overall survival and recurrence-free survival. The rate of adjuvant chemotherapy delivery should be increased.

Staged Management of Septic Sternoclavicular Joint Arthritis

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BACKGROUND

By invading mediastinal structures septic arthritis of the sternoclavicular joint may lead to life threating complications such as mediastinitis. Therefore, early diagnosis and appropriate surgical treatment are essential. The treatment options range from antibiotics to radical resection of the sternoclavicular joint (SCJ). The purpose of this study is to evaluate our experience with the management of this rare condition and to provide an algorithm.

METHODS

We retrospectively reviewed the charts of patients referred to our thoracic surgery department with septic sternoclavicular joint arthritis (SSJA).

RESULTS

Included in the study were 13 patients (12 men, 1 woman) from

July 2008 to November 2017. Mean age was 61.8 years (range 41 – 83). The main symptoms were pain, and swelling at the localization of SSJA. CRP and white blood cells were elevated in all patients. Known risk factors such as diminished host immunity, diabetes mellitus, or hepatic dysfunction were found in 8 patients whereas 4 patients did not present any particular risk factor. In one patient the reason for SSJA was supposed to be actinic. In all patients a partial resection of the sternoclavicular joint with debridement of all infected tissue including resection of the adjacent part of the clavicle and sternum was performed. In all patient care was taken to preserve the posterior part of the SCJ. Upon resection a negative-pressure wound therapy (VAC©) was installed. Staphylococcus aureus was found in 9 of 13 wound cultures. Osteomyelitis was verified histologically in 5 patients. No patient experienced recurrent SSJA.

CONCLUSION

In our experience, SSJA requires an aggressive surgical management with at least partial resection of the sternoclavicular joint in order to prevent further spreading of infection and allow correct diagnosis in case of osteomyelitis. By preserving the posterior part of the SCJ, the shoulder girdle stays intact, preventing late sequelae such as shoulder instability associated with chronic pain. VAC© therapy not only accelerates wound healing but also makes muscle flap closure unnecessary.

Sternal Wire Neo Rib Technique for Chest Wall Reconstruction

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PURPOSE

The oncologic resection of chest wall tumor involves resection of the involved rib and soft tissue with a wide margin of 2 to 4 cm beyond the tumor. This results in a large defect of the chest wall with impaired respiratory mechanics. Reconstruction involves bridging the bony defect and a soft tissue cover of the resulting defect.The ideal material which is cheap, easily available and reproducible to cover the defect as well as maintain respiratory mechanics is yet to be established. We describe a technique of reconstruction of the skeletal defect using sternal wire providing a semi rigid, dynamic chest wall which is cheap, easily available and reproducible.

METHODS

The skeletal defect of the chest wall was bridged using the easily available stainless steel sternal wires which have adequate tensile strength and malleability. The ends of the ribs and cartilage were drilled using drill bit to allow passage of steel wire. The wire was passed and moulded in the desired curvature and tightened and reinforced with another 2 layer of steel wire to form the neo rib with adequate strength. Over this semirigid neorib prolene mesh was laid by fixing to the adjacent soft tissue around the defect. This provided a semi rigid skeletal system reinforced with prolene mesh over which the soft tissue cover or musculocutaneous flap will lie to cover the defect.

RESULT

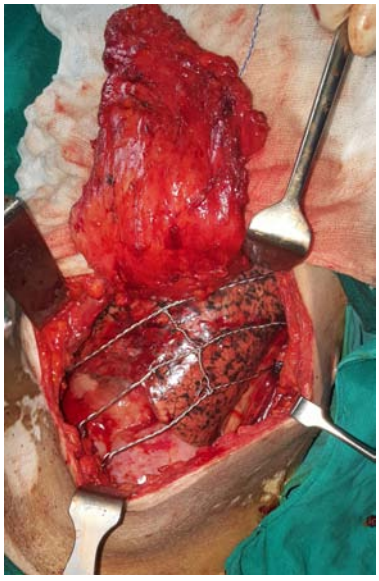
This technique was used in 4 patients of chest wall tumor for neo rib reconstruction. Table 1 shows the patient characteristic and soft tissue cover used.

CONCLUSION

Neo rib reconstruction using stainless steel wire is a cheap, effective and easily reproducible method of dynamic chest wall reconstruction.

Table 1

Case no	Diagnosis	Age/ sex	Nos of ribs resected	Soft tissue cover
1	Chondrosarcoma right 5th rib	52/M	3	Lattisimus dorsi myocutaneous flap
2	chondrosarcoma right 1st and 2nd rib	44/M	3	Pectoralis major muscle flap
3	Endometrial ca metastasis to left 7, 8th rib	59/F	3	Lattisimus dorsi muscle flap
4	Osteosarcoma left 7th rib	19/M	3	Lattisimus dorsi muscle flap



• Free Paper: Oral

The Use of Vacuum-assisted Closure in Sternal Dehiscence and Difficult-to-heal Wounds Following Sternotomy

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OBJECTIVES

Sternal Dehiscence and wound infection following cardiac surgery are not common with 0.8-8.4% of the cases. It is generally accompanied by mediastinitis which makes it serious and potentially fatal. We hereby present and analyze our results of sternal dehiscence patients who treated following vacuum-assited closure (VAC) system.

METHODS

We retrospectively evaluated 15 patients who admitted to Marmara University Department of Thoracic Surgery outpatient clinic with the diagnosis of sternal dehiscence between 2014-2017. All patients received debridement of the sternum and performing VAC system (KCL VAC Systems) prior to repair. Tissue and discharge cultures were routinely collected during the debridement. Adequate antibiotherapy was iniated after the results of cultures and antibiogram. The standard time interval between changes of dressings was 3 days. In most patients, a wound culture was taken each time the dressing was changed; in cases of longterm VAC therapy, cultures were taken at every second change of dressing.

Main principles for terminating the VAC were; negative cultures in 2 consecutive tests, no visible evidence of discharge and infected tissue in the wound. Patients were repaired surgically or left for secondary healing according to the integrity of their sternum.

RESULTS

All of the patient had gone through a cardiac operation. 12 (80%) of the group were male and 3 (20%) were female, who aged between 38-76 (mean age 59.4 years). Among them; 13 (86.6%) patients developed infection in addition to sternal dehiscence. In the other 2 (13,3%) patients sternal dehiscence and continuous discharge was observed but repeated cultures did not reveal the presence of any bacteria. Gram-negative bacteria were responsible for %70 of the infections. In the culture negative group, length of hospital stay was shorter than in the positive group. We did not experience mortality during this time of period. Our data identified diabetes, obesity, age, male gender as risk factors. No complications were related to VAC system. While two patients (13,3%) were treated with secondary healing, two patients (13.3%) needed reconstruction with muscle flaps. The other 11 (73.4%) patients surgically treated via primary closure.

CONCLUSION

The use of negative-pressure wound therapy (vacuum assisted closure system) with other concomitant surgical procedures is satisfactory method of treating sternal dehiscence patients with infection as well as non-contaminated dehiscence of the wound and sternum. Also in selected patients whose sternum have mild infection and total bone integrity, VAC itself without the need of any further surgical interventions can be curative.

Follow up and Outcomes in Patients of Chronic Empyema Having Undergone Open Window Thoracostomy

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INTRODUCTION

Open window thoracostomy is the most optimal method of drainage in patients of chronic empyema with persistent bronchopleural fistula, fixed mediastinum and prolonged intercostal tube drainage with medical management. This process allows complete egress of the purulent fluid and yields excellent results.

AIMS AND OBJECTIVES

To demonstrate the process of re-expansion of lung after open window thoracostomy.

MATERIALS AND METHODS

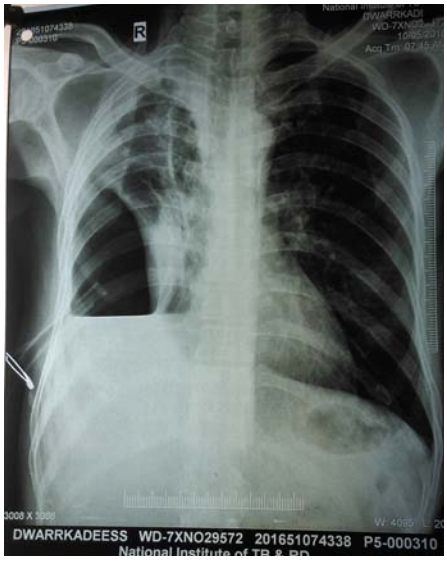
A prospective study was done at the National Institute of Tuberculosis and Respiratory Diseases, New Delhi in the Department of Thoracic Surgery from June 2016 to May 2017. 75 patients of chronic empyema underwent open window thoracostomy. The procedure was done in patients who had already been treated with intercostal chest tube drainage with appropriate medical therapy and yet their lung had failed to expand fully. Only those patients were taken up for this procedure in whom the mediastinum was presumed to be fixed and their lungs were judged to be not suitable for complete re-expansion with decortication because of the disease process. Patients were followed up for a period of six months to one year and their outcomes were analysed clinically and radiologically.

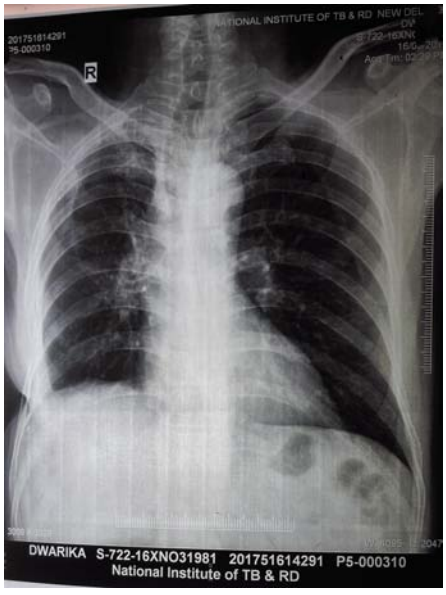
RESULTS

Age of patients ranged from 15 to 65 years. There were 67 male and 8 female patients. Forty one patients (54.67%) out of 75 showed complete re-expansion of the lung, while 13 patients (17.33%) showed partial expansion and 21 patients (28%) did not show any lung expansion. Those without lung expansion were considered to be candidates for space reducing thoracoplasty if found fit, after appropriate investigations.

CONCLUSION

In cases of non-expansion of lung after prolonged intercostal tube management, open window thoracostomy offers excellent results in terms of lung expansion in majority of the cases.





Session 4: Risk-free Pectus Surgery

3 Keys for Risk-free Pectus Surgery

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BACKGROUND

Pectus surgery with using pectus bars has inherent risks. First, cardiac injury during passage of pectus bars or removal of the bars has been a formidable challenge. Bar displacement after the procedure was another major source of risk peri-operatively. There have been serious or catastrophic complications related with above mentioned complications. At this stage of pectus surgery, already approaching 20 years after the first introduction of this procedure, we should not allow any further life threatening problems in our pectus surgery. To make pectus repair risk-free, we propose the 3 key techniques to eliminate major hazard-prone components of the procedure.

METHODS

To prevent cardiac injury, we propose the device that offers thorough visualization of the path of the introducer/pectus bar with a specially designed scope device, which is curved dissecting path finder with a contact view to the heart (Fig. 1). To make space at the heart-chest wall interface and reduce the pressure from the chest wall, we introduced the crane system as a preliminary elevation of the sternum using sternal wire sutures to be attached and lifted by overhung strut (Fig. 2). To eliminate the bar displacement, we developed 3 bar fixation device systems: the claw fixator, the hinge plate, and the bridge fixation, which has made our pectus surgery with bar displacement (Fig. 3).

RESULTS

In our database of minimally invasive pectus deformity repair with 2,970 consecutive patients in the period between 1999 and 2017, there was no mortality. Total 3 cases of cardiac perforations were uneventfully repaired, in which one case surgery performed before the pectoscopy, one case with inappropriate pectoscopic technique, and other 2 cases of post-cardiac surgery/congental diaphrgmatic hernia repair patients with severe cardiac adhesions to the chest wall. All other cases were successfully repaired with pectoscopy visualization. The crane was instituted since 2001, and make the procedure easy and safe. 3 Bar fixation system totally replaced conventional stabilizer and suture fixation of the bars. Since 2013, with the aid of combinations of 3 fixation devices, we see no longer

bar displacement in our practice. Of note, bridge connection of two or more bars had bar displacement rate of zero.

CONCLUSIONS

We identified 3 key risk factors of significant complication prone elements of pectus surgery. As a method to eradicate those problems, we propose the pectoscope, crane, and bridge fixation.

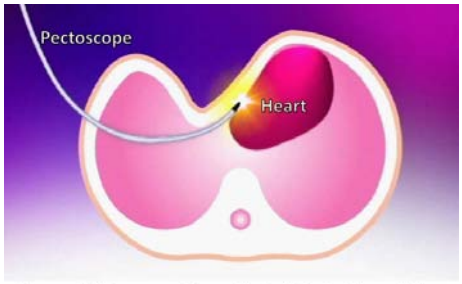

Fig. 1. Pectoscope.

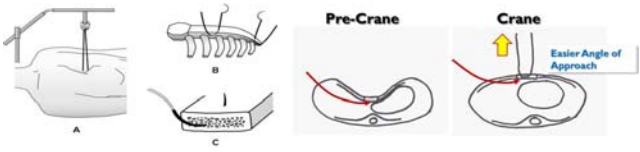

Figure 2. The Crane Technique: Make the procedure safer and easier

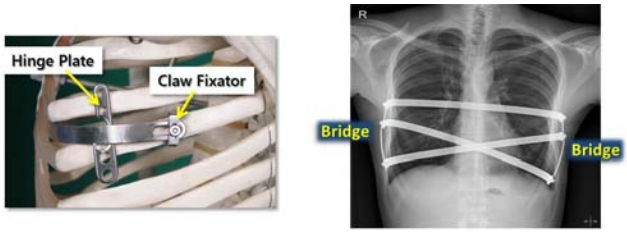

Figure 3. The Fixation Systems: Make the bar un-rotatable
1. Claw fixator, 2. Hinge Plate, 3. Bridge Connection

A Simple Technique for Effective Sternal Elevation During the Nuss Procedure

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PURPOSE

The minimally invasive technique for repair of pectus excavatum (MIRPE) is now accepted as one of the preferred methods for treatment of this condition. Although very rare, cardiac perforation during placement of the pectus bar has been reported. Since the first description of the Nuss technique, many technical variations have been proposed to obtain intra-operative sternal elevation in order to minimize the risk of major complications. Over the past three years, we have used an innovative and simple technique for sternal elevation that can be easily applied without the need for any specialized equipment, training, or instruments.

METHODS

A retrospective review was conducted on 58 of our patients in which sternal elevation technique was employed during MIRPE. Our technique involved the use of a standard 25 mm bone hook (Figure 1) that is utilized to lift the sternum in order to facilitate dissection of the anterior mediastinal space between the heart and the sternum. The tip of the bone hook is inserted under the sternum at the point of maximal depression on the right side using a small 2 mm skin incision. Placement is aided by thoracoscopic visualization. Once the tip is in position under the sternum, the bone hook is lifted by the assistant surgeon, displacing the sternum anteriorly and opening the anterior mediastinal space. This allows for safe passage of the pectus bar passer instrument and pectus bar. The procedure is otherwise completed in standard fashion. In 20 of our cases, we compared the bone hook sternal elevation technique with the vacuum bell application.

RESULTS

Mean age was 14.0±3.5 years, and 74% were male. Haller index was 4.8±2.2. Mean operating time was 58.0±18.9 minutes, length of hospitalization was 4.5±1.5 days. Our technique of sternal elevation proved to be efficient in all cases. In 20 cases, the technique of bone hook sternal elevation was compared to intra-operative use of the vacuum bell. In all such cases, the bone hook approach was considerably more effective. There were no cases of mediastinal, pericardial, or cardiac injury. The small puncture hole used for bone hook insertion was utilized for placement of the third point of fixation (absorbable suture around the bar and around one rib).

CONCLUSIONS

The bone hook sternal elevation technique during MIRPE is a very simple, safe, and reproducible method for placement of the pectus bar that minimizes the risk of injury to mediastinal structures. It is a reliable method for sternal elevation, considered a critical step of the operation.

Techniques of Sternal Elevation To Improve Safety During the Nuss Procedure

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OBJECTIVE

To evaluate the routine use of sternal elevation techniques (SET) for elevating the sternum during minimally invasive repair of Pectus excavatum (MIRPE, the Nuss procedure).

METHOD

We performed a review of the literature with focus on different techniques of sternal elevation during MIRPE. Reported effects and side effects were evaluated and compared with our own experience concerning the routine use of the vacuum bell for sternal elevation during MIRPE during the last 12 years.

RESULTS

SET is more often used in adult patients than in adolescents. SET improves visualization and safety of the procedure. Advancement of the Pectus introducer, retrosternal dissection and placement of the pectus bar is easier. The risk of cardial and/or pericardial lesion is reduced significantly.

Different types of retractors with or without an additional clamp, a crane combined with a wire and/or customized hooks are reported to be used for SET. However, more technical equipment (crane), and in some SETs additional incisions are necessary. In contrast, no additional incision is necessary for the vacuum bell. The routine intraoperative use of the vacuum bell was safe and effective in 131 patients as it facilitates the retrosternal dissection and the insertion of the pectus bar like other SETs. Besides a temporary mild hematoma, no relevant side effect was observed.

CONCLUSION

An increasing number of authors/studies report on the routine use of SET during MIRPE to improve safety of the procedure. If available, we recommend the routine intraoperative use of the vacuum bell during MIRPE.

Oblique Inserted Pectus Bar to Avoid Displacement

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BACKGROUND AND HYPOTHESIS

Bar displacement is the most common complication of minimally invasive repair of pectus excavatum (MIRPE) that may require reoperation. The pectus bar may slide laterally, flip around its hinge axis or shift dorsally consequently of intercostal musculature tearing. Although different methods to avoid bar displacement have been proposed (utilization of stabilizer; bar fixation to the ribs; bending the ends of the bar; use of a shorter bar), the problem still occurs.

An oblique inserted pectus bar is less susceptible to secondary displacement than a perpendicular to the sternum implanted pectus bar. Thus, the ends of the pectus bar are placed perpendicularly to the lateral ribs, and have a broader base of support straddling at least two ribs.

METHODS

We retrospectively reviewed 94 charts of patients who underwent MIRPE at our institution. Pectus bar stability was evaluated by chest X-ray 5 days and 3 months after MIRPE.

RESULTS

The average age was 19 years (range, 14-55), and 88% were boys. Lateral stabilizer was used for bar stabilisation. The bar was inserted to sternum obliquely in 22 patients, and perpendicularly in 72 patients. Dislocation of the pectus bar occurred in the oblique group in 4/22 cases (18%), and in the perpendicular group in 7/72 cases (9.7%). In the oblique group, the pectus bar slide laterally (n=3) and dorsally (n=1), in the perpendicular group, rather around its hinge axis (n=5) and dorsally (n=2).

CONCLUSION

An oblique to the sternum inserted pectus bar seems not impede all mechanism of displacement of pectus bar following MIRPE.

• Free Paper: Oral

Bridge Fixation System with Two Bars for Pectus Excavatum Repair – Single Center Experience

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PURPOSE

Many fixation methods or systems are being applied for bars stabilization after pectus excavatum repaired surgery. We found the bridge fixation system applying for two bars is excellent in term of stabilizing bars, time of surgery, post-op complications compare to our pervious fixation systems.

METHODS

Retrospective review results of 1760 pectus excavatum repair cases in our thoracic department, comparing the later 560 cases using bridge fixation system with two bars with the previous 1200 cases using other fixation techniques such as wire sutures, L shaped for single bar fixation with either one or two bars or even 3 bars. The main issues for comparing including the quality of stabilization, time of surgery, and complications postoperatively.

RESULTS

Series of 560 cases using bridge fixation system showing excellent results comparing two our other previous stabilizing techniques in all terms of bars stabilization, time of surgery, and complications

CONCLUSIONS

Bridge fixation system with two bars have been showing excellent results in pectus excavatum repair. Using three bars is not necessary. In some mild cases with very young ages, using one bar is possible with other fixation technique but could not be as good as using two bars

KEYWORDS

PE repair, Pectus bar, Fixation system

Bar Displacement and Stabilization Method in the Minimally Invasive Repair of Pectus Excavatum: Systematic Review and Meta-analysis

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Seoul St. Mary's Hospital, Catholic Univ. of Korea, Seoul, Korea

INTRODUCTION

Bar displacement after repair of pectus excavatum is one of the major complications, requiring re-intervention in severe cases. For decades, numerous methods preventing bar dislocation or rotation have been developed, and the results of various combinations of techniques have been reported. The obejective of this study is.

METHODS

We conducted a systematic review and meta-analysis of studies to evaluate these procedures. A systematic search of the literature was performed from three electronic databases, hand-searching, and grey-literatures, published from the year of 2010 and after. Meta-regression was conducted to evaluate the effect of the number of fixation points and the bar displacement rate.

RESULTS

A total of 35 studies comprising 8,268 patients were identified. The studies for redo series, carinatum studies, pectus surgeries combined with other open heart surgeries, Ravitch procedures, studies reporting the number of patients less than 11 patients, or studies without detailed information about bar stabilization technique or outcome of bar displacement/rotation were excluded. The stabilization methods were vary – included unilateral or bilateral stabilizers, bridge, claw fixator, suture or wire fixation, single point or multipoint fixation, etc. We divided the studies into four groups based on the number of fixation points, regarding the method. The result showed the decreasing incidence of bar dislocation/rotation rate from single point to four points (p=0.035).

CONCLUSION

These results suggests that the method for stabilization point 3 or more ensures the stability of the procedure.

Gasless Endoscopic Surgery with Lifting Technique for Correction of Bifid Ribs

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OBJECTIVES

Gasless laparoscopic surgery using lifting device was first introduced by Nagai in 1993, and this technique was mainly used in general surgery and gynecology. This study aimed to introduce the application of lifting technique in correction of bifid ribs, and to explore the feasibility and safety of this surgery.

METHODS

A retrospective analysis from July 2008 to July 2017, 221 patients of bifid ribs received gasless endoscopic surgery with lifting technique in our hospital. The study was approved by the Ethics Committee of our hospital. The main procedure as follows: a) a 3 cm incision at the lateral side of the chest, b) separate the tissue between the rib cage and chest wall muscles using lifting technique and gasless endoscopy, c) resect the deformity rib, d) leave a negative pressure drainage tube under the muscles.

RESULTS

All the 221 cases were successfully completed the operations. There were 145 males and 76 females. They are more common on the right side (148 cases) than on the left (73 cases). Most frequently in the fifth rib (incidence: fifth > fourth > third > sixth). The mean operation time was 45.1min; mean blood loss was 3.9 ml. No serious complications happened during the surgery and less postoperative complications (pneumothorax, pleural effusion). Follow-up from 6 to 108 months, there was no recurrence patient.

CONCLUSIONS

Gasless endoscopic surgery with lifting technique applied in the correction of bifid ribs is safe and feasible. This surgery has less injury, smaller incision, and no scar in the front chest. Gasless endoscopic surgery with lifting technique can be one of the options for correcting bifid ribs.

Needlescope-assisted Nuss Procedure in Patients with Pectus Excavatum

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PURPOSE

The aim of this study was to evaluate the usefulness and safety of 2 mm sized-thoracoscope (needlescope) during Nuss procedure in patient with pectus excavatum.

METHODS

Since August 2008 to June 2017, patients who underwent Nuss procedure with needlescope were enrolled in this study. Along the mid axillary line, 2mm sized trochars were inserted via the 7th intercostal space. Under needlescopic guidance, the pectus bar was fixed by suturing both ends and the left hinge point using K-wires. At the end of operation, small-sized catheters were introduced into both pleural cavities through needlescopic ports to treat postoperative pneumohemothorax.

RESULTS

A total of fifty-four patients (45 males, 9 females) were included in the study. The mean age of patients was 16.3 (±6.2) years and the mean BMI was 17.8 (±2.2) kg/m^2. The preoperative mean Haller index was 4.2 (±0.8), the median asymmetric index was 1.1 (range; 1.0-1.3), and the mean angle of sternal rotation was 12.9 (±6.1) degrees. One pectus bar of median size 12 inches (range; 9-14) was inserted in each patient. Mean operative time was 52.8 (±13.7) minutes, and median hospital stay was 8 days (range; 7-18). Prolonged pneumothorax was found in 5 patients (9.3%) and hemothorax in 3 (5.6%) during postoperative course. All those patients were successfully treated by aspiration through a catheter except for a patient with hemothorax, who required closed thoracostomy. One patient (1.9%) underwent reoperation due to bar dislodgement 3 months after discharge.

CONCLUSIONS

Needlescope provides safe and secure guidance during the Nuss procedure, and has a better cosmetic effect and less postoperative pain than 5 or 10mm sized thoracoscope. Furthermore, the small catheter inserted through needlescopic port was effective to treat postoperative complications through without the need for additional intervention.

Table. Demographics data and primary outcomes of patients

		Patient data
Age (mean, years)		19.2±7.1
Gender	Male	15 (100%)
	Female	0 (0%)
Type of deformity	Pectus excavatum	4 (26.7%)
	Pectus carinatum	9 (60%)
	Traumatic depression	2 (13.3%)
Operative time (mean, minutes)		225.0±72.6
Hospital stay (mean, days)		15.7±5.5
Complication	Chest tube reinsertion	2 (13.3%)
	Temporary arm weaknessb	1 (6.7%)
	Delayed pericardial effusion	1 (6.7%)

Treated under local anesthesia.
Spontaneously recovered

• Free Paper: Oral

Detection of Sternal Bar Adhesion to the Heart Using an EKG Monitor During a Nuss Bar Removal

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INTRODUCTION

A fatal complication that may arise during a Nuss bar removal is cardiac tear and bleeding. This may occur if the Nuss bar becomes adhered to the heart due to the inadvertent subpericardial placement of the Nuss bar. A test or study to elucidate whether the bar may have adhered would be useful. We describe a simple method that can be utilized to test whether the sternal bar is stuck to the heart.

METHOD

A patient is brought to the OR for sternal bar removal. A standard three electrode lead monitoring is used for electrocardiogram. Two of the three electrodes are placed on the shoulders of the patient. After general anesthesia, patient's chest is prepared and draped. The two ends of the bar are dissected and straightened in preparation for the removal. The third sterile electrode is then applied to the Nuss bar itself. With the third lead on the sternal bar, the bar is wiggled sideways, up and down, and caudal and rostral direction while the continuous EKG reading is monitored on the anesthesia machine. If the sternal bar is not fixed to the heart, there will not be any cardiac rhythm aberration with the wiggling of the Nuss bar. Once it is observed that there is no cardiac rhythm anomaly, it is safe to pull out the Nuss bar.

CONCLUSION

The method as described may alert the surgeon that the sternal bar could be adherent to the heart. This information could provide time for the surgeon to prepare for the worst scenario or abort the procedure for further testing.

Effect of Pectus Deformities on Spinopelvic Parameters

Esra Şirzai, Erhan Okay, Tural Khalilov, Nezih Onur Ermerak, İlhan Ocakcıoğlu, Tunç Laçin, Murat Bezer, Mustafa Yüksel

Marmara University, Faculty of Medicine, Istanbul, Turkey

OBJECTIVES

Sagittal balance can be described as the mutual harmony of cervical lordosis, thoracic kyphosis and lumbar lordosis. The sagittal vertical axis also known as 'the plump line', is a straight line lying down $C7^{th}$ vertebra inferiorly and passes through the supero-posterior edge of the sacrum. When the sagittal balance is impaired due to patological reasons, plumb line and the gravity line match each other and try to re-establish the sagittal balance as a pysiological response. This condition refers to "sagittal imbalance".

METHODS

This study is designed in a prospective clinical manner with patients admitting to Marmara University, Department of Thoracic Surgery. Fifty-six patients patients who aged between 14-20 years old and diagnosed with pectus excavatum or pectus carinatum were included into the study. The parameters were measured with two-sided scoliosis orthorectography and evaluated by Marmara University, Department of Ortopedics.

RESULTS

Among 56 patients; Fifty-one were male and 5 were female. The mean age was 17,3±3,2. Twenty-three of the pectus deformities were carinatum, and 33 were excavatum. In pectus excavatum patients, the Haller index was calculated as 4,7±1,95. Sixteen (48,5%) patients had scoliosis / asymmetry. In 7 patients, sagittal balance shifted forwards, while 3 patients were shifted to the backwards (10 patients 30,3%). Thoracic kyphosis increased in 3 patients and disappeared in 2 patients (5 patients, 15,15%). While seven patients have increase in lomber lordosis, it dissappeared in other 5 patients. (12 patients, 36,4%).Nine patients (39,1%) with pectus carinatum had scoliosis. While sagittal balance was displaced forwards in 4 patients, it was shifted to backwards in 8 patients (12 patients 52,2%). Elevated thoracic kyphosis was detected in 11 patients (47,8%). There were increased lomber lordosis in 2 patients and loss of lordosis in 9 patients (11 patients, 47,8%).

CONCLUSION

Eventhough further investigation is needed, we detected that pectus patients were affected more than the normal population in terms of spinopelvic parameters. In the light of this data; early rehabilitation of pectus patients having concomitant other spinalpelvic abnormalities might be beneficial for preventive purposes.

Grand Rounds : Fact Sheets on Crossbar Technique-To Cross, Or Not to Cross?

Use of Non-horizontal Bars in the Nuss Procedure

Hans K. Pilegaard

Aarhus University Hospital, Aahrus, Denmark

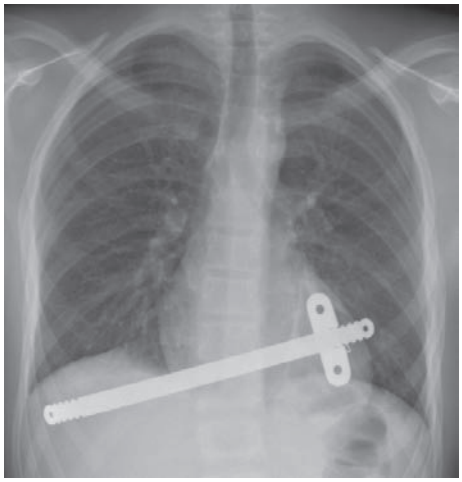
The purpose of correcting pectus excavatum (PE) is to have a:

1) A good cosmetic result

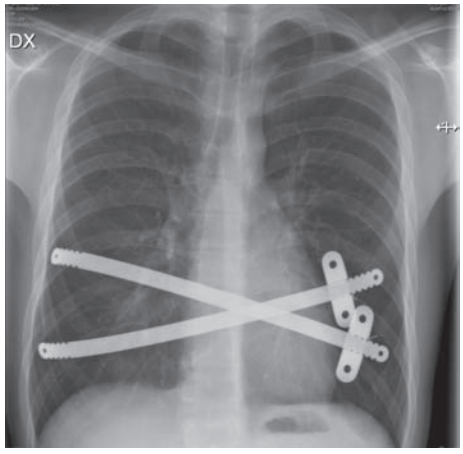
2) Relieve the pressure on the heart to increase the cardiac performance

When the bar(s) are placed we want to support the deepest point under the PE to have the best elevation and normally the bars are placed horizontally; but in some cases this position of the bar do not catch the deepest point or elevate the sternum too much. In this cases an oblique bar does a better job (A). In other cases the deepest point is between two intercostal spaces and cannot be reached by a horizontal bar. In this cases an oblique bar might support the deepest point and finally when you have a short narrow PE you need more force to push the sternum to a normal position and in these cases crossed bar might be used (B).

These different possibilities and indication for these will be discussed and examples will be shown.



(A) Oblique bar:



(B) Crossed bars.

27 Reasons to Cross the Bars

Hyung Joo Park

Seoul St. Mary's Hospital Catholic Univ. of Korea, Seoul, Korea

BACKGROUND

We propose a new method of pectus bar placement for pectus excavatum repair. The cross-bar technique has a great potential because it is designed to settle the bar at the promontory of the depression and covers wider lateral chest wall areas to remodel. the crossbars are suitable for the bridge fixation for the most secure bar stabilization.

METHODS

We placed two bars so that they crossed on the target. The singularity of this modus operandi is the lifting forces of the two bars converge on the bull's eye. Besides, the second bar promotes the further elevation of the resistant and inflexible chest wall depression. Additional effect of the cross bars is to cover more lateral chest wall even lower than the level of the xiphoid. The bars are fixed at the tips by their connection to the bridge plate (the bridge technique), which is proven to make the bars unrotatable (Fig. 1).

RESULTS

In our database of minimally invasive pectus deformity repair with 2,970 consecutive patients, there were 110 cases with the cross-bar technique and 415 cases with bridge pectus bar fixation according to our “Total Chest Wall Remodeling” approach adopted since 2016. The mean age of the patients was 17.8 years old (range: 8 to 42 years). The indications for the cross-bar technique were very acute focal xiphoid depressions; inflexible focal chest wall

depression; bilateral costal depressions lower than the sternum; reoperation cases that were unable to accommodate the bar accurately on the target; and long deformities with Grand Canyon type. There were no bar displacement cases using the bridge technique. Complications occurred during or after operation were in 36 patients (6.9%): thoraic outlet syndrome 3, wound infection 22, pleural effusion 10, bridge plate dislodgement 1.

CONCLUSIONS

The cross bar/bridge technique is inspiring by enabling the pectus bar to stay precisely on the target without any shake. The crossed bars pinpoint all the forces to a single spot and include entire chest wall into the repair. The bridge fixation of the multiple bars accomplished the bar displacement rate of zero.

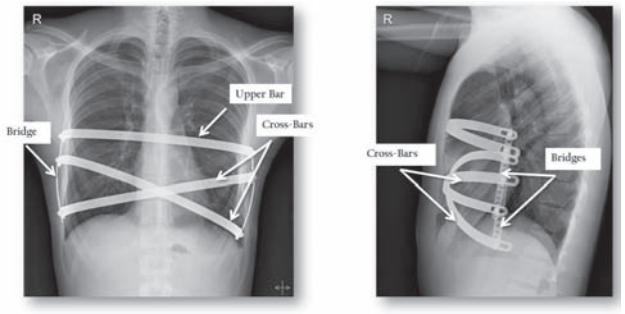


Figure 1. Cross-Bar + Bridge Technique: Two bars converge on the target and connected with the bridges.

Cross-bar – Fashion or Breakthrough?

Vladimir Kuzmichev, Sergey Tarasov, Ksenija Ershova, Vladimir Gatsutsyn, Alexander Mashkov, Alexander Nalivkin, Dmitry Pykhteev

MSU Medical Center, MONIKI, Moscow, Russia

PURPOSE

Analysis of advantages and disadvantages of new surgical technique.

METHOD

Retrospective study of 149 cases operated in 2016-2017 was performed. Number of bars, position of bars (horizontal, oblique or cross) were analyzed.

RESULTS

After first experience with cross-bar in 2016 this technique became the most common method of correction (Table 1) in our practice. There were no surgical complication also time of surgery increased. Compared to our previous technique we noticed better aesthetics and stability (no bar dislocation). There was also impression of less pain and easier rehabilitation. At the same time pleural effusion with need for thoracentesis was significantly more common in this group.

CONCLUSION

Cross-bar is a new promising technique, however long-term observations and better understanding of indications are needed.

Table 1. Number and position of bars

	2016		2017	
	abs	%	abs	%
1 bar (horizontal)	20	32,7	8	9,1
1 bar (oblique)	17	27,8	14	15,9
2 bars (parallel)	12	19,7	7	7,9
2 bars (1 horizontal + 1 oblique)	11	18,1	19	21,6
2 bars (cross-bar)	0	0	29	32,9
3 bars (1 horizontal + cross-bar)	1	1,7	10	11,4
3 bars (2 parallel + 1 oblique)	0	0	1	1,2
	61	100	88	100

Elevating the Deepest More: Cross Bar vs Parallel Bar Technique

Mi Hyoung Moon, Hyo Chan An, Hyung Joo Park

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INTRODUCTION

Complex and severe pectus excavatum frequently requires two or more bars for the best outcomes after MIRPE. The alignment of double bars is commonly parallel; however, the researchers developed the "Cross bar technique" in the way searching for elevating the deepest point of the chest wall. Under the hypothesis that cross bars can converge the power more efficiently, we developed and applied cross bar technique, and here we report the early outcome.

METHODS

We reviewed medical records and CT images of the MIRPE performed between Jan 1, 2016 to Jan 20, 2018 in Seoul St.Mary's Hospital. To assess the differences between the cross bar and parallel bar technique in the degree of elevating the deepest point of the sternum, we measured the distance from the anterior surface of the vertebral body to the posterior plate of the sternum at the level of axial CT image of the maximal chest wall depression. This distance was measured preoperatively (A1) and postoperatively (A2). Then we calculated the degree of increased height, B=(A1-A2)

/A1 *100(%). This parameter (B) was compared between the two groups.

RESULT

The following MIRPE cases were excluded from the study: (1) combined with pectus carinatum; (2) sandwich procedure; (3) redo cases; (4) younger than 10 years old (5) foreigners; and (5) MIRPE done 3 or more bars. There were 48 patients of cross bar technique, 50 patients of parallel bar technique. There were no significant differences in age, sex, body weight or height at the time of operation, degree of asymmetry, the proportion of Grand Canyon type between the two groups. The parameter B indicated that parallel bars could elevate average 52.7% of height compared to the preoperative distance, however, cross bars could elevate the sternum average 79% compared to the preoperative value. There were two pneumothoraxes, one right-sided pleural effusion in the cross bar group, and one right-sided pleural effusion in the parallel bar group. There were no other major complication including bar dislocation, rotation, or infection.

CONCLUSION

The surgical repair of the pectus excavatum should tailor to the specific morphology of each patient's chest wall. The Cross Bar technique developed most recently and discussed herein cover the specific need and elevate the chest wall most efficiently, via converging and transmitting the reinforced power of the crossing portion of the two bars.

Effectiveness of Two-bar Correction for Pectus Excavatum: Comparison of Parallel Bar and Cross Bar Insertion Techniques

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Gangnam Severance Hospital, Yonsei University College of Medicine, Seoul, Korea

PURPOSE

This study evaluated and compared the effectiveness of pectus excavatum correction using parallel and cross bar insertion techniques.

MATERIAL AND METHODS

Between January 2015 and January 2018, patients with pectus excavatum who underwent parallel bar insertion (Group 1) or cross bar insertion (Group 2) were evaluated retrospectively. Patients who underwent both preoperative and postoperative chest computed tomography were enrolled. The Haller index (pectus index, PI) was defined as the ratio of the largest transverse diameter to the shortest anteroposterior (AP) diameter of the rib cage. The vertebral level-specific PI was defined as the ratio of the largest transverse diameter to the AP diameter of the rib cage at a specific vertebral level. For precise comparisons, vertebral level-specific PI was measured at 3 levels up (3Up-PI, 2Up-PI, 1Up-PI), and 1 vertebral level down (1Down-PI), from the narrowest point. The effectiveness of two-bar correction was compared between the groups by using postoperative, (vertebral level-specific) PI change (preoperative PI – postoperative PI).

RESULTS

The study enrolled 19 patients (M:F=17:2, mean age=17.4±4.2 years) in Group 1, and 11 (M:F=10:1, mean age=16.0±4.5 years) in Group 2. Preoperative PI values were not different between the groups (4.1±0.7 vs. 4.7±1.1, p=0.086). After two-bar correction, PI was significantly decreased in both groups (2.6±0.3 in Group 1, 2.9±0.4 in Group 2); there was no different in postoperative PI between the groups (p=0.268).

The postoperative changes at 3Up-PI, 2Up-PI, and 1Up-PI were not significantly different between the groups (0.95±0.46 vs. 0.71±0.51, 1.05±0.36 vs. 0.92±0.83, and 1.30±0.46 vs. 1.39±0.67 respectively, all p>0.05). At the narrowest point, PI change was not different between the groups (1.50±0.5 vs. 1.93±1.18, p=0.272). However, postoperative change at 1Down-PI was significantly greater in Group 2 (1.70±0.86) than in Group 1 (1.02±0.50) (p=0.040).

CONCLUSION

Two-bar correction is effective for pectus excavatum. Cross bar insertion technique might be superior to parallel bar insertion technique for correction of a wider range of deformities, especially at the lower chest wall.

How Many Nuss-bars Can You Fit in a Thorax?

Gerda Zijp, Jan-Hein Allema, Pieter-Jan van Huijstee

Juliana Children's Hospital/Haga Hospital of the Hague, Hague, Netherlands

Aiming to find the best method for correction of pectus deformities, we reviewed our patient data to see if the placement of multiple bars improves the quality of correction.

In Europe pectus excavatum (PE) seems to be the predominant chest wall deformity and PE was seen in 84% of our patients. Out of the 295 patients with PE, 190 received primary Nuss-bar

corrections, several a modified Ravitch procedure and 27 are in the process of getting surgery. The other patients refrained from surgery or are too young for a procedure at this stage.

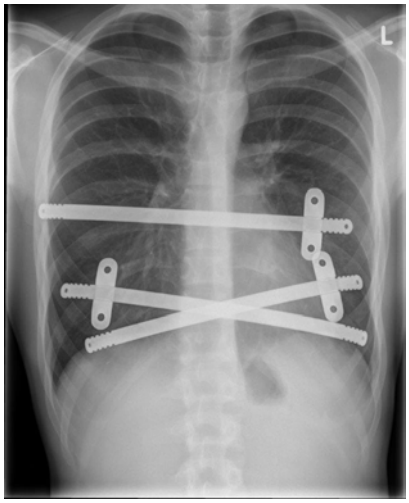
RESULTS

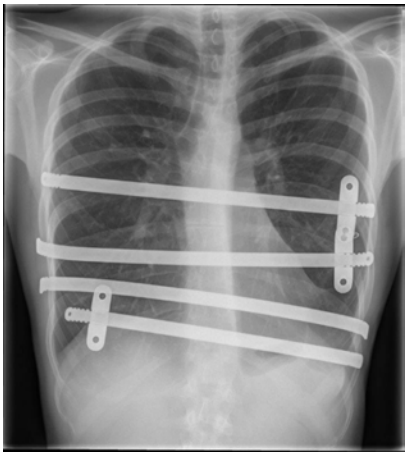
At the start of our program in 2011, most patients (85%) received just one Nuss-bar. Over the years we noted that the placement of multiple bars often leads to more satisfactory cosmetic results and seems to be correlated with decreased post-operative pain and less re-do surgery. In the last few years, only 20-25% of patients have a single-bar correction at their primary operation.

In total (including re-do surgery n=15) we have placed 1 bar in 87 patients (42%), 2 bars in 113 patients (55%), 3 bars in 4 patients (2%) and even 4 bars in one very severe and asymmetrical challenging case (0,5%). If two bars are placed, we prefer the short bar technique with one stabilizer per bar on opposite sites, via one bilateral incision. In addition, we have varied the direction of the bar, from straight across, to diagonal and recently even crossed. The patient satisfaction is very high (> 90% is satisfied or very satisfied), and has grown over the years.

CONCLUSIONS

We believe that the treatment of PE with a Nuss-bar procedure has to be tailored to the individual patient and his or her needs. The placement of multiple bars, in our series up to 4 bars, leads often to better cosmetic results. Asymmetrical bending and variation in number of stabilizers can result in satisfactory results even in challenging cases.





Session 5: Innovations

The Ideal Pectus Bar. Predictions of the Future

Ivan Schewitz

University of Pretoria, Johannesburg, South Africa

This is a discussion on the ideal shape of the pectus bar based on mathematical predictions, the ideal substance of the bar and a prediction on how it will be manufactured. It is a preliminary discussion and not based on physical research.

The shape is based on the formula which predicts that a semi-circle is the strongest shape. The Roman arch is an example with bridges built in antiquity still standing.

The substance that we use is steel or titanium. The complications are the nickel allergies, the cost, and the requirement of importing and transportation to the various centers. The ideal material is one that is strong enough to support the sternum, is slowly absorbable over 3 years, such that removal is not only unnecessary but the bar can easily be cut by an electric saw if a sternotomy is necessary.

Once an ideal material is identified the next step will be 3D printing making it possible for the bars to be manufactured wherever a printer is available, which I predict will be the next generation not only of pectus bars but of a wide variety of prosthesis, as well as many non-medical substances as well.

This is a theoretical discussion with the research still to be undertaken.

Evaluating the Bioadaptability of 3D Printing Material Nylon 680 Co-polymer Prior to Implantation into Human Subjects

Nezih Onur Ermerak[1], *Mustafa Yüksel*[1], *Tunç Laçin*[1], *Barış Yüksel*[2]

Marmara University, Faculty of Medicine[1], Free Lance Consultancy[2], Istanbul, Turkey

OBJECTIVES

3D printing gained popularity among all fields of science in the recent years. New reports about utilization of 3D printing in terms of medical devices and human implants has been published. We presented our experience with 3D Printing in 24th ESTS Conference Copenhagen 2016 Young Investigator Award Session in an animal model on chest wall reconstruction. We hereby prove that our material Nylon 680 Co-Polymer, which is used in 3D Printing, is bioadaptable and can be used on human subjects.

METHODS

In our previous research;we produced ribs with Nylon 680 Co-Polymer / FDA approved material (Taulman3D,Saint Peters, MO, USA) by using 3D Printer. (Afinia H480, Chanhassen, MO, USA). We operated swines and resected ribs from each of them. Then, we replaced those resected areas with 3D printed ribs. Specimens were evaluated pathologically and compared with the pathological response in standard meshes. No difference was detected. In this study; we produced ribs in different shapes and sizes with the same material by using the same 3D Printer. We designed a project in concordance with The Scientific and Technological Research Council of Turkey (TUBITAK) consisting of 7 different tests.

Printed materials had been delivered to Marmara Research Center-Genetic Engineering and Biotechnology Institute of TUBITAK. these 7 tests include;

1-Cytotoxicity (ISO 10993-5)
2-Sensitization (ISO10993-10)
3-Irrıtation and intracutaneous reactivity (ISO10993-10)
4-Acute Systemic Toxicity (ISO10993-11)
5-Subacute Systemic Toxicity (SIO10993-11)
6-Genotoxicity (OECD 471)
7-Implantation (ISO 10993-6)

RESULTS

It is reported after 8 weeks that Nylon 680 Co-Polymer is safe for using in interventions on human subjects. All of those tests revealed that our material is not toxic (bioadaptable to) human tissues and genes following implantation.

CONCLUSION

By the help of this project we proved that Nylon 680 Co-Polymer is a 3D Printing material that can be safely used for medical interventions on human subjects. This brought forward producing custom made implants according to the necessity of the patients designed by ourselves. We can produce any kind of implant by the help of medical tests and imaging modalities without the need for ordering it to commercial companies. We can produce custom-made implants,instruments etc. by ourselves with low cost in shorter time.

Evaluation of a New Model of Metallic Bar and Stabilizer for Use in Minimally Invasive Repair of Pectus Excavatum

Miguel Tedde, Jose De Campos, Joao Macedo, Rafael Carvalho, Niura Hamilton

Heart Institute (InCor), Hospital das Clinicas, Sao Paulo University, Sao Paulo, Brazil

PURPOSE

The objectives are to evaluate the safety and effectiveness of a new set of titanium bars and stabilizers developed to be used in the minimally invasive repair of pectus excavatum. The main characteristics are bars with a smooth surface without grooves, stabilizers that incorporate two screws in their structure and two different models of stabilizers: one that moves perpendicular and other that moves oblique to the bars.

METHODS

Thirty patients with funnel chest, ten years or older, are been included to be submitted to surgical correction with this new bar and stabilizers. The exclusion criteria is complex pectus morphology, pectus too deep to be corrected by MIRPE, or presence of other comorbidities. The cases are been randomized in two groups, one using the perpendicular and other using oblique stabilizers.

RESULTS

Fifteen (14 males) patients have been operated with a medium age of 17,3 (15 to 25) years old and with Haller index varying between 3 and 9.4. All cases except one were corrected with one bar and two stabilizers. The obliquos stabililzer was used in 9 patients. The medium lenght of hospital stay was of 4,7 (4 to 7) days. In one case there was lateral displacement of the bar with need of reintervention. Another case presented partial rotation less than 30 degrees, opted for conservative conduct. There were no other major

complications.

CONCLUSION

The screws in the stabilizers allows it to be fixed at any point of the bar, even at its end, without the need to use steel wire or having to bend the end of the bar, and screws incorporated into the stabilizer structure prevents it from loosening and becoming a foreign body. And having available the two models of stabilizers, the perpendicular and the oblique, has show that sometimes one of then adapt better to the chest wall than the other.

Pectus Press in the "Pre-and Postoperative" Correction of Pectus Excavatum with the Nuss Procedure

Jose Ribas Campos, Adriana Imamura, Maria Candida Luzo, Paulo Pego Fernandes

University of Sao Paulo, Sao Paulo, Brazil

OBJECTIVE

Evaluation of effectiveness of the use of the Pectus Press (PP) on patients with Pectus Excavatum (PE) as initial and post-operative treatment of the Nuss procedure for the correction of posture, reduction of pain and prevention of bar displacement.

METHODS

Between August 2015 and December 2017, 159 patients, from 7 to 46 years (M=17), with PE were treated. On first visit patients received the orthotic equipment and oriented to follow a home exercise program and physical activities. Thirty-six (64.4%) underwent surgery during this period of time. We checked the correct size, position of the supports, the pressure of the shoulder straps on each visit every 30-60 days. The Valsalva maneuver with a "Pectus Whistle" after October-2016 was also recommended.

RESULTS

Better posture and more flexibility of the thorax were observed by patients and parents after the first three weeks including reduction of costal flaring in 73 (84%) that used the device for more than 12 hours a day including nighttime use. In the first 30 - 90 days of post-operative period, helped to reduce the pain and the possibility of bar bending, with the maintenance of a corrected posture. No bar displacement was observed in the operated group and less pain medication were prescribed.

CONCLUSIONS

Treatment using orthosis and exercises for PE has been very well described (Haje Method). "Pectus Press" is a flexible low-profile orthosis and has shown to be a useful tool in the pre- and post-operative periods of the Nuss procedure. Adding exercise's + Pectus whistle's, it provides thoracic chest wall flexibility. In the post-operative period, less pain and no bar displacement were observed. The success of treatment was directly linked to the patient age, time and frequency of the use of the device.

3D Printing Combined with Finite-element Analysis in the Design of Customized Nuss Bar

Hui Wang, Wei Liu, Fenghua Wang, Jianhua Liang, Jiahang Zeng

Guangzhou Women and Children's Medical Center, Guangzhou, China

OBJECTIVES

To improve the orthopedic effect, we proposed a novel method to individually design and optimize the shape of the Nuss bar.

METHODS

By using the CT imaging data of pectus excavatum case, the three-dimensional model of thoracic structure was reconstructed, which was further employed in finite element analysis to determine the operation plan. Mimics, Geomagic, ANSYS, and SiemensNX were adopted to design the curve of Nuss bar. The digital data of designed Nuss bar was imported to 3D printers.

RESULTS

The customized template of Nuss bar was gained by 3D printers. The designed curve of Nuss bar matched the contour of anterior chest wall referring to a healthy peer.

CONCLUSIONS

3D printing combined with finite-element analysis was a reliable tool for the individual design of Nuss bar, more accurate and individualized compared to conventional methods especially for the complicated pectus excavatum cases.

From Theory to Practice: 3D Reconstruction and Printing as a Valuable Tool for the Chest Wall Surgeon. Implementation in a Series of 78 Consecutive Patients

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Fundacion Hospitalaria[1], CEMIC[2], Buenos Aires, Argentina

OBJECTIVE

To assess the applicability of 3D reconstruction and printing for surgical procedures of the chest wall.

MATERIALS AND METHODS

78 consecutive patients from November 2015 to January 2018 were included and were divided into 3 groups:

1. Pectus Excavatum and Carinatum: (A) a 3D printed template was generated after digital processing of 3D CT scan with a specifically designed software. Metal implants including lateral bridges were custom made for each patient following this template. (n=73)

2. Poland Syndrome and Currarino-Silverman: (B) a 3D impression of the patient's sternum was used as a model for surgical planning and manufacturing of custom made titanium sternal plates. (n=4)

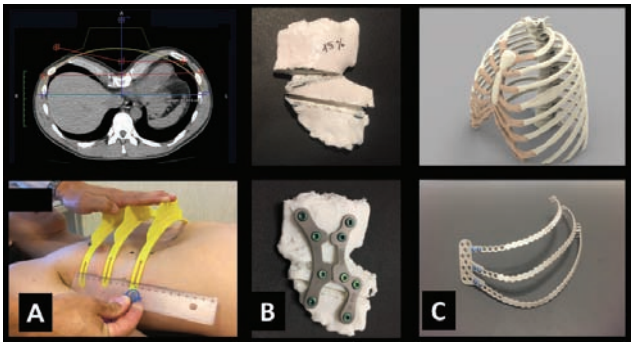
3. Malignant Costal Tumor: (C) a complete real size 3D printed chest was created, on which the team planned step by step the resection, reconstruction of the wall and appropriate fixation of the implants. A complex implant that included multiple ribs and sternal attachment was custom manufactured for a specific patient. (n=1)

RESULTS

The correction was achieved having previously planned the surgery step by step in all (100%) of the cases. There was no need to mold or modify the designed implants. The results were satisfactory in all the three groups.

CONCLUSION

Since November 2015 our team managed to implement (applicability) these tools (3D printing and reconstruction) in our current practice on a daily basis in all our chest wall surgical patients. We envision that in a near future these digital technologies may become available and accepted by most chest wall surgeons.



Session 6: Pectus Carinatum & Mixed Deformity : Repair Technique/Bracing

How to Deal with Complications in the Minimally Invasive Repair of Pectus Carinatum

Horacio Abramson

Cetrangolo Hospital, Buenos Aires, Argentina

The minimally invasive procedure for pectus carinatum repair has been widespread since 2005 when the first communication appeared and has been utilized progressively in many centers worldwide.

The aim of this presentation is to analyze the complications that can happen with the procedure and comment on the way to avoid and deal with them.

We consider among other issues: the correct selection of patients, the preoperative preparation, the availability of the necessary instruments, the correct technique of the implantation, the role of the surgical team, and the postoperative evolution.

The tips, tricks and pitfalls include issues like: marking the skin, curettage of the costal arches, the lateral plates and the bar location, the bar design, etc.

We take into account other complications like pain, infections, metal allergy and cutaneous adherence.

• Free Paper: Oral

Development and Validation of the Pectus Carinatum Body Image Quality of Life (PeCBI-QOL) Questionnaire

Robert E. Kelly. Jr.[1,2], *James F. Paulson*[1,2,3], *Kelsey Ellis*[3], *Robert J. Obermeyer*[1,2], *M. Ann Kuhn*[1,2], *Frazier W. Frantz*[1,2], *Margaret M. McGuire*[1,2], *Erika Ortiz*[3]

Children's Hospital of The King's Daughters[1], Eastern Virginia Medical School[2], Old Dominion University[3], Norfolk, USA

INTRODUCTION

While body image disturbances and quality of life in persons with pectus excavatum (PE) has been well documented, very little has been done to systematically measure and document the same phenomena in patients with pectus carinatum (PC). Because of this, the current study aimed to develop and validate an instrument to assess body image related quality of life in patients with PC and their parents.

METHOD

Participants. Two waves of data collection took place. The development phase enrolled 78 PC patients and 76 matched parents. The validation phase enrolled 84 PC patients and 76 parents. Mean age at the initiation of treatment was 15.14 (SD=2.54).

Table 1. PeCBI-QOL Subscales and Items

PATIENT QUESTIONNAIRE	
Body Image Disturbance Subscale	I am bothered by the way my chest looks.
	I often feel shy or self-conscious because of the way my chest looks.
	I feel good about the way I look with my shirt or top off.
	In general, I am happy about the way I look
	If I had to spend the rest of my life with my chest as it looks now, I would be happy.
	I try to hide my chest to keep people from knowing about it.
Treatment Motivation/ Engagement Subscale	I like my treatment plan.
	If I had a friend with a chest condition like mine, I would recommend my treatment plan.
	I wish I had treatment earlier.
	I have participated in physical therapy for my chest.
	I am doing everything doctors tell me to do.
	I am now more physically active than I was before the treatment.
Physical Limitations Subscale	In the past months, I had trouble running around or exercising because of my chest.
	In the past months, I have experienced shortness of breath because of my chest.
	In the past months, I felt often tired because of my chest.
	In the past months, I felt pain or discomfort because of my chest.
Social Disadvantage Subscale	Other children make fun of me because of my chest.
	Others my age make fun of me because of the way I look.
PARENT QUESTIONNAIRE	
Body Image Disturbance Subscale	Because of pectus carinatum, my child is reluctant to change clothes in front of others.
	Because of pectus carinatum, my child hides his/her chest to keep people from knowing about it.
	Because of pectus carinatum, my child is reluctant to wear a bathing suit without an additional shirt or top on.
	I feel bad because my child gets upset because of his/her chest appearance.
	Because of pectus carinatum, my child is sad or depressed.
	I am concerned about the effects pectus carinatum has on my child's life.
	Having pectus carinatum puts my child at disadvantage compared to his/her peers.
Treatment Motivation/ Engagement Subscale	Treatment for my child is going very well.
	We are happy with the treatment.
	I can see physical change in my child's chest that I believe are due to treatment.
	My child is very compliant with the treatment.
Physical Limitations Subscale	My child complains of chest pain when physically active (such as running or playing sports).
	My child often complains of shortness of breath.
	My child often becomes tired.
	When others look at my child they focus too much on pectus carinatum.

Participants were mostly male (85.9%) and White or Caucasian (89.7%).

Instrument Development, Refinement, and Validation. A group of 5 experts in chest wall deformities used existing measures of body image disturbances in PE, combined with the broader body image literature, to develop an item pool of 62 items for patients and 40 for parents. Item analysis from this phase was used to remove poorly-performing or statistically redundant items.

In the validation phase, the refined 22-item patient and 17-item parent instruments were examined using exploratory principal components factor analysis (EFA) with parallel analysis for factor retention, followed by Varimax rotation to identify a final factor solution.

RESULTS/DISCUSSION

This development and refinement process yielded a final questionnaires for patients (18 items) and parents (15 items). The patient questionnaire includes four subscales, each with good internal consistency: Body Image Disturbance (α=.92); Treatment Motivation/Engagement (α=.71); Physical Limitations (α=.84); Social Disadvantage (α=.86). The parent questionnaire includes 3 subscales: Body Image Disturbance (α=.92); Treatment Motivation/ Engagement (α=.91); Physical Limitations (α=.79). Patient and parent scales showed moderate correlations. Among patients with measures pre- and post-treatment, there was a significant improvement in overall PeCBI-QOL score (Patient: t(9)=.412, p=.003; Parent: t(9)=2.58, p=.030).

Surgical Repair of Pectus Carinatum and Mixed Deformities: The Sandwich Technique

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BACKGROUND

We introduce our new technique to repair asymmetric pectus carinatum or excavatum-carinatum complex (mixed deformity) using the sandwich technique (press-molding). The purpose of this study is to elaborate the details of the sandwich technique and appraise the early results.

METHODS

Between January 2007 and May 2016, 554 consecutive patients of pectus carinatum and pectus excavatum/carinatum complex were analyzed retrospectively. There was no patient excluded during the study period. The sandwich 1 and 2 techniques using the internal and external pectus bars were for pectus carinatum repair. Modified techniques using the external string and the internal bar were the solutions for the lower costal flare (the flare-buster) and focal protuberances (the magic string), which were aesthetic problems emerging after pectus excavatum repair.

RESULTS

The sandwich repair with the external and internal bars was applied to 59 pectus carinatum patients: 5 symmetric (8.5%), 12 asymmetric (20.3%), and 42 carinatum-excavatum complex (71.2%). After pectus excavatum repair, 446 patients had the flare-buster and 49 patients received the magic string. The sandwich 1 technique achieved near complete resolution of carinatum in 52 patients (88.1%). The sandwich 2 technique accomplished almost symmetric configuration with no residual carinatum in all 7 cases.

CONCLUSION

The sandwich technique using the external and internal bars seems effective in treating asymmetric pectus carinatum and complex excavatum/carinatum deformities. The flare-buster and the magic string were effective in relieving the costal flare and focal protuberances emerged after pectus excavatum repair.

Evaluation of a new MIRPC Bar Fixation Technique in a Biomechanical Cadaver Study-first Results

Stephan Rohleder[1], *Jessica Kempgen*[1], *Max Ackermann*[2], *Oliver Muensterer*[1], *Jan Goedeke*[1]

University Medical Center Mainz[1], Johannes Gutenberg University[2], Mainz, Germany

PURPOSE

Safe and firm fixation of the stabilizers is mandatory during a modified Abrahamson/Yüksel pectus carinatum repair. This study evaluates a novel fixation technique using PEEK cable ties compared to the sternal cable wires in a human cadaver model.

METHODS

In human cadavers a simulated Abramson/Yüksel procedure was performed. The lateral stabilizers were either being attached with PEEK cable ties or sternal cable wires. Specimens were subjected to static traction forces of 200N as well as continuous dynamic loading (from -100N to 100N) to perform a matched-pair comparison using a material testing device. Dislocation (in mm) and load to failure forces (in N) of both groups were compared.

RESULTS

Initial results show that the PEEK cable ties were easily placed around the ribs. There was no obvious difference in mobility. Dislocation of the stabilizer plates or cut-out of the wires/cable ties at a force of 100N did not differ between both fixation methods, although our preliminary findings suggest that wires but not the cable ties caused an appreciable impression of the ribs when extreme pressures (100N) were applied.

CONCLUSION

Preliminary results show that the biomechanical stability PEEK cable tie fixation is at least as good as the conventional cable attachment for stabilizer fixation. Furthermore, using cable ties might prevent rib cutting due to their flat shape compared to wires, particularly when subjected to high pressure. Further investigations are in progress to confirm our results.

Modified Reversed NUSS with Presternal Compression for Repair of Pectus Carinatum Deformity

William CF Chong

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PURPOSE

We described an alternative modified reverse NUSS with presternal compression for repair of pectus carinatum using single pectus bar.

METHODS

Case report of a 9 years old boy with pectus carinatum undergoing the modified reverse NUSS with presternal compression repair.

RESULTS

The procedure was carried out under general anaesthesia. A 11inch pectus bar was pre-bent to require correction. The sixth ribs on the right and left was chosen and marked for entry and exit points for the pectus bar into the thoracic spaces on the right and left. The procedure is carried out similar to NUSS procedure, except the bar is seated anterior to the sternum to provide presternal compression and correction of the pectus carinatum deformity. Unlike the Abramson's technique which requires two NUSS hinge plates anchored to two lateral ribs to provide anchorage for the compression presternal bar, our technique uses the patient's own ribs, on the left and right, where the bar enters and exit the thoracic space under the selected right and left ribs laterally to provide counter force for the presternal compression. Secure anchorage of the ends of the pectus bar are required to prevent early bar displacement. Satisfactory correction was achieved.

CONCLUSION

Our technique provides an alternative method for repair of pectus carinatum with satisfactory correction of pectus carinatum deformity.

Long Term Results of Compressive Brace Therapy for Pectus Carinatum

Duk Hwan Moon, Sungsoo Lee, Min Kyun Kang

Yonsei University College of Medicine, Gangnam Severance Hospital, Seoul, Korea

PURPOSE

Pectus carinatum (PC) is one of the most common types of congenital chest wall deformity. Recently, non-invasive compressive brace therapy has been more frequently used than invasive surgical correction to treat PC. Hence, the purpose of this study was to determine the long-term outcome of compressive brace therapy.

METHODS

We retrospectively reviewed patients with PC who underwent compressive brace therapy between January 2014 and December 2016. All patients followed a regimen of a 2-week compression period, in which braces were worn for 20 hours per day, followed by a 6-month maintenance period, in which braces were worn for 12 hours per day. Patient satisfaction was investigated via telephone survey.

RESULTS

A total of 320 patients were included in this study. The average age

was 13 years, and 280 were males (87.5%). The median follow-up period was 41 months (13-68). Good compliance was seen in 286 patients (89.4%; compliance group). In this group, the initial Haller index significantly increased from 2.20±0.31 to 2.59±0.38 after the 6-month therapy period (P=0.001). Satisfaction after the 6-month period in the compliance group was very satisfied in 255 patients (89.2%) and satisfied in 31 patients (10.8%). Satisfaction at the last follow-up via telephone survey was very satisfied in 253 patients (88.5%) and satisfied in 33 (11.5%). In the compliance group, no patient needed compressive brace again after the therapy period.

CONCLUSIONS

Given the findings presented in this study, compressive brace therapy appears to be a relatively simple and safe method to treat patients with PC with a good long-term outcome.

Nonsurgical Treatment of Pectus Carinatum and Associated Improvements in Body Image and Related Quality of Life

Robert E. Kelly, Jr.[1,2,3], *James F. Paulson*[1,2,3], *Kelsey Ellis*[3], *Robert J. Obermeyer*[2], *M. Ann Kuhn*[1,2], *Frazier W. Frantz*[1,2], *Margaret M. McGuire*[1,2], *Erika Ortiz*[3]

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INTRODUCTION

Pectus carinatum (PC) is characterized by a protrusion of the sternum and anterior chest wall. Until recently, the primary method of managing PC was intrusive surgical intervention involving costochondral resection with sternotomy. However, a newer noninvasive treatment is now available for PC patients which involves applying a corrective brace across the protruding chest wall. Although extant literature addresses the general effectiveness of bracing intervention, the evidence of its impact on body image and related quality of life is minimal. This study uses a prospective cohort framework and a newly-developed measure, the Pectus Carinatum Body Image Quality of Life (PeCBI-QoL) questionnaire to assess the impact of bracing treatment across physical and psychosocial domains.

METHOD

A total of 97 participants were enrolled. Approximately, 84% of participants were male and 91% Caucasian. Participants' mean age at initiation of treatment was 14.66 years (SD=2.24) with mean length of treatment being 11.5 months (SD=7.74). The PeCBI-QOL was given to patients and their parents at each treatment visit, producing a prospective dataset.

RESULTS AND DISCUSSION

Data on body image and physical symptoms were analyzed using hierarchical linear modeling, a variant of regression that is well-suited for longitudinal data of this nature. On the PeCBI-QOL, body image-related quality of life improved for patients (β=-.033, t(240)=2.51, p=.013) with matching parent report (β=-.096, t(398)=7.71, p<.001). Physical symptoms also improved (patients: β=-.024, t(240)=2.09, p=.037; parents: β=-.036, t(397)=3.37, p<.001).

These findings indicate that for the average 11.5 month course of treatment observed this study, patients see a 13.3% improvement in body image and a 27.6% improvement in physical symptoms.

Neither race nor gender were associated with rates of improvement. Older children, however, showed greater baseline levels of body image disturbance (βint=.27, t(239)=2.10, p=.037) and had more rapid improvements in body image over time (βslope=-.021, t(239)=2.36, p=.019).

13 Years of Experience on Minimally Invasive Repair of Pectus Carinatum

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Marmara University, Faculty of Medicine, Istanbul, Turkey

OBJECTIVES

Pectus Carinatum (PC) is the second most common congital chest wall deformity Minimally invasive repair of pectus carinatum (MIRPC) have become treatment of choice in recent years due to high patient satisfaction. We started performing MIRPC since 2005 which leads us to a respective experience on minimally invasive carinatum surgery. We hereby, present and investigate our 13 years of experience with results of MIRPC at our institute.

METHODS

Patients who had had MIRPC between August 2005- April 2018 were evaluated retrospectively, according to demographics, form of the deformity, number of placed bars, operation duration, perioperative and postoperative complications, length of hospital stay, bar removal timing and patient satisfaction.

RESULTS

Among 184 patients; 163 (88.5%) were male and 21 were female

(11.5%). Median age was 17,71 (10-44). 78 (42.3%) of them had symmetric deformity and 106 (57.7%) had asymmetric deformity. We measured the preoperative pressures in all cases and the mean pressure was 16.47 kg (7-30 kg). All patients were operated with with single bar and bilateral stabilizers. Median duration for the operation was 77 minutes (45-120 minutes) and median length of hospital stay was 3.7 days (2-10 days). Pneumothorax (5.4%, 10 patients) and wound infection (3.2%, 6 patients) were the most frequent early complications. 1 of those pneumothorax patients needed chest tube drainage and all wound infections were treated conservatively. Metal allergy (7.1%, 12 patients), over-correction (6.7%, 1 patients), steel wire breakage (2.7%, 5 patients) and recurrence (2.7%, 5 patients) were the leading late complications. Up to date, bars of 154 (83.7%) patients had been removed as planned. Mean time interval between MIRPC and bar removal was 25.23 months (8 days-89 months). Quality of life questionnaire revealed 96.4% patient satisfaction.

CONCLUSION

During this 13 years of our pectus journey, we experienced different types of pectus carinatum deformities. By the help of lessons that we learned from our experiences, we modified our own technique by developing new carinatum bar and stabilizator. We experienced most of our complications on the first 50 patients. Now; we rarely have to deal with those complications.

MIRPC is the treatment of choice in pectus carinatum patients because of being minimally invasive and having low mortality and short length of hospital stay. It can be performed with low morbidity and high patient satisfaction in experienced hands.

CAD-devised Cutting Template to Perform Precise Transversal Sternotomy in Pectus Arcuatum (PA) Treatment

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Meyer Children Hospital[1], University of Florence[2], Florence, Italy

BACKGROUND AND PURPOSE

PA is a rare anterior chest wall malformation due to a manubrium-sternal junction protrusion with early ossification of Louis angle and elevation from 2nd to 5th rib cartilage. Its surgical correction requires, after chondrectomies, a V-shaped horizontal sternal osteotomy followed by sternal edges approximation. The present paper reports our recent experience with one case in which transversal sternotomy was performed using a CAD-devised cutting template, manufactured by 3D additive technique.

METHODS

In patients with PA, our usual technique is to perform through a median longitudinal skin incision, chondrectomies from 2nd to 5th rib cartilages, followed by transverse wedge sternum osteotomy. Sternal edges are fixed using titanium plates. In a 12 year old male patient, through CT scan analysis, we planned before surgery the optimal sternotomy angle. By means of 3D additive printing technique we generated a cutting template to guide the horizontal V-shaped osteotomy.

RESULTS

The post-operative chest x-rays demonstrated a good correction of the defect. The CAD-devised template guided us in performing a perfect V-shaped osteotomy, safely sparing the posterior bone plate.

CONCLUSION

Although this is a single case experience, we suggest that CAD-devised cutting templates are a straightforward technology that may aid to perform adequate osteotomy angle in PA surgical treatment. The use of cutting templates should allow a safer and faster surgical procedure so improving the post-operative course. More cases are undoubtedly needed to validate such hypothesis.

Session 7: Pectus Surgery-Follow up & Management of Complications

Two Year Experience with Perioperative Co-management at a Free-standing Children's Hospital

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PURPOSE

Our 200-bed children's hospital instituted a program of co-management in the operating suite to engage stakeholders and improve processes.

METHODS

50 surgeons worked with >160 nurses, staff members, and administrative leaders to identify and address problems. As incentive, additional compensation was provided for physicians, nurses and

other perioperative staff members based on participation time and results achieved. Governance was provided by a physician-chaired committee. Projects were executed in 100-day cycles with intermittent team reports to the larger group at scheduled check-in meetings.

RESULTS

In the first two years, 48 projects were accomplished in four broad categories: (1) quality outcomes and patient safety (18), (2) efficiency and effectiveness (7), (3) patient experience and access (9), and (4) strategic development (14). Initially, projects were designed to be either specialty-specific or involving issues that affected the entire perioperative area. In the second year, modifications were made to reflect the first-year experience. Recognizing that 100 days was not sufficient for certain problems, the 100-day cycles were made part of year-long, non-specialty-specific projects. During the second year, 5/6 teams worked on year-long projects, with the first cycle for assessing the structure of the problem, the second for process improvement, and the final to achieve outcomes. One of the 6 teams was assigned three different single-cycle problems. Overall, goals were met in 81% of projects.

CONCLUSIONS

Engaging with physician and non-physician stakeholders in a two-year peri-operative co-management program produced good return on investment for our hospital and improved esprit de corps for the participants.

Do Patients with Pectus Excavatum Fail to Engage Satisfactorily in Exercise Protocols?

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INTRODUCTION

Pectus excavatum (PE) is commonly attributed only cosmetic importance and reported exercise dysfunction attributed to physical deconditioning. This study has examined whether patients with PE engage actively in exercise assessment protocols.

METHODS

Between 2006 and 2017, 65 consecutive patients, with a mean age 20.2 Years (range 14-46 years) completed physiological assessment. The patients required surgical correction and underwent preoperative evaluation of exercise function by cardiopulmonary exercise test (CPET) evaluation. The bicycle ergometer protocol, standardised in accordance with The American College of Chest Physicians was used. Metabolic assessment of capillary blood samples was performed before and at peak exercise. Physiological parameters of intensity of exercise were evaluated, peak heart rate (HR), Systolic Blood pressure (SBP), Respiratory rate (RR), Respiratory Exchange Ratio (RER). Data was compared to referenced values, mean and standard deviation values are presented. Statistical analysis included the Students t-test, $p<0.05$.

RESULTS

At peak exercise values of HR was 88.7% of predicted (+/- 6.8), SBP was 159.5 mmHg (+/-24.1) and RR 41.4 (+/-7.8 - Normal < 40). The RER achieved was 1.27 (+/-0.13), [ref 1.21+/- 0.12], $p<0.0001$. The change in blood metabolites during exercise was: pH 7.42 to 7.29 [Ref 7.31], $p<0.05$; bicarbonate 24.9 to 17.5 mmol/L, decrease of 7.5 [ref 6.2], $p<0.01$; and lactate from 1.3 to 10.4 mmol/L, an increase of 8.7 [ref 6.6], $p<0.001$.

CONCLUSION

The data shows that patients with PE achieved significantly greater changes in respiratory rate, and metabolic markers of acidosis during exercise than reference data predicted. Patients experienced very significant levels of acidosis are achieved, which may limit greater degrees of exercise. We conclude patients with PE apply supra-normal degrees of effort to exercise testing protocols, thus should test results indicate reduced exercise capacity, symptoms of exercise dysfunction should not be dismissed as insignificant or attributed to deconditioning.

Re-do Surgery after Nuss-bar Procedures

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Juliana Children's Hospital/Haga Hospital of the Hague, Hague, Netherlands

PURPOSE AND METHOD

In our large non-university teaching hospital, we introduced a program for the treatment of chest wall deformities in 2011. Our center combines the treatment of adults, in the main department of surgery, with the treatment of children, in the adjacent children's hospital. Adult patients are primarily seen by a general thoracic surgeon and children (up to 18 years) primarily by a pediatric surgeon. Operations are performed in a combined session with a general thoracic surgeon and a pediatric surgeon, to build up experience in both adults and children. From June 2011 until December 2017 351 patients with a chest wall deformity were seen in our center, and of them 228 underwent some form of surgery.

RESULTS

Sixteen out of the 190 patients (8.4%) who underwent primary Nuss-bar correction had revision surgery, ranging from repositioning dislocated stabilizers, bar replacement to adding or removing a bar. In one severe case a secondary Ravitch procedure was done to fully correct the deformity. In our starting year of 2011, we treated 13 mainly uncomplicated cases who underwent single bar surgery, and none of them needed revision. However, out of the patients operated in 2012 end 2013 20% had revision of their bars due to secondary dislocation, unsatisfactory results of the procedure or allergy. In the years 2014-2017 this percentage of re-do surgery dropped to 6%. In these last 4 years more patients were treated with multiple bars: 89 out of 136 patients (65%).

CONCLUSIONS

The high percentage of redo surgery in our startup years might be due to the learning curve of the surgeons (though both had experience with the procedure at previous hospitals). In our experience the number of Nuss-bar patients who need re-do surgery for incomplete correction or bar dislocation, is around 6%. Even though we started to do more complex cases, our re-operation rate has gone down, this might also be due to the placement of multiple bars more frequently, rather than single bars.

Management of Pectus Excavatum Recurrence: What Shall We Do?

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PURPOSE

Recurrence after Pectus Excavatum (PE) correction is generally not an easy problem to solve. Management protocols of this complication do not exist and setting the indication for a new intervention and the way to do it remains difficult.

This is an analysis of the patients who required a redo-procedure or a second intervention after PE surgery.

METHODS

Retrospective descriptive study of the patients with PE who recurred after surgery and required a second procedure, redo-intervention or a vacuum bell. We analyze the indications, complications and results.

RESULTS

Five patients required a second procedure after PE correction in our unit between 2016 and 2018. Median age was 12 years (8-16). Initial surgery in 4 cases was Nuss technique with insertion of 1 bar fixed by unilateral stabilizers in 3, and bilateral stabilizers in 1 case. One patient initially was corrected by Pectus-up technique. Indications for the second procedures were: 3 recurrences related to early removal of the pectus bar, 1 recurrence and displacement of the pectus-up plate and progressive displacement of the Nuss bar with recurrence 1 year after surgery. Early removals were due to complications during initial surgery (hemothorax and pericarditis) and short age at initial surgery. Three cases were managed operatively performing an initial thoracoscopic approach to liberate pulmonary and mediastinal adhesions and removal of the previous bars or plates. New correction was gained by placement of 2 bars fixed by lateral bridges under sternal elevation. We had no complications and a complete correction of the depression was achieved in all. Two cases, mean age of 9, were managed with vacuum bell device. Treatments are still going on but improvement of the depression has been documented in the 3D external scans done after 3 months.

CONCLUSIONS

Redo-procedures by Nuss technique are feasible but complex, requiring an initial thoracoscopic approach to liberate pulmonary and mediastinal adhesions and sternal elevation. The use of Vacuum bell is an interesting alternative to surgery especially in younger patients. Therefore, the treatment of each patient should be individualized considering his initial surgical technique, complications and age.

Use of Cryoanalgesia During a Nuss Procedure: Update

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PURPOSE

We previously reported the use of cyroanalgesia for post-operative Nuss procedure pain management. We describe in this report modifications and additional results since our report two years ago.

METHOD

T-fastener suture technique is used to elevate the chest. Bilateral Rultract Retractors are used for more stable chest elevation. Single lung ventilation is used to pause the ipsilateral lung movement during the cyroprobe application. Bilateral four level intercostal nerve cryoablation is performed for each side.

RESULT

Twenty boys and one girl underwent the cryoanalgesia and Nuss procedure. The average age was 15. The mean Haller index was 4.28. The mean length of postoperative length of stay was 1.5 days. All patients had return of normal sensation. No patients developed neuralgia.

CONCLUSION

The long-term analgesic effect of cryoanalgesia decreases the morbidity of pain for patients recovering from a Nuss procedure. No complications due to cryoanalgesia were observed.

Enlargement of the Intercostal Space after Primary Nuss Procedure Creates an Adverse Impact on the Reconstructed Thoracic Shape

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INTRODUCTION

In the management of Nuss procedure for pectus excavatum patients, the reconstructed thoracic shape after operation period is satisfactory, but occasionally it feels that the chest has not been raised high enough over time after post-operative pain disappeared and posture improved. This phenomenon usually occurs in the lower thoracic wall of adolescent cases. We hypothesized that the shift in the location of the rib that supported the bar with the load of sternal elevation was the cause of the deformity. In this report, we evaluated the pre-and postoperative location of the inserted point and considered its impact on the thoracic wall that was reconstructed with Nuss procedure.

METHODS

We evaluated eleven patients who underwent Nuss procedure after adolescent. We measured pre- and postoperative distance between the top end of the cephalad rib and the caudal one at the intercostal region where the bar was inserted. We also evaluated the change in the height at the supporting point of the bar, however, postoperative one could not measure because of the artefactual influences. Therefore, we measured the perpendicular distance from the anterior spine to the cost-chondral junction at the rib of supporting point (Fig. 1). These data were analyzed by paired-t test and p values <0.05 were considered statistically significant.

RESULTS

The changes in the distance between the ribs at the supporting point were significantly wider at the fourth, fifth and sixth intercostal spaces. The changes in the height of the rib at the supporting point, were increased at second intercostal region, however, it was decreased at the fifth and sixth ones and they were statistically significant.

DISCUSSION

Our study revealed that the elevation of the depressed sternum with Nuss procedure tends to widen the intercostal space. Shift of the supporting point after operation is one cause of the residual deformity.

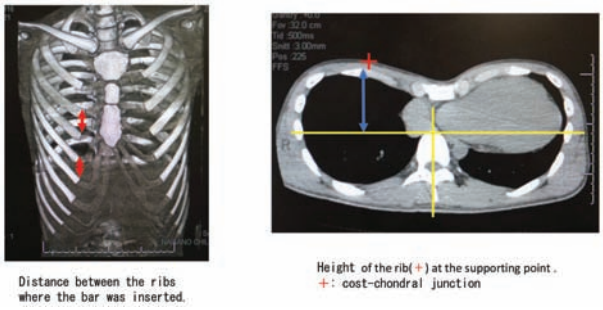

Fig. 1. Evaluation items.

Session 8: Institutional Experience

Nuss Procedure Results 5-10 Years Postop

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BACKGROUND

Few studies have addressed the long-term outcomes of the Nuss procedure for correction of Pectus excavatum.

METHODS

We sought information concerning patients treated at Children's Hospital of The King's Daughters in Norfolk, Virginia, USA, who were between 5 and 10 years postop, utilizing a previously validated questionnaire (the Pectus Excavatum Evaluation Questionnaire, or PEEQ). Additional questions were added regarding postop medical problems not included in the original questionnaire. The questionnaires were sent out via regular- and e-mail to 623 patients (ages 13 to 39) who underwent operation between 2004 and 2009.

Telephone surveys were attempted with all patients who did not respond. Follow-up efforts extended from 2014 to present.

RESULTS

A total of 191 (31%) patient questionnaires and 80 (13%) parent questionnaires were received. For questions pertaining to physical limitations (trouble exercising, shortness of breath, tired, not able to do gym, missed school), median Likert-scale score was 4 (never). PEEQ questions concerning psychosocial variables (hides chest, feels shy/self conscious because of chest, etc.), median responses were also at the top of the scale, reporting complete absence of the psychosocial limitation specified in the question. Parent responses closely mirrored the patient responses. While 36 patients and parents specified having a medical problem after surgery, only 16 (2.6%) could be identified as related to operation. Of those, 6 remain unresolved. These included (one each): sinus tachycardia, myoclonus, kyphosis, scoliosis, low lung capacity and recurrent pectus excavatum.

CONCLUSION

The Nuss Procedure can greatly improve the function and appearance of the chest of those suffering from Pectus Excavatum. Even 5 to 10 years after surgery, the overwhelming majority of patients are asymptomatic, pleased with the physical results and report little to no psychosocial limitations.

Minimal Invasive Surgery for the Correction of Pectus Excavatum in Patients with Marfan Syndrome: The Mexican Experience

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BACKGROUND AND AIMS

In Mexico, the focus has been placed on the cardiac aspects of Marfan syndrome patients. Limited attention is drawn to chest wall malformations, and these also have an adverse implication for the correction of cardiac alterations. Our research intends to demonstrate that treating Pectus Excatavutm leads to the improvement of the cardiac functions of patients with Marfan syndrome.

METHODS

Retrospective study. Patients in the sample were diagnosed with Pectus Excavatum and Marfan syndrome. Analytical variables included age, gender, patient evolution, Haller index, cardiac symptomatology, surgery duration, bar number, bleeding, pneumothorax, allergy to bars and complications.

RESULTS

From December 2012 to January 2018, 9 patients, 11 males and 2 female with an age range from 12 to 33 years, were treated. Treatment included losertan and all displayed progressive disnea. 4 patients had mitral insufficiency, 2 ventricular fibrillation, 4 moderate aortic insufficiency, 5 precordial pain and 3 cyanosis. Haller index from 4.5 to 53. 8 patients required 1 bar and 5 patients 2. Surgical time of 1 bar patients was 60 minutes and 2 bar patients 95 minutes. Average bleeding 20 ml. After treatment, patients improved their cardiac symptomatology. Cardiac arrhythmia was corrected in the 2 patients. A valvular surgery in patients with severe mitral insufficiency was conducted 1 and 2 years after treatment. In case with 53 Haller index one bar was dislocated. Bar was retrieved in 5 patients after 3 years, without recurrence or cardiac symptomatology. Esthetical result satisfactory in 9 patients.

CONCLUSIONS

The Nuss procedure not only improves the cardiac symptomatology in patients with Marfan syndrome but allows cardiac correction procedures. It is more than an esthetical procedure. Furthermore, early treatment is recommended to mitigate complications.

Nuss Procedure; Actual Outcome for Pectus Excavatum in Mexico

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INTRODUCTION

Nuss procedure has proved advantages in reducing trauma, pain, sooner recovery and cost. Surgery is performed in patients when Haller index is higher than 3.26.

MATERIAL AND METHODS

In a follow of 14 years in patients with pectus excavatum, we have registered: age, sex, indication of surgery, number of bars applied, surgical time, length of hospital stay, respiratory tests, complications and actual outcomes. Analysis was done by using dispersion measure and averages, Mann Whitney U test.

RESULTS

160 patients, 70 females, 90 males, average age 11.1 years. Haller CT index average 5.12. In 94% patients one nuss bar was needed and in 6%, 2 bars. Average operation time was 1 hour. Average length of hospital stay was 6 days. Vital capacity and forced expiratory volume increased, with findings of significant improvement in all patients with P <0.05. Complications: 5 emphysemas, 6 pulmonary atelectasis, 10 pneumothoraxes. Major complications: pericardium laceration 4, hepatic laceration 2, bar rotation 4, exposure of bar 4, bleeding at bar removal 4, bar ossification 3, lung injury that need a lobectomy 1. No deaths occurred. The bar was removed after 3 years in 123 patients with good outcome without affection on respiratory test.

DISCUSSION

In our serie patients with chest wall deformity type pectus excavatum, the Nuss procedure has shown be the best option of treatment, improving respiratory function and good cosmetic results with low rate of complication and recurrences. In 14 years we discover that is not only a way to do it, we have to adequate the procedure according severity and the patient conditions.

13 Years of Experience on Minimally Invasive Repair of Pectus Excavatum

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OBJECTIVES

Minimally invasive repair of pectus excavatum (MIRPE) have become the standard treatment in many centers in recent years due to successful surgical outcomes. We started performing MIRPE since 2005 which leads us to a respective experience on minimally invasive pectus surgery. We hereby, present and investigate our 13 years of experience with results of MIRPE at our institute.

METHODS

Patients who had had MIRPE between August 2005- April 2018 were evaluated retrospectively, according to demographics, form of the deformity, number of placed bars, operation duration, perioperative and postoperative complications, length of hospital stay, bar removal timing and patient satisfaction.

RESULTS

Among 822 patients; 715 (87%) were male and 107 were female (13%). Median age was 18.48 (14-58). 631 (76.77%) of them had symmetric deformity and 191 (23.23%) had asymmetric deformity. We repaired the deformity with 1 bar in 507 (61.6%) patients, with 2 bars in 300 (36.4%) patients and with 3 bars in 15 (1.8%) cases. Median duration for the operation was 71.51 minutes (20-180min) and median length of hospital stay was 4.02 days (1-15 days). Pneumothorax (30 patients - 3.64%) and pleural effusion (7 patients - 0.85%) were the most frequent early complications. 11 of those patients needed chest tube drainage. Wound infection (44 patients - 5.35%), insufficient correction (15 patients - 1.8%) and nickel allergy (9 patients - 1.09%) were the leading late complications. Up to date, bars of 482 (58.6%) patients had been removed as planned. Mean time interval between MIRPE and bar removal was 34.4 months (1 week- 123 months). We experienced recurrence only in 4 (0.5%) patients after bar removal. Quality of life questionnaire revealed 95% patient satisfaction.

CONCLUSION

During this 13 years of our pectus journey, we experienced different types of deformities suc as asymmetrical deformities. Up to 5 years ago; we were trying to treat all of the deformities with the standard classical NUSS procedure but now we have different kinds of modifications like Cross-Bar Technique, Double-Hump Method and Sandwich Technique. Although classical method of Minimally invasive Repair of Pectus Excavatum is the golden stardard and most commonly used technique, surgical approach still keeps evolving day by day.

MIRPE is the treatment of choice in pectus excavatum patients because of being minimally invasive and having low mortality and short length of hospital stay. It can be performed with low morbidity and high patient satisfaction in experienced hands.

Minimally Invasive Repair of Pectus Deformities: Selcuk University Experience

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PURPOSE

Dr Nuss explained a new procedure for repair of pectus deformities in teenagers in 1988. This procedure performed via videoassisted surgery which inserted transthoracic and elevated the sternum. This minimally invasive method was primarily used and acceptance in recent years. We aimed in this study to present the our clinic experience on pectus surgery.

METHODS

From 2011 to 2018, 114 patients were evaluated for chest wall deformity at Selcuk University Medical Faculty Thoracic Surgery, Minimally Invasive Division, Konya Turkey. All patients underwent follow 3-6 months period after operations. All patients performed CT scans and cardiopulmonary works up. The effects of surgical operation on cardiac functions of people with pectus excavatum (PE) who have right ventricular pressure were evaluated with echocardiography.

RESULTS

All of these patients, 81 had pectus excavatum and 33 had pectus carinatum (Table 1, Table 2). There were 65 (80,2%) boys and 16 (19,8%) girls for a sex ratio of pectus excavatum patients. 3 (9,1%) girls and 30 (90,9%) boys had pectus carinatum. The mean Haller index was 3,70 (2,21-12,8). The pectus bars were removed for 54 of PE and 13 of PC patients. 1 patient underwent VATS lobectomy for congenital cystic adenoid malformation when MIRPE was performed and 1 patient underwent thoracoscopic thoracal sympathectomy when the bar was removed at the same time. In 54 patients of pectus excavatum the echocardiographic findings were normal, for 19 patients with pectus excavatum there was right ventricular pressure without cardiac pathology. 2 patients with pectus carinatum was performed Ravitch procedure and 2 patients were followed with braising technique.

CONCLUSION

It was turning point since we encountered the MIRPE. We believe that minimally inavsive repair is safer via thoracoscopy. You have a good exposure. One of the problems with MIRPE is the bar rotation in the postoperative period. It is preventable stronger fixation and using the stabilizator.

Table 1.	Characteristics of 81 patients who underwent repair of pectus excavatum
Gender	Male: 65 (80,2 %) Female: 16 (19,8 %)
Symmetry	Symmetric 44 (54,3%) Asymmetric 37 (45,6%)
Associated anomaly or disease	2 Marfan's Syndrome (2,4 %) 1 Scoliosis (1,2 %) 1 Congenital cystic adenomatoid malformation (1,2 %)
Haller Index > 3,25	37 (45,6 %)
Age at operation (mean-range) years	16,26 (6-36)
Haller Index (mean-range)	3,70 (2,21-12,8)
Postoperative hospital stay (days)	4,5 (2-8)
Bar removal time (mean, month)	27,18 (4-56)
EKO findings	54 - normal 7 - MVP (mitral valve prolapsus) 1 – Ebstein anomaly 19 – right ventricule pressure without cardiac pathology

Table 2.	Characteristics of patients with pectus carinatum
Gender	Male: 30 (90,9 %) Female: 3 (9,1 %)
Operating age (mean)	15,45 (13-24)
Surgery	2 Ravitch procedure 31 Abramson procedure (MIRPC)
Postoperative hospital stay (mean)	4,15 (2-9)
Bar complication	6 bar dislocation 2 bar skin reaction
Bar removal time (mean month)	15,69 (4-35)

Session 9: Surgical vs. Conservative Approaches-New or Alternative Techniques

Proposal of a New Operation for Pectus Excavatum Based on the Recovery of Pulmonary Function after Operation in Young Children

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PURPOSE

The indication of Nuss procedure for young children is controversial. Recurrence and chest wall constriction may occur in children. However, recovery of lung function after operation should be considered. We studied pulmonary function test in children after bar removal. And our new and minimally invasive surgery for young children is introduced.

MATERIALS AND METHODS

45 children who underwent bar removal after Nuss procedure were divided into two groups; 27 young cases (<10 years old) and 18 aged cases (10 to 15 years old). Spirometry was performed 1 month and 1 year after bar removal and %VC was compared between these groups.

An idea of our new operation is to pull-up the depressed costal cartilages and lower sternum instead of pushing up the sternum. An external brace, 16cm or 18 cm long, was placed in the subcutaneous tissue at the xiphoid area and depressed chest was fastened to the brace with multiple non-absorbable sutures. 10 children less than 10 years old with pectus excavatum underwent this operation.

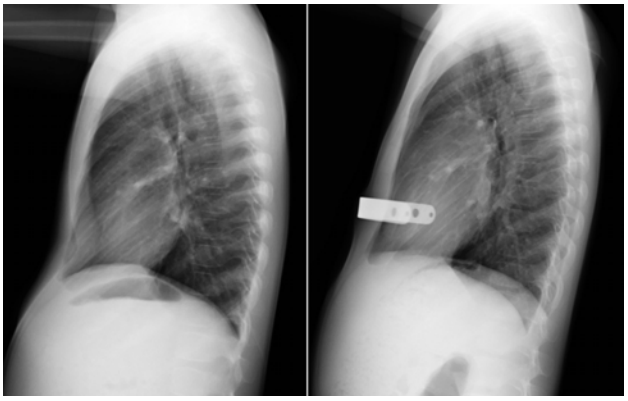
RESULTS

%VC in young group at 1 month and 1 year after bar removal were 95.8±11.4 and 103.8±11.9, and in aged group, 81.7±16.8 and 83.3±14.8. %VC showed significantly improved in young group after bar removal.

Post-operative course in 10 patients with the new operation was uneventful in all cases except a case with bar flipping. Chest wall appearance was excellent in all cases.

CONCLUSIONS

Postoperative recovery of lung function was much better in young children. Surgery for these cases should be considered based on the idea that chest wall constriction, recurrence, and serious complications never happen. The external brace will be remained in place to prevent recurrence until they reach puberty. Our new operation might be suitable for young children with pectus excavatum.



Short and Asymmetrically Bent Bars with Minimal Intrathoracic Passage Could Improve Results in PE Patients?

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BACKGROUND

Since 1998 the Nuss procedure has been adopted with worldwide success while its concept has been subsequently modulated with innovations and expedients in the effort to make the procedure safer and easier. In the present work we aimed to retrospectively compare outcome and complication rates in a consecutive series of PE patients operated at our Institution.

METHODS

A retrospective medical chart analysis of two consecutive surgical series beyond the usual learning curve was performed. In the first group (2012-2014), the Nuss technique with a short barand lateral stabilizers was performed. In the second cohort (2015-2017) we used mostly double, short, asymmetrically bent bars with reduced intrathoracic passage and proximal single stabilizers.

RESULTS

There were 114 patients in first group and 119 in the second one. Mean age was respectively 15.6 years (12-23) and 16.1 years (13-24) whereas M/F ratio was 103/11 in the first group and 104/15 in the latter.

CONCLUSION

The use of double short asymmetric bars and stabilizers placed in a proximal fashion associated with a minimal intrathoracic passage enabled higher mechanical stability of the implantreflecting in a better outcome for PE patients.

	2012-2014	2015-2017	*p-value*
*Single vs Double bars**	98 vs 16	18 vs 101	*<0.05*
Length of stay	7.3 days	6.1 days	*ns*
Surgical site infection	4	2	*ns*
*Minor bar displacement (<30°)**	11	2	*<0.05*
Pericarditis	1	1	*ns*
*Persistent pain impairing early mobilization**	4	1	*<0.05*
*Bar displacement which required reoperation**	3	-	*<0.05*
Pleural effusion which required drainage*	2	2	*ns*
Persistent pneumothorax which required VATS	-	1	*ns*
Cardiac perforation	1	-	*ns*

**these parameters might be related with mechanical stability.*

Do We Always Need Surgery to Treat Chest Wall Deformities?

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For decades, surgical repair was the only available method to treat congenital and acquired chest wall deformities. In 1998, D. Nuss described a minimally invasive procedure for surgical repair of Pectus excavatum (PE), and a few years later H. Abramson reported on his experience with the "reversed Nuss technique" for surgical repair of Pectus carinatum (PC). Both procedures are performed

with increasing frequency worldwide.

However, non-surgical measures such as vacuum bell therapy for conservative treatment of PE and more differentiated bracing systems for conservative treatment of PC were established 15-20 years ago. Nowadays information on new therapeutic modalities circulate not only among surgeons and paediatricians, but also rapidly among patients. In particular patients who refused operative treatment by previously available procedures, now appear at the outpatient clinic and request to be considered for the new method.

Analysing the group of patients who visited a busy outpatient clinic in a small country within the last 15 years, we have to realize that the majority of patients asked for non-surgical treatment of their chest wall deformity. Based on my personal experience, I will display the figures for PE patients as well as PC patients.

Surgical and Orthotic Techniques Are Complementary Procedure Dealing with Chest Wall Congenital Deformities

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Recently The Surgical And Orthetic Techniques Have Had Impressive Developments.

Traditional Open And Resective Techniques Have Had To Compete Progressively With The So-Called Minimally Access Procedures.

Innovations Such As Videothoracoscopy, Novel Implant Materials And Novel Designs Have Triggered This Evolution.

According To Our Experience Orthesis And Implant Procedures Constitute Complementary Techniques.

This Complementation Resulted In Being Particularly Useful Dealing With Asymmetry, With The So-Called Dismorfic Cases, And The Flared Ribs.

This Paper Analyzes Our Experiences Concerning This Matter Based On Hundreds Of Surgical Corrections And 250 Orthotic Treatments.

The Strategy Planning The Correction Of Each Patient Must Be A Taylored One.

1) We Take Into Account The Age Of The Patient In Order To Proceed In The Best Way.

2) We Submit Our Criteria In Chosing The Orthotic Or Surgical Treatment As The Only Procedure.

3) We Show Cases In Which Both Techniques Are Interwoven, Either Because They Start With Surgery, And Are Later Complemented With Orthesis Or Inversally.

Different Nuss Procedures and Risk Management for Pectus Excavatum after Surgery for Congenital Heart Disease

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OBJECTIVES

In Nuss procedure for pectus excavatum (PE) after surgery for congenital heart disease (CHD), retrosternal adhesion may increase the risk of cardiac injury. This study aimed to explore different Nuss procedures and their implications for reducing the incidence of serious complications and improving surgical safety.

METHODS

We retrospectively reviewed 49 cases of Nuss procedures for PE after surgery for CHD that were performed between April 2003 and December 2016. The median age was 5.8 years, and the median Haller index was 4.6. All patients were evaluated on their cardiac function and severity of PE by echocardiography and computed tomography scan, respectively. Three surgical procedures were used. Perioperative conditions were analyzed, including CHD type, interval between two operations, blood loss, operation time, hospital stay, complications, and postoperative results.

RESULTS

All 49 cases were completed successfully. Fourteen casesinvolved the standard three-incision thoracoscopic Nuss procedure, 30 cases involved the Nuss procedure assisted by a median sternum incision, and 5 cases involved the Nuss procedure with sternal suspension. The median interval between the CHD surgery and Nuss procedure was 4.0 years. The median blood loss was 2.0 mL. The median operation time was 45.0 min, and the median hospital stay was 6.0 days. Three patients experienced severe surgical complications. Patients were followed up for 7-120 months after surgery. The postoperative results were excellent in 46 cases and good in 3. Twenty-four of the 49 patients have had their bars removed. The median time for bar removal was 36.0 months (24.0-47.0). The outcome after bar removal surgery was excellent in 20 cases and good in 4.

CONCLUSIONS

Patients may develop PE or worsening of preexisting PE conditions after surgery for CHD. An individualized surgical plan for each patient will increase safety and decrease the risk of the procedure.

Task Force : Which Index Should We Use? The CWIG Guideline / Perspective

Browsing the Current CTIs: Science or Myth?

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Since the minimally invasive technique for pectus excavatum has been proposed, many indices have also been proposed to describe the chest wall morphology, to clarify the surgical indications, to assess the surgical outcomes. However, there is no consensus in the surgical community either on which index is the gold standard or what cut-off value is acceptable for the guiding surgery.

The ideal index can provide following information; (1) reliable and comprehensive assessment of the severity, shape, and classification of the deformity, (2) providing a cut-off value for treatment strategy, (3) quantifying and comparing the surgical outcomes, and (4) simple and reproducible in measurement [1]. There are many indices stemming from different references, such as chest X-ray, CT, MRI, ultrasound or even clinical measurement. With the widespread use of the preoperative CT scans, the indices based on CT scan are most commonly used at present.

The Haller Index (HI), first described in 1987, remains predominant index and as the standards for reimbursement in certain countries. However, the HI seemed to be adopted in our practice without proper evaluations or critical judgements. Dividing transverse by the anteroposterior diameter is simple and intuitive, but it has inherent limitations as many researchers have pointed out. Since the value depends on the denominator, the width of the chest, a person with normal shape but wide chest can be misclassified to a pectus patient. St. Peter et al also showed the lack of discriminating power of HI =3.25, about 40% of normal and pectus excavatum patients overlaps [2].

There have been other CT indices designed to overcome the limitations of HI: notably, Depression Index (DI) and the Correction Index (CI). DI was devised in 2001 by our group to measure directly the pure depth of pectus depression [3]. CI was developed later to represent the percentage of chest depth to be corrected by surgery [4]. Both DI and CI were independent of the chest width. However, the CI is not applicable in asymmetric cases due to discrepant dimensions on both sides of the chest wall.

It is about the time to set a universal CTI, thereby, a CWIG "task-force" work by the experts seems to be necessary to validate which index would be the best one or combinations of indices that best fit for pectus excavatum satisfying the necessity and sufficiency.

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Undertreating Pectus? Comparison Between Haller Index with Correction and Depression Index

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PURPOSE

In the last years new indexes are gaining ground in the evaluation of Pectus Excavatum (PE). The aim of our study is to compare surgical indication established by the classical Haller index (HI) in relation to the Correction (CI) and Depression index (DI).

METHODS

Retrospective study (2010 and 2017) of all CT scans and MRI of PE patients evaluated in our paediatric outpatient clinic. Each index (HI, CI, DI) was measure twice, by a facultative and a trainee.

Since indication for corrective surgery is established and internationally accepted for a HI > 3.25, we evaluated CI and DI in patients with HI inferior and superior to 3.25. Reviewing literature CI > 20% and DI > 0.2 were considered indicative for surgery.

RESULTS

Eighty-one studies in 77 patients (mean age of 12 years) were analysed.

The correlation for measures done by a trainee versus facultative was significant with the following correlation indexes: HI 0.942 ($p<0.0001$), CI 0.862 ($p<0.0001$), and DI 0.762 ($p<0.0001$).

Twenty-five had a HI ≤ 3.25. Of those 21 (84%) had a CI> 20% and 24 (96%) a DI > 0.2 indicating surgery. Changing the set of CI to 10% (proposed by St.Peters 2011) all 25 should have undergone surgery.

Fifty-six studies had a HI >3.25. Of those just 1 (1.78%) presented a CI < 20% and 3 (5.35%) a DI < 0.2.

CONCLUSIONS

Following the criteria published for the new indexes, PE patients may be undertreated in 26% and over-treated in 3.7%. An international consensus is mandatory to establish the most reliable index and its limits for surgery indication.

ADiEU Index for 4-way Measurements of Severity of Pectus Deformity: A Universal Index Comprehending All Types of Deformity

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OBJECTIVES

Morphological evaluation of different types of pectus deformities is crucial for successful repair of pectus excavatum. We developed computerized tomogram Indices (CTI) in four different perspectives for better understanding the details of malformation. Particularly, as the Haller index has been proved to be inaccurate, how the Depression Index works for a universal in measuring the depth of the chest wall depression in pectus excavatum.

METHODS

The 4-way CT Indices (Figure 1) were devised in 2002 (presented in Chest meeting, 2004) to identify the volumetric configurations of the deformity by providing the severities of the given deformity. The ADiEU Index comprises the Depression Index (DI) for measuring the depth of the depression; Asymmetry Index (AI) for degree of asymmetry of both sides of the chest wall; Eccentricity Index (EI) for location of the depression; Unbalance Index (UI) for measuring the difference of the slopes of both sides of the depressed wall. Pre and postoperative CT scans were calculated and compared from our database of pectus excavatum repair, the data of 2419 patients repaired between 1999 and 2014.

RESULTS

The mean age of the patients were 9.9 years (range: 16 months to 55 years). Male to female ratio was 3.69. Mean values of CTI's were: DI, 1.84 (1.05-35); AI, 1.05 (1-1.8); EI, 1.54 (1-3.75); UI, 1.50 (1.05-6.0). Depression index furnished how deep the depression was: e.g., DI of 2 represented depressed chest wall is halfway between the sternum and the vertebra. Likewise, asymmetry index, eccentricity index, and unbalance index offered how much each asymmetric component in a quantitative manner for volumetric identification.

CONCLUSION

The combination of authors' 4 CT Indices could offer volumetric image of the deformity and effectively guided selecting appropriate repair techniques for each proposed specific deformity. The Depression Index seems to be universally accurate in evaluating all forms of pectus deformity including unbalanced deformity. Therefore, Depression Index can be proposed to the new tool to guideline pectus surgery, and safely replace the Haller Index.

Session 10: Chest Wall Trauma

Rib Fixation a Game Changing Intervention in the Management of Major Chest Wall Trauma

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INTRODUCTION

Severe chest trauma, commonly associated with multiple injuries of major trauma, is known to carry a high risk of complication and death when managed conservatively. The role of internal plate fixation of fractured ribs is yet to be established. Since becoming a centre for major trauma management in 2014, we have introduced this therapy and we report of results.

METHODS

Patients recorded on our surgical database from September 2014 to have been treated by rib fixation were analysed. Radiology and clinical records were examined to identify the mechanism and severity of trauma, the number of systems injured and the number of ribs requiring fixation. The investigation and treatments strategies undertaken since its inception have evolved. We therefore record our protocol for investigation, our indication for fixation and the outcome following treatment.

RESULTS

65 patients were admitted following trauma to the chest wall. 53% of these followed road traffic collisions, of which a large proportion had associated injuries; dead injury in 20.6%, limb fractures in 35%, spinal fractures in 21.5%, abdominal injury in 19%. Right rib fractures were treated in 57%, left in 43% and sternal fractures in 15%. 62 of 65 patients survived to discharge.

CONCLUSION

Our early experience following the introduction of this therapy in the management of chest trauma has suggested that the treatment

has had markedly improved recovery from chest wall injury, achieving excellent survival and enhancing hospital discharge. We have identified a need to modify the current radiological and clinical definition of flail chest. This definition requires that the chest wall and clavicles are considered to be a single cylindrical entity, and a flail segment be considered a disrupted segment of the whole cylinder. It is our impression that timely intervention markedly improves patient outcome.

Evaluated the Results of Rib Fixation Procedure in the Patient Had Rib Brokens

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SUBJECTS

Rib fractures, depend upon quantity, location, and severity, could cause pain, hemothorax, flail chest. Fixation of broken ribs could refrain or stop those consequences. There have been several methods to fix broken ribs. We applied rib plating method and perform this research to evaluate its outcome and feasibility.

METHODS

Retrospectively review rib fixation cases in our thoracic department from 11/2015 to 9/2016.

RESULTS

There were 33 cases. Among them, 12 patients were applied 2 plates, 16 patients with 3 plates, and 5 patients with 4 plates. There was 4 cases of flailed chest and no have case of two fractures in the same rib. Postoperatively, patients were free of pain, rib cage volume were restored, retained hemothorax were finished.

CONCLUSIONS

Fixation of the broken ribs resulting in completely free of fracture pain, facilitating fracture healing, restoring rib cage volume, finishing retained hemothorax and cloting hemothorax.

KEYWORDS

Rib fixation, Rib plating, Chest trauma, Rib fracture

Comparison of Conservative and Surgical Treatments for Traumatic Flail Chest Associated with Respiratory Failure

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OBJECTIVE

To discuss the effect of surgical and conservative treatment on patients with traumatic flail chest and respiratory failure.

METHODS

Retrospective analysis of 126 patients with flail chest and respiratory failure from July 2011 to July 2017.

65 cases treat with external fixation, ventilator support and other conservative treatment, 60 cases treat with internal fixation surgery or internal fixation surgery and thoracic hemostasis. The ventilator support, mechanical ventilation time, ICU time, post-traumatic pain index, rate of improvement and fatality rate were compared between the two groups.

RESULT

The difference of rate of ventilator support was not statistically significant between the two group ($P>0.05$). The differences of mechanical ventilation time, pain index and fatality rate were statistically significant between the two group ($P<0.05$).

CONCLUSION

The internal fixation of the flail chest can quickly and effectively stabilize the chest wall, correct the thoracic deformity, restore the effective capacity of the chest, and improve the effect of flail chest on respiratory function. It also can shorten the mechanical ventilation time, ICU hospital stay and the length of hospital stay, reduce the degree of pain and the mortality.

Summary of Experience in Surgical Treatment of Congenital Sternal Cleft in Children (Report of 21 Cases)

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OBJECTIVE

Explore the diagnosis and treatment of congenital sternal cleft in

children and evaluate the efficacy and safety of surgical operation.

METHODS

We retrospectively analyze the cases of congenital sternal cleft treated by surgery from July 2010 to December 2016 in our hospital. Chest CT and thoracic reconstruction are performed routinely before surgery. We analysis and comparison different types of sternal cleft from surgical methods, operation time, intraoperative hemorrhage, surgical complications, prognosis, etc.

RESULTS

There are 21 cases in this group, including 6 males and 15 females. Aged from 8 to 12.25 years old. The complications of the 21 cases includ cardiac diverticulum, pericardial defect, pericardial adhesion, atrial septal defect, abdominal fissure, webbed neck, facial hemangioma, etc. All of the 21 children underwent surgery successfully. The operation time is 30-180mins, and the intraoperative blood loss is 2-20ml. After the operation, there is no obvious compression of the heart and lung, the postoperative follow-up time is 6 months to 2 years, with only 1 case has postoperative complications which the chest wall fibroid tumor appeared one month after the surgery. The chest wall appearance, cardiopulmonary function and life condition of the other 20 children recovered well.

CONCLUSION

Sternal cleft is a rare congenital malformation in children, the optimal time of surgery and the surgical method of choice is closely related to the patient's age, the scope of lesions and the complications. Combined with cardiac diverticulum, diaphragmatic defect, abdominal fissure, and other complications are suggested to surgery at the same time. In order to achieve satisfied therapeutic effect, individualized treatment plan should be developed for different situations of children.

Video-assisted Thoracoscopic Surgery for Intrathoracic First Rib Resection in Thoracic Outlet Syndrome

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BACKGROUND

First rib resection is a surgical treatment for decompressing the neurovascular structures in thoracic outlet syndrome (TOS). Historically, extrathoracic approaches have used a posterior, supraclavicular, or transaxillary incision to remove the first rib. In this report, we demonstrate video-assisted thoracoscopic surgery for intrathoracic first rib resection (VATS-IFRR).

METHODS

Between 2009 and 2014, eight patients underwent VATS-IFRR for TOS. Surgery was performed through two 5-mm ports and one 10-mm port. Endoscopic graspers, a hook-type electrocautery probe, a long peapod intervertebral disc rongeur, and Kerrison punches were used. The types of disease, operative times, chest tube indwelling days, lengths of hospital stay after operation, perioperative complications, postoperative pain scale ratings, and postoperative symptom recurrence rates at provocation tests were reviewed. The surgical outcomes were compared to published outcomes of extrathoracic approaches and other VATS approaches.

RESULTS

The eight patients (3 right ribs, 5 left ribs) exhibited neurogenic (1), combined type (2), arterial (4), and venous type (1) thoracic outlet syndrome. The mean operative time was 190 (range 155-310) minutes. No mortalities or major complications occurred. The mean chest tube indwelling duration was 6 (range 3-10) days, and the mean postoperative hospital stay was 9 (range 4-21) days. The mean immediate postoperative pain numeric rating scale (NRS) score was 2.7/10 (range 2-4). No recurrence was observed during follow-up (median 25.5 months, range 10-64 months) in any patient.

CONCLUSION

VATS-IFRR was safe and had several advantages. Thus, VATS-IFRR is a minimally invasive surgical option suitable for treating selective cases of TOS.

En-bloc Diaphragm and Chest Wall Resection & Reconstruction for Solitary Colon Cancer Metastasis: Unusual Indication

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In this video, we present a case of a 45-year-old woman who was treated for colon cancer 2 years prior. Then, she presented with a painful mass involving the lower part of the left hemithorax posteriorly. Percutaneous needle biopsy confirmed a metastatic deposit of colon origin. On imaging, a massive mass involving the left lower ribs and part of the diaphragm was noted. Since the primary disease is controlled and there was no evidence of extra thoracic disease, we elected to proceed for en bloc resection of the mass with partial diaphragmatic resection. Reconstruction method was also illustrated. At one year follow up, the patient is still alive and free of any recurrence.

The Development Process of Double Compression and Complete Fixation Bar System in MIRPE

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BACKGROUND

Minimaly invasive repair of pectus excavatum (MIRPE) is a widely used technique for correction of pectus excavatum. Yet despite the advancement in the surgical techniques, it is still associated with various complications including bar displacement leading to reoperation.

To overcome this problem, we developed the double compression and complete fixation-double bar (DCCF) system which consists of two metals bars that are inserted above and below the sternum and compressed to correct pectus excavatum.

METHODS

Patients who underwent pectus excavatum correction surgery at this center between April 2006 and March 2017 were divided into the DCCF system group and the conventional Nuss procedure group and their demographic, clinical and surgical characteristics were compared.

RESULTS

A total of 220 underwent DCCF system procedure, and 306 patients underwent conventional Nuss procedure. The DCCF system group had significantly shorter operation time ($p<0.001$) and postoperative hospital admission time ($p<0.001$) compared to the conventional Nuss procedure group. There were only 2 cases (0.9%) of postoperative complications in DCCF system group which was significantly less than that of the conventional Nuss procedure group (n=64, 20.9%, $p<0.001$). In particular, there were no cases of bar displacement in DCCF system group.

CONCLUSIONS

DCCF system was applied to surgical correction of pectus excavatum which led to significant reduction in the operation time and postoperative hospital admission period, as well as reduced MIRPE complication and bar displacement rates.

Table . Demographic, clinical and surgical characteristics of patients

Variables	DCCF (n=220)	Conventional Nuss procedure (n=306)	P value
Age, years, mean ± SD, median(range)	10.3 ± 7.2, 8.0 (2-34)	12.4 ± 7.7, 13 (3-40)	< 0.001
Gender, n (%)			0.972
Male	180 (81.8)	250 (81.7)	
Female	40 (18.2)	56 (18.3)	
Obesity, n (%)	4 (1.8)	6 (2.0)	1.0
Low weight, n (%)	31 (14.1)	49 (16.0)	0.545
Haller index, mean ± SD, median (range)	4.2 ± 1.1, 3.9, (2.4–9.1)	4.6 ± 2.2, 4.3 (2.3-35.4)	< 0.001
Operation time, minute, mean ± SD, median (range)	52.3 ± 18.6 45 (25–115)	67.8 ± 21.3, 65 (25–145)	< 0.001
POD, days, mean ± SD, median (range)	5.4 ± 1.6, 5 (3-18)	7.3 ± 3.1, 7 (4-43)	< 0.001
Type, n (%)			0.035
Symmetry	66 (30)	67 (21.9)	
Asymmetry	154 (70)	239 (78.1)	
Stabilizer, n (%)			< 0.001
With	0 (0)	32 (10.5)	
Without	220 (100)	274 (89.5)	
Complication, n (%)			< 0.001
No	218 (99.1)	242 (79.1)	
Yes	2 (0.9)	64 (20.9)	
Acute	1 (50)	29 (45.3)	
Delayed	1 (50)	35 (54.7)	

DCCF, double compression and complete fixation; n, number; SD, standard deviation; BMI, Body mass index; POD, postoperative day; TII, Trans-illuminated introducer; VATS, Video assisted thoracic surgery.

• Video

30 Cases of Re-operation Using Submuscular Nuss Method after the Initial Nuss Method Treatment

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PURPOSE

We present our pectus excavatum re-operation cases using submuscular Nuss method after the initial Nuss method treatment.

METHOD

We performed 65 pectus excavatum re-operations from April 2005 to December 2017. The initial procedure was mostly Nuss method followed by sternal costal elevation, sternal turn over and Ravitch methods. Of these, 30 cases of submuscular Nuss re-operation after the initial Nuss method were reviewed. The patients were aged 7 to 61 years, with the average 24.8 years old and the male-female ratio 24:6. In 11 cases, all bars had been removed when the patients were first seen. 1 bar was remained in 5 cases, and 2 bars in 6 cases. In the re-operation, after an incision in skin and subcutaneous tissue, we made pockets by removing pectoralis major muscle and serratus anterior muscle from the ribs, costal cartilages and intercostal muscle. For narrow intercostal space, the upper costal cartilage was trimmed about 2 cm near the rib to open the thorax. The coalesced anterior mediastinal tissue was removed bluntly, where a tape followed by a bar were navigated through. The bar was rotated 180 degrees to release the anterior chest depression, and then fixed to two ribs at its each end using 2 to 4 surgical threads. A drainage tube was placed for both bilateral pleural space and muscular layer on each side to complete the operation.

RESULT

1 case required re-operation due to primary complaint of tightness in the chest because bar removal caused the heart to move to the correct position, resulting another depression. 13 out of 30 cases showed favorable results after bar removal.

CONCLUSION

Re-operation by Nuss procedure after the initial Nuss treatment is difficult, but our experience showed that re-operation by submuscular Nuss method was a safe and sure way to achieve favorable results.

Submuscular Nuss Procedure by Inserting 3 Bars in the Intercostal Space with Single Bilateral Skin Incision

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PURPOSE

We conducted submuscular Nuss procedure using 3 bars for pectus excavatum cases, in which long vertical depression was observed in the anterior chest wall. We present the procedure on video.

METHOD

924 cases of pectus excavatum were treated surgically at our hospital from June 2000 to December 2017. Besides, from April 1997 to December 2017, 41 cases of submuscular Nuss procedure were performed by inserting 3 bars with single bilateral skin incision. One of the cases was of a 24-year-old male patient. After making skin incision of 2.5 cm in parallel to the ribs, we made a skin pocket above the ribs and intercostal muscle, and under the pectoralis major muscle and serratus anterior muscle. When anterior chest elevation was made in the 3rd, 4th and 5th intercostal spaces, we broke the deformed costal cartilage. Then, we rotated the bars 180 degrees starting from the 5th costal space, to the 4th and 3rd to correct the depression in the anterior chest.

RESULTS

Favorable results were obtained in the 41 cases by adopting this procedure.

CONCLUSION

We consider that the technique with use of 3 bars in the submuscular Nuss procedure should be recommended for pectus excavatum with long vertical depression.

Oblique - (cross-) Bar Fixation Technique

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PURPOSE

Demonstration of surgical technique designed for oblique bar fixation.

METHOD

In case oblique or cross-bar is preferred for better correction the cranial side of a bar is almost parallel to supporting rib. To avoid stripping we perform preventive intercostal space reinforcement by polyspast suture that supports a bar as a hammock. The distal part of a bar is fixed by pericostal suture.

RESULTS

There was no intercostal space stripping when described technique was applied and there was no need in supportive stabilizer.

CONCLUSION

Preventive intercostal space reinforcement is a safe and reliable method for oblique- (cross-) bar stabilization.

Bimanual Tunnel Technique: Another Strategy to Prevent Pericardial Injury During Nuss Procedure

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INTRODUCTION

20 years ago, the Nuss technique has been propagated and is now considered as the golden standard in the treatment of pectus excavatum.

In order to avoid penetration of the pericardium, still the most frightening complication, some technical modifications were added to the procedure during the past years.

To increase safety in the Nuss procedure, we developed a bimanual tunnel dissection technique.

METHODS

As our group adheres to the 'Scandinavian school' using short bars, two lateral incisions are made at the level of the anterior axillary line. CO2 insufflation is used to increase lung collapse and to facilitate retrosternal dissection once the mediastinal pleura is opened. A 5mm 30° camera and the classical pectus introducer are inserted at the right side. One rib space higher we perforate the thoracic wall to introduce an Ethicon Endopath 10mm blunt tip dissector. This tool is used to create tension onto the pericardium when the tunnel creation begins. Progressively, the blunt dissector is advanced in the tunnel together alongside the Nuss dissector, pushing the pericardium downwards, enhancing visualisation during tunnel creation. Tunnel dissection ends when the left pleural space is opened and the left exit site is created under direct vision.

RESULTS

By using this technique, the retrosternal tunnel is created in less then 10 seconds with a continuous view onto the pericardium. We applied this technique in more than 450 cases without cardiac perforation. Standardisation of the tunnel creation also aids in stress reduction amongst the team members.

CONCLUSIONS

A 30° 5mm camera, CO2 insufflation and the use of a blunt 10 mm dissector next to the Nuss introducer improves direct visualisation of the pericardium and enhances the safety during mediastinal tunnel creation. Our modification could be of value for teams starting the Nuss technique, in order to increase safety.

Sternal Plating for Traumatic Manubriosternal Pseudoarthrosis after Steel Wire Repair Failure (Case Presentation)

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PURPOSE

Demonstration of rare clinical case.

METHOD

Steel wire repair of traumatic manubriosternal dislocation was performed to 44 yo female patient 2 months after hang-gliding accident. However repair failed and resulted in pseudoarthrosis. Patient was referred for reoperation due to pain and deformity. After steel wire removal, the area of fracture was cleared off scar tissue till "fresh" bone edges. Locked plate fixation was performed with 2 parallel plates.

RESULTS

Good cosmetic and functional result was achieved. 4 months after repair bone consolidated, however patient is reluctant for bar removal.

CONCLUSION

Locked plate repair is a safe and reliable method for transverse sternal fractures when surgical correction is required.

• Video

Thoracic Softening Method During Nuss Procedure with Use of an Engine Jack in Anterior Chest Wall Elevation

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PURPOSE

According to the original Nuss procedure, a bar is simply rotated 180 degrees and indwelled for 2 to 3 years. In some cases, however, sufficient improvement for depression is not obtained. We present our thoracic softening method by elevating the anterior chest using an engine jack before rotating a bar, ensuring sufficient improvement.

METHOD

We conducted 920 cases of surgical treatment for pectus excavatum from April 1989 to December 2017. Among them were 775 cases, where anterior chest wall elevation was performed by softening the wall using an engine jack to fracture costal cartilages and junctions, sternum-cartilage junctions and sternal angles. Shackle for yacht, chains, rock climbing carabiners, and then an engine jack are connected to the holes at the bar ends. While the jack remains fixed, the operation table is lowered to lift the anterior chest wall. a plastic hammer, with wet gauze underneath it to prevent damage to the skin, has been used to compress the left and right sides of the chest downward. A bar for sternum elevation is inserted from the upper rib to the lower rib for fracture. With a tape used to remove the lower bar, a pre-bent indwelling bar is inserted upward from the lower part, rotated 180 degrees, and then properly placed using 2 to 4 surgical threads.

RESULT

We applied our softening method for the patients aged 3 to 66 years and then, obtained sufficient softening in the thorax where indwelling bars were placed for 2 to 3 years. The method yielded the expected effect and favorable improvement after the procedure.

CONCLUSION

The softening process during Nuss procedure by first elevating the anterior chest wall using an engine jack, softening the thorax and then rotating an indwelling pre-bent bar 180 degree secured improvement in removing heart strain.

Total Crane-Triple Crossbar in Extreme Pectus Excavatum Repair: A Challenge

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PURPOSE

A video demonstration of a case extremely severe Pectus excavatum repair.

METHODS

Sternal lift was instituted with total crane techniwue with 5 wire sternal stitches.

RESULTS

Excellent immediate result with 3 cross bars.

CONCLUSIONS

Total crane technique with crossbars are effective in severe pectus excavatum repair.

Radiological Assessment of Surgical Treatment Results in Children and Adolescents with Pectus Excavatum: Medium-term Results of 75 Cases

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OBJECTIVE

The minimally invasive repair of pectus excavatum (MIRPE) has been established as the preferred technique for PE repair PE. Modified techniques of repair based on D. Nuss method for PE are promoted to improve the safety of the procedures.

PURPOSE

Purpose of this work was to analyze the results of PE surgery with accounting of the toracometric parameters in children and adolescents.

METHODS

The toracometric parameters were the followings, as: the sternum rotation degree, the cardiac and pulmonary vein rotation angles, Haller and asymmetry indices in children and adolescents with PE. 48 (64%) patients are operated by D. Nuss procedure and 27 (36%) with using modifications, due to the intensity of parameters, which are exhibited the significance difference between pre- and postoperative indices, mainly, in patients who have a severe degree changes preoperatively.

RESULTS

The sternum rotation degree (in 75 patients) was decreased till 0.4±0.02, whereas was 20.7±0.46 preoperatively (P=0.001). Preoperatively, the mean of cardiac rotation angle significantly reduced, preoperative was 56.0±2.9 (in 75 patients) and after operative intervention made up 47.0±2.7 (P=0.001). Haller index also is decreased till 2.3±0.2, whereas was 3.9±0.2 preoperatively (P=0.002). The pulmonary vein rotation angle was preoperatively 51.0±3.4 and after operation was increased till 53.0±1.8 (P=0.01).

CONCLUSIONS

It is necessary to apply the computer tomography investigation in patients with PE. Also, it cannot miss the stage of the sterno-costal complex strength, its pliability and the intensity of the sternum rotation, which may lead to raise the share of good and excellent results.

Incentive Spirometry as a Measure of Recovery Following Chest Wall Surgery

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Royal Hospital for Children, Glasgow, United Kingdom

PURPOSE

To track patient's inspiratory capacity (IC) following chest wall surgery using an Incentive Spirometer (COACH 2 Device) as part of their Physiotherapy post-operative management to help prevent post-operative pulmonary complications (PPCs).

METHOD

The IC is the volume of gas that can be taken into the lungs in a full inhalation, starting from the resting inspiratory position. The IC was measured prior to surgery and postoperatively every day until discharge for eight patients undergoing a NUSS procedure at the Royal Hospital for Children, Glasgow. Each patient followed the post-operative recovery pathway for Nuss procedure, which included physiotherapy intervention to prevent PPCs. All patients were seen at 3 weeks and 3 months post procedure and IC measured. The predicted IC for each patient was calculated in accordance with the Global Lung Function Initiative and expressed as a percentage of the predicted value.

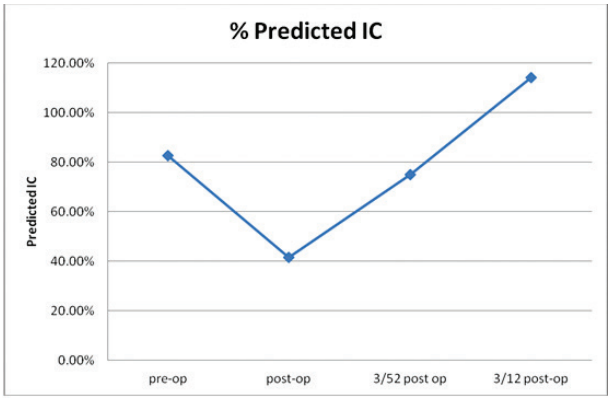
RESULTS

The mean percentage predicted IC of the patients preoperatively was 84%. After surgery this dropped to 40%. This improved 3 weeks post-surgery to 78% and improved further to 112% at 3 months post-surgery. Of note, two patients IC did not improve at 3 weeks post procedure both of which had wound infections.

CONCLUSION

IS has been suggested as an effective tool to assess respiratory recovery following thoracic surgery. The results indicate that patients with anterior chest wall deformity have a decreased IC preoperatively which significantly declines immediately following surgery. The IC increases above the preoperative value by 3 months with patients following a recovery pathway and receiving regular Physiotherapy review. These findings support the value of IS to monitor recovery following chest wall surgery.

Poster



Is It Necessary to Remove the Bar?

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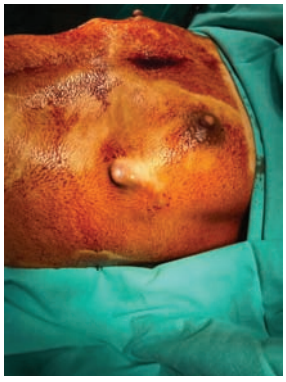
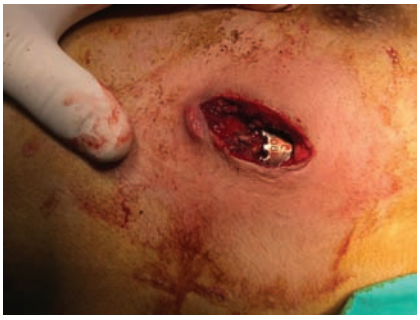
Pectus carinatum is a chest wall deformity and its surgical indications are postural and aesthetical. The minimally invasive surgical approach was described by Ambramson. The most seen complications of surgery are pain and cutaneous bar reaction.

A 13 year-old female patient who was operated because of pectus carinatum 1 year ago admitted to hospital with complaint of right skin reaction adjacent to the bar stabilizator. The stabilizator was determined protruted and there was allergic hyperemia on it. The right stabilizator was removed and 3 months later skin reaction occured on the left side (Figure 1). The findings were similar. The left bar stabilizator was removed and the bar was leaved (Figure 2).

The minimally invasive correction of pectus carinatum is the gold Standard treatment now. When the skin reaction occurs due to metal pressure, if the bar has correct position, the stabilizator can be removed easily and safely one by one. So the chest wall appearance can be fixed.





Nursing Care in Patients Undergoing Minimally Invasive Pectus Deformity Repair

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BACKGROUND/PURPOSE

Pectus excavatum (as sunken or funnel chest) and pectus carinatum (keel-shaped deformity of the chest) are the most common congenital chest wall deformities in children. Cosmetic and psychosocial complaints arise when deformities become more prominent in puberty, and the need for treatment of patients is increasing. At the present time, the most preferred operations are the Nuss and Abramson techniques, which are minimally invasive correction surgical methods. In this study, we aimed to share our experience of preoperative and postoperative nursing care in patients who underwent surgical correction.

METHODS

We retrospectively reviewed all patients who underwent minimally invasive surgical procedure between January 2013 and December 2017 for pectus deformity correction in our hospital. Gender, age, length of hospital stay, duration of operation and Visual Analogue Scale (VAS) pain score and postoperative pain scores were examined.

RESULTS

Of 58 patients, 47 were males, 11 were females and the median age was 18.6 (range, 11-37) years. The type of deformity was pectus excavatum in 47 patients, pectus carinatum in 8, and pectus arcuatum in 3 of the patients. Operations performed were Nuss in 49 patients, modified Ravitch in 1, Nuss + modified Ravitch in 1, superficial cartilage shaving in 6 patients, and cartilage excision in 1 patient. Two patients underwent bar revision after 1

and 4 months after Nuss procedure, due to the occurrence of bar rotation / malposition. Minor complications seen were minimal pneumothorax not requiring drainage in 7 patients and serous incision drainage in 7 patients. No major complication or mortality was seen. The mean duration of operation was 50 minutes (range, 30-200 min). Patient mobilization and respiratory exercises were initiated at 6 hours postoperatively. On postoperative day 0, VAS pain score was 6 (0-10) and postoperative 1st day average was 3 (0-10). The average hospital stay was 3.5 days (1-7).

CONCLUSION

Although cardiovascular and pulmonary problems do not occur frequently in patients with chest wall deformities, they psychologically disturb the person and cause self-esteem detoriation. The high postoperative pain score prevents mobility and affects the mood of the patient. For this reason, pain assessment of patients should be done frequently and the pain should be controlled. Early mobilization activates the cardiovascular and gastrointestinal system, thus reduces the risk of pulmonary embolism. Training should be provided and controlled so that the patient does not lie down, the upper half of the body does not bow and the upper region of the body does not move to the right or left, do not lift hard, and do not force difficult activities in the early postoperative course. Mobilization increases as the pain score decreases, and self-confidence increase by seeing that the chest deformity dissappears. It is known that the tips of the pectus bar may be felt under the skin, so it is necessary to explain in the patient education that the bar can be prevented from sticking to the skin by light massage to these areas after surgery. Patient discharge training should include information about pain control, exercise, nutrition, deep breathing exercises and 'bar removal' after an average of 2.5-3 years postoperatively.

Conservative and Surgical Treatment of Children with Pectus Carinatum (PC)

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TOPICALITY

PC is a complex congenital defect of development. Apparent anatomic and cosmetic defect and changes in psychiatry of children, especially in children at older ages (5-18).

RESEARCH OBJECTION

Determine the efficiency of conservative and surgical repair.

MATTER AND METHODS

In Children Orthopedic Department 312 children with PC have been under care and observation since 2015. From them 194 (62,1%) boys and118 (37,9%) girls, at the ages from 4-18. We used G. Bairova and A. Fokina's classifications, (Russia, 1983), by type the followings were detected: monubriocostal in 74 (23,7%) children; corpocostal - 172 (55,1%) (from them pyramidal- 129; round chest-43); rib-type 66 (21,1%) patients. By level they were divided into: I-level 95 (33%), II-level 92 (30%), III-level 125 (37%) children. Symmetric type is in 198 (66,9%) patients, asymmetric in 82 (24%) and mixed form (by Park H.J.) in 32 (9.1%). All patients have passed complex examination in hospital. 178 (57%) patients were treated by conservative and surgical methods.

Evidence to conservative method of treatment has been cosmetic defect and intrathoracic pressure (p≤10 by M.Yuksel classification, Turkey). During conservative treatment the compressing orthosis (made by M. Yuksel) were used in 145 (81,4%) patients.

Evidence to the surgery was high intrathoracic pressure (p≤10-25 and more p≥25 kg by M.Yuksel), high thorax rigidity and uncorrectable deformation by conservative way. Mostly with children at 15 and older. 31 (17,4%) patients were used minimally-invasive method by Abramson, 2 (1.1%) by Ravich.

RESULTS

In 6-12 months: after conservative method 119 (82%) children are considered "good"; 23 (15,8%) "satisfactory"; 3 (2%) patients to continue wearing orthesis again. Leveling of thorax form could be observed. Satisfactory of chest cosmetic repair and improvement of psychology have been detected.

CONCLUSION

Treatment of PC by suggested method allowed to get high percentage of positive results.

Poster

Conservative and Surgical Treatment of Children with Pectus Excavatum (PE)

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TOPICALITY

PE is an anatomic disease linked with cardio-pulmonological symptoms, cosmetic defect and also psychological perception.

OBJECTION

Determine the Conservative and Surgical Repair efficiency.

RESEARCH METHODS

In Children Orthopedic Department, by examination 619 children from 2 to 18 have been found in Samarkand since 2015, from them 344 (55,5%) boys and 275 (45,5%) girls. All patients have passed complex examination in hospital. The patients have been treated by conservative and surgical methods.

By N.Kondrashina's (1968) classification of PE the following was detected: simple form in 564 (91,1%), plano-PE in 55 (8,9%). By shape: 163 (26,3%) symmetric, 456 (73,7%) asymmetric; By level: 198 (31,9%) patients with I-level (depth up to 2sm without ectopia-cordis); II-level 266 (43,1%) (depth 2-4sm, ectopia-cordis to 2-3 sm), III-level 155 (25%) (depth more than 4sm, ectopia-cordis more 3 sm). 23 (3,7%) patients were observed combination with other congenital pathology: congenital dislocation of hip-joint 15 (2,4%), scoliosis 5 (0,8%), Morph's syndrome 3 (0,4%).

By stage of growth-compensatory in 487 (78,6%), subcompensatory in 127 (20,5%) and decompensation in 5 (0,8%) patients.

The Vacuum Bell was used in 38 (6,1%) patients with symmetric and asymmetric form of I-II-level. In apparent deformation of II, III-level method by NASS was used in 95 (15,3%) patients and by Ravich in 2 (0,3%).

Good results have been observed after conservative treatment with Vacuum Bell in 24 (63,1%) patients and by NASS's method in 77 (81%) in 6-12 months. Deformation in patients wasn't observed, the capacity of breath became normal. Satisfied results were found in 6 (6,3%), unsatisfied in 7 (7,3%) - from them 2 (2,1%) had plate rotation problem, 3 (3,1%) hypercorrection and 2 (2,1%) fixed wire movement. Second surgery was carried out with positive results.

Therefore, PE requires careful observation, preparation and selection of patients to both conservative and operative methods of correction.

Minimally Invasive Repairment of Pectus Excavatum in State Hospital: 2 Cases Experience

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PURPOSE

Minimally invasive surgery for pectus deformities is being performed in many centers which are research and education hospitals generally. Because of utilizing from thoracoscope in this surgery needs some spesific instruments. It is aimed to emphasize that the minimally invasive surgery in pectus deformities can be performed easily and safely in public and state hospitals and to present our 2 cases.

CASE 1

14 year-old male patient was admitted to the clinic with the complaints of depression of middle of the chest and effort dyspnea. On the physical examination there was symmetrical pectus excavatum, and the Haller index was determined as 3,5 in thorax tomography. Echocardiographic evaluation was normal. Pulmonary function test showed obstructive disease (FEV1/FVC: 60%). The surgery was planned and a bar was placed (Figure 1). The patient was discharged on postoperative 7th day.

CASE 2

18 year-old male patient was admitted to the clinic with discomfort with his chest. On the physical examination, there was a symmetric arcuate pectus deformity which had combined pectus excavatum and pectus carinatum. The patient's cardiopulmonary evaluation was normal. The surgery was planned. Firstly, the bar was placed with a stabilizator, after that the protruded anterior 3rd costal cartilages were resected bilaterally (Figure 2). The patient was discharged on 6th postoperative day.

CONCLUSION

The thoracoscopic surgery is being performed for many thoracic procedures. The pectus surgery also needs thoracoscopy nowadays with new methods. Minimally invasive surgeries are begun to use routinly by thoracic surgeons in public and state hospitals also.

Concave Deformity Centered at Left Hypochondrium

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Here we report a case with an unusual deformity of chest wall and our corrective surgery for that.

A five-year-old boy, complaining that his left chest wall has been congenitally depressed, came to see us. The deformity was localized at his hypochondriac region, showing steep concave skin pocket. He was born at 26 weeks gestation with 544 g body weight and already had the deformity at his birth. His general condition was fine and functionally there was no problem in his daily and school life. In the CT images his left 7th rib was positioned inward and its costal cartilage had wavy shape, pushing deep into the liver.

In the corrective surgery we partially resected the involved cartilage and suspended up the inwardly displaced rib with steal wire. As a supporting point for the suspending wire a straight-shaped mandibular reconstruction plate was used. It was inserted on the thoracic cage just like a bridge over the deformed ribs. As the plate had many screw halls and its surface was not smooth but bumpy, we were allowed to apply relatively flexible and firm wiring for rib-suspension. Though the plate is still there for six years, aesthetically nice result is achieved now.

A case with a concave deformity of chest wall induced by an inwardly positioned left 7th rib was reported and a mandibular reconstruction plate was used for its aesthetical improvement.

Brachial Plexus Palsy after Nuss Procedure

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PURPOSE

Brachial plexus palsy (BPP) rarely occurs after Nuss procedure for pectus excavatum. We present our experience which BPP might be caused by narrowing of the costoclavicular space after Nuss procedure, not related with surgical positioning.

METHODS

We performed Nuss procedure with insertion of three bars in a 21-year-old man for severe pectus excavatum with upper and lower depression.

RESULTS

After the procedure, he complained of severe weakness of the left arm. The left deltoid, biceps, and brachioradialis muscles had strengths of Medical Research Council (MRC) grade 1/5. Electrodiagnostic study revealed reduced recruitment at the deltoid, biceps, brachioradialis, and triceps muscles. The conduction studies were normal. Chest CT demonstrated that the shortest costoclavicular distance was narrowed after Nuss procedure from 7.60 to 2.83 mm (Figs 1A and B). We removed the upper bar on post-procedure day 4. After reoperation, the shortest costoclavicular distance was increased to 4.51 mm (Fig 1C) and the weakness of the arm was slightly improved. On post-reoperation day 2, the interference patterns of the deltoid, biceps, and brachioradialis were increased with normal conduction studies. On post-reoperation day 23, the left deltoid, biceps,and brachialis had strengths above MRC grade 3/5. The motor and sensory symptoms were fully recovered on 3-month follow-up.

CONCLUSIONS

Our experience showed narrowing of the costoclavicular space after Nuss procedure might cause BPP, not related with surgical positioning. Further study with large data about the effect of Nuss procedure on the costoclavicular space will be needed.

Bar Removal and Breast Implants-Important Area for Thoracic and Plastic Surgeon Cooperation

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MSU Medical Center[1], MONIKI[2], Petrovsky RNSCS[3], Russian Federation

PURPOSE

Discuss problems of bar removal in patients with breast implants.

METHOD

Retrospective analysis of 12 female PE patients to whom breast augmentation was performed by different plastic surgeons 6-18 months after MIRPE. In 3 cases plastic surgeons discussed details of previous PE surgery. Before bar removal all patients had CT-scan, in selected cases also preoperative skin marking locating position of a bar. In one case intraoperative X-ray with C-arm.

RESULTS

5 bar removals had no difference compared to regular cases (1-st group) In 4 – ends of a bar were hidden under implant (one or both sides) and it required additional time for deep behind implant bar clearing from calcified capsule (2-nd group). The most problematic were bar removals after short bar + stabilizer correction (3-rd group). In case of 2 bar + 2 stabilizers and significant ossification almost complete retroprosthetic mobilization was done, which later caused 4 days of drainage. One additional patient in group 3 had retroprosthetic seroma formation diagnosed 2 weeks after surgery. The were no other surgical complications. There were no prosthetic capsule damage during bar removal. In one case (group 1) simultaneous repair of periprosthetic contracture was discussed, but patient refused it.

CONCLUSION

Plastic surgeon should be aware of problems which thoracic surgeon can face during bar removal. In case of short bar + stabilizer MIRPE we recommend to avoid breast augmentation before bars are removed.

Pathological Influences of Connective Tissue Dysplastic Disorders to Surgical Treatment Results of Pectus Excavatum in Children

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OBJECTIVE

Recently, the several complications associating with the instability of the installed bar, PC deformity occurrence and PE relapsing have been occurred in more than 20% after surgery.

PURPOSE

Purpose was the determination of the role of the connective tissues dysplastic disorders for remodeling processes of the anterior chest wall in children with PE. Methods. The investigation is performed on 40 children with PE, who operatively treated using D. Nuss procedure in Clinic of RSSPCTO RUz. The genetic assessment was carried out by the Milkovska-Dmitrova and Karakeshev classification (1985).

RESULTS

The good results are achieved in 35 patients at the nearest postoperative periods, 5 cases were with the intensity pain and in long-term periods it was occurred the PC deformity in 2 cases, the secondary atypical deformation in 1, the PE relapsing in 1 and, also

in 1 it is saved the neuralgic pain.

DISCUSSION AND CONCLUSION

The connective tissues dysplasia is a congenital character genesis, characterized by metabolic disorders in the stroma tissues and several enzymopathy. The osseo-cartilaginous structural system growth processes are not behavioral in the necessary age norm of locomotors apparatus and the delaying of ossification processes also in the adolescent's age and the sterno-costal complex became most pliable. These changes complicated the correction of PE, extended the period of immobilization. It is hard to determine the outcome operative results in patients with considerable of connective tissues dysplastic disorders.

Sternal-Preserving Manubrial Resection: The "Chaudhery-Mutairi" Reconstructive Technique

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PURPOSE

Malignant sternal tumors require extensive resection and reconstruction. Most of the methods described previously entail partial or complete resection of the sternum. We report an innovative method devised to preserve the sternum without oncological compromise.

METHOD

Manubrial tumors, primary and secondary, were resected with wide free margins while preserving the sternal continuity and stability. The defects were reconstructed with methyl methacrelate sandwich mesh stitched to the remaining of the sternal body using sternal wires and to the adjacent ribs using prolene stitches (Fig. 1). Pathological examinations confirmed complete tumor removal with wide free margins.

RESULTS

Two cases have been operated with this technique. The first case was a 45-year-old woman with past history of breast cancer and presented with tumor recurrence at the lateral border of the manubrium. The second case was a 48-year-old woman with primary osteosarcoma of the manubrium (Fig. 2). Both surgeries were done under general anesthesia in supine position, with minimal blood loss, and with smooth recovery (Fig. 3). No perioperative complications were encountered. Both patients are still free of recurrence at the time of this publication, 2 years and 1 year respectively.

CONCLUSION

This reconstructive technique is safe, feasible, and provides rigid, stable, and mechanically and oncologically sound reconstruction. Longer follow up is needed to establish the long-term outcome.

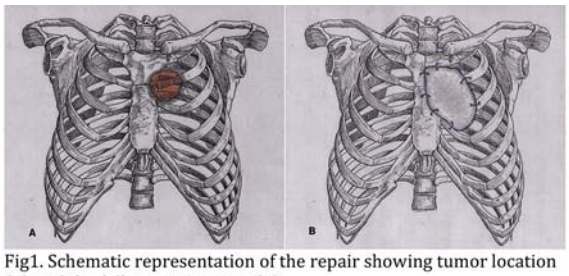

Fig1. Schematic representation of the repair showing tumor location (A) and the full reconstruction (B)

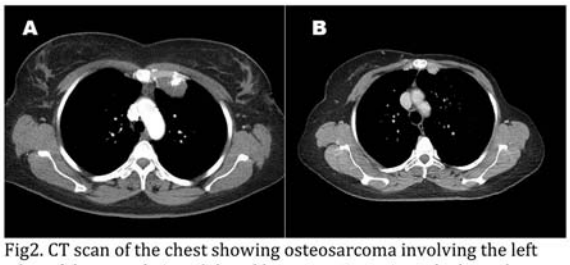

Fig2. CT scan of the chest showing osteosarcoma involving the left edge of the manubrium (A) and breast metastasis at the lateral border of the manubrium (B)

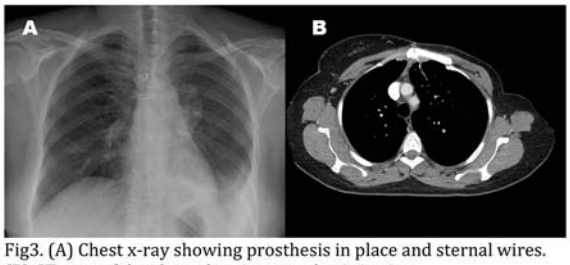

Fig3. (A) Chest x-ray showing prosthesis in place and sternal wires. (B) CT scan of the chest showing prosthesis in situ

An Interesting Chest Wall Tumor: Lung Cancer Metastasis

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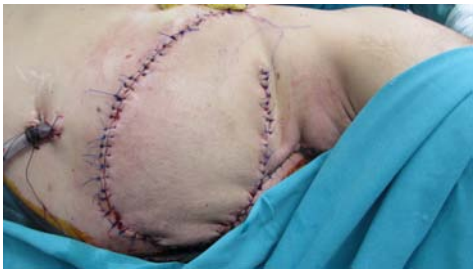
Lung cancer is the most mortal malignancy in male people. The diagnosis and treatment have been very well known. In most, multi modal treatment is a gold standard option.

A 53 year-old male patient which had the diagnosis of lung epidermoid cancer, admitted to the emergency room with the complaint of bleeding from tumor located on the right chest wall

Poster

(Figure 1). In his history, he had been followed up for 3 years with lung cancer, first he was taken neoadjuvant chemotherapy, after that right superior bilobectomy was performed in 2014 and after surgery he was continued radiochemotherapy treatment. In 2015, PET/CT scanning showed FDG uptake on right chest wall. The chemotherapy was continued. After this, the tumor had progression and invased the chest wall skin. And suddenly bleeding was started. While the patient admitted to the hospital, general condition was normal, the vital signs were normal. The thorax tomography and magnetic resonance imaging were performed to evaluate the tumor size and borders. He consulted to the plastic surgery clinic. The resection of tumor and chest wall reconstruction were planned. In surgery, the tumor was resected with anterior portion of right 3rd, 4th and 5th ribs. There was no tumor invasion into the lung parenchyma. Then, the lattisimus dorsi musculocutaneous flap was used for the reconstruction (Figure 2). The pathology was lung epidermoid cancer metastasis.

The treatment of pulmonary malignities has a wide spectrum. According to tumor localization, the treatment options can be choosen. The chest wall metastasis is very rarely clinical condition, while the tumor is resected, the chest wall reconstruction is needed.



Application of Pectus Bars for Chest Wall Reconstruction after Sternal Tumor Resection

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PURPOSE

Chest wall reconstruction after extensive resection of sternal tumor is important to support bony structures and to protect thoracic organs. Various types of stabilizers have been used for sternal defects, but application of pectus bars was not reported yet. We introduce a case of chest wall reconstruction using pectus bars in a patient with sternal tumor.

METHODS

A 60 year-old female presented with chest wall pain and protruding sternal tumor (12 cm in length), having a history of decortication due to chronic empyema 10 years ago. During the surveillance of breast cancer (intraductal carcinoma, pT1N0M0) for 7 years, sternal tumor with SUVmax of 13.9 was detected. We resected whole sternum and parasternal costal ribs. Thymic tissues with mediastinal nodes were removed and Gore-Tex patch was covered over the pericardium. Finally, two parallel pectus bars (9 inches) were bridged around the ribs, and pectoralis muscles were interposed. Two chest tubes and two drainage catheters were placed with negative pressures.

RESULTS

The operative time took 235 minutes and the blood loss was 100 ml. The postoperative recovery took 10 days. The size of specimen ranged up to 17 x 8.5 x 2.8 cm, and 12 cm length's metastatic poorly differentiated carcinoma was proven with ER (+) /PR (+) /HER2 (-). She continued additional chemotherapy with stable disease status for 7 months.

CONCLUSION

With the extensive removal of the metastatic sternal tumor and reconstruction using supporting pectus bars, we successfully managed broad sternal defects. We suggest modifying usage of pectus bars in selective patients having broad sternal defects, but R0 resection with long term recurrence-free survival should be warranted.

Severe Thoracic Trauma Initial Evaluation and Management: Analyses of Our Cases Period of Time July 2004-Decembre 2017

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University Hopspital "Shefqet Ndroqi"[1], University Hospital of Trauma Center[2], Public Pharmacy[3], Albania

INTRODUCTION

Severe thoracic trauma is main cause of deaths in US about 10-20% of deaths. Causes of Severe Thoracic Trauma are. Penetrating trauma. Gunshot wounds; Stab wounds; Lower mortality rate – less massive, less multiorgan injury •Gunshot wounds on the chest is the most lethal – 50% •Only 7-10% undergoes hospitalization prior to death •Death due to heart & great vessel injuries. Battlefield chest wounds: •65-70% immediate death •10-15% of survivors die of complications. •Blunt trauma •More common – motor vehicle accidents •Higher mortality – more multiorgan injury. Potentially life-threatening major Injuries: –Flail chest –Open pneumothorax –Tension pneumothorax –Massive hemothorax – Major airway injury –Pericardial tamponade –Aortic disruption –Diaphragmatic rupture Severe Thoracic Trauma, Blunt trauma. Mostly managed non-operatively •- Tube thoracostomy may be needed •- Ventilatory support may be needed. Resulting injuries •Rib fractures •Sternal fractures. Open / closed pneumothorax •Haemothorax •Haemo-pneumothorax • Pulmonary contusion •Myocardial contuson •Diaphragmatic rupture •Bronchial disruption •Pneumomdiastinum

AIM OF STUDY

Analyses of patients with Severe Thoracic Trauma, Initial Evaluation and Management analyses of our cases period of time 2004-2017 treated in thoracic surgery service

MATERIAL AND METHODS

Patents treated in our hospital during July 2004-Decembre 2017 are 105 patients, rate male/female 3:1. Age of presentation 9-71 years old, mean age presentation 49 years old. Blunt chest wall trauma 42 (40%) and penetraiting chest wall trauma 63 (60%) patients. Ribs and sternal fractures, two or more costal fractures in 18 (17%) patients (flail chest 10 patients); unilateral pneumothorax 38 (36.1%) patients, bilaterally pmeumothorax 10 (10.5%) patients; massive hemothorax 15 (14.3%) patients, pneumomediastin et subcutaneous emphysema 6 (5.7%) patients. Hammans syndrome, lung contusion and parenchimal pulmonary hemathoma in 15 (14.3%) patients; bronchial rupture 2 (1.9%) patients, tracheal rupture 1 (0.9%) patient.

RESULTS

Only medical treatment in 28 (26.6%) patients; uni lateral pleural tub drainage 40 (38%) patients, bilateral chest drainage 10 (9.5%) patients ;thoracotomy in 27 (25.7%) patients, wedge resection, lung hemostasis and aerostasis from lung lacerations, bronchial injury 14 (13.4%) patient, bilateral thoracotomy 3 (2.8%) patients, clamshell incision in 1 (0.9%) patient; thoracoabdominal approach 2 (1.8%) patients, flail chest wall stabilization 10 (9.5%) patients by vicryl suture, steel wire suture 7 (6.2%) patients, titanium plate 3 (2.8%) patient. By VATS are treated 2 (1.8%) patients. Mean hospital stay was 11 days (average 3-36 days). Morbidity rate in 6 (6.3%) patients, mortality was on 5 (5%) patients.

CONCLUSION

Most common injury locations was lung and chest wall and less common abdominal and cranial trauma. Surgical and intensive treatmen are very important and with low mortality rate.

KEYWORDS

Penetrating thoracic injury, Blunt trauma of chest wall, Surgery treatment

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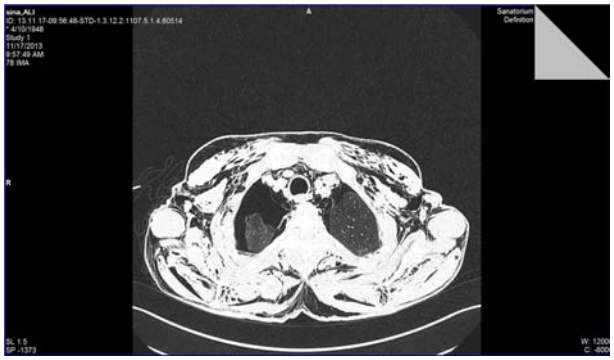
Poster



An Interesting Gunshot Trauma to the Right Chest Wall

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PURPOSE

Thoracic gunshot traumas are life-threatening clinical situations that should be evaluated carefully and immediately. The usual clinical presentations include hemothorax and pneumothorax due to injury of major vessels, lung parenchyma and the hearth. It is aimed to present an interesting case injured by gunshot with rifled slug without any parenchymal trauma.

CASE

A 15-year-old male patient admitted to the emergency service after a gunshot trauma. In his anamnesis, the patient said that while he was walking to his horse, some hunters who wanted to hunt wild boar shot him accidentally. On the physical examination, vital signs of the patient were normal, he had severe pain and a limited movement of right shoulder and arm. A wound on the biceps muscle through the axilla was seen (Figure 1). There was no bleeding. There were not any pathological findings according to the examination. The chest X-ray was applied and the metal body was seen by the right chest wall (Figure 2). It was shown that the metal body between scapula and 3rd rib by the computed thorax tomography, there was not any rib fracture. Surgery was planned and the metal body (about 3×3 cm-diameter rifled slug for boar hunt) was taken out. A hemovac draine was inserted into the between scapula and thoracic wall. The patient was discharged after 3 days postoperatively.

CONCLUSION

The gunshot accidents are always life-threatening traumas while they penetrates thoracic wall. The surgery have to be performed urgently because of major bleeding. In this case, the rifled slug stopped in the extrathoracic muscles near the thoracic wall fortunately. But the diameters and the location of the rifled slug made the patient not to move his arm and shoulder and he had pain because of the slug. This presents an additional interesting indication for exploration of gunshot accidents even if there is not any major bleeding.

Is It Lung Herniation or Subcutaneous Emphysema after Cardiopulmonary Resuscitation?

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Selcuk University Medical Faculty[1], Kars Harakani State Hospital[2], Turkey

PURPOSE

Pneumothorax and subcutaneuos emphysema are the thoracic complications of cardiopulmonary resuscitation (CPR) especially in old patients or in patients whose cartilage development is incomplete. Fractures of anterior ribs are seen commonly in the thorax. It is aimed to present this interesting case which had

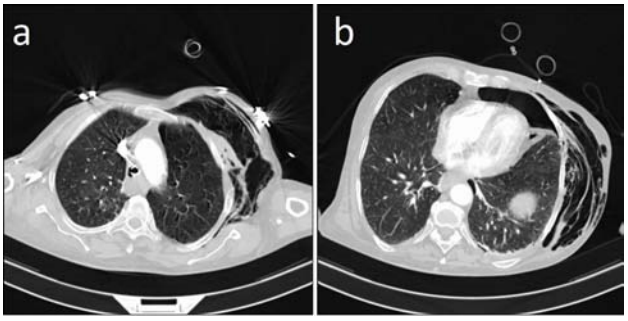
severe subcutaneous emphysema seem like lung herniation after cardiopulmonary resuscitation.

CASE

A 73 year-old woman, who had hepatic cirrhosis, suddenly developed cardiac arrest while eating at home. The emergency medical team performed the entubation and started cardiac massage. At the 5th minute of heart massage, the emergency team noticed subcutaneous emphysema in the left hemithorax, and the team continued the CPR. When the patient was transferred to the hospital, the hearth started to beat. After the positive inotropic agents were started and the arterial blood pressure was started to be taken. Left pneumothorax was seen in the computed thorax tomography (Figure 1), and chest tube was inserted into the left hemithorax. The patient was underwent dialisis urgently because of hyperpotassemia. The lung was expanded after tube thoracostomy and the subcutaneous emphysema was decreased (Figure 2).

CONCLUSION

The fact that the patient is old and the compliance of the thorax wall is low increases the rib fracture and other complications caused by CPR. Pneumothorax and subcutaneous emphysema due to bullous tears can be observed without sustaining rib fractures during continuous compression. This case is very interesting because it displays the apparence of left lung herniation through the left anterior chest wall in thorax tomography.



Development of Numerical Techniques for Minimally Invasive Surgery of Pectus Excavatum

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The aims of the present study are to develop a numerical modelling technique for minimally invasive surgery of pectus excavatum based on computational biomechanics and to supply optimized information s such as a location, size, shape and thickness of the Nuss bar for the surgeon. The feasibility and the effect of the Nuss procedure have been investigated. Furthermore, the effect of the joint forces among sternum, costal cartilage and ribs on the behaviour of the chest wall under Nuss procedure. To achieve this goal, finite element method for Nuss bar Simulation and the design of experiment for optimization are applied. The findings of the research have the potential to enhance the modelling techniques in computational biomechanics.

Establishing the Role of a Dedicated Physiotherapist as Part of the Scottish National Chest Wall Service

*Ashley Johnstone**, *Kathryn Sharp*

Royal Hospital for Children, Glasgow1, United Kingdom

PURPOSE

The number of children and young adults presenting to the Chest Wall Service (CWS) at the Royal Hospital for Children, Glasgow (RHCG), with musculoskeletal symptoms and dysfunctional breathing supported the requirement for a dedicated Physiotherapist.

METHOD

Information on service provision from established Paediatric Chest Wall Services in the United Kingdom (UK) was obtained and the physiotherapy service in Scotland benchmarked against this. Attendance at the Chest Wall International Conference in 2017 established contact with International Centres to share practice.

As the potential role of Physiotherapy is not recognised in the literature, attendance at the weekly Chest Wall Clinic was implemented to screen all patients.

A pilot study was undertaken with 14 patients undergoing corrective surgery, who received Physiotherapy and a patient satisfaction questionnaire was used to gather feedback.

Poster

RESULTS

No Paediatric CWS service in the UK reported a designated out-patient physiotherapist. At the RHCG, the physiotherapy service absorbed any referrals. Having a dedicated Physiotherapist will facilitate a specialist service enabling data gathering and pathways to be established.

The Service at RHCG mirrored the UK Centres contacted which only provide post-operative Physiotherapy. No structured rehabilitation pathway existed for this group of patients.

The questionnaire identified the importance of ensuring patients are well informed and part of decisions being made. A Recovery Advice Leaflet and Pathway were devised as an outcome of the pilot study to guide patients through their rehabilitation.

DISCUSSION

It has been identified the importance of education and supporting patients pre-operatively, through their recovery and providing ongoing follow up. Having a Physiotherapist as part of the CWS enables Physiotherapy intervention and data gathering from diagnosis, continuing throughout the patient journey to gather information to shape the future management of patients.

Delayed Intrathoracic Nuss Bar Dislocation after MIRPE

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University Medical Center Mainz, Germany

PURPOSE

Two years ago, we adopted a short bar technique for minimal-invasive repair of pectus excavatum. Since then, we experienced two delayed bar dislocations. This case report describes the particular circumstances and discusses possible future prevention strategies.

CASES

Both patients underwent uneventful MIRPE using a short bar technique (10" bar, two stabilizers). They were completely back to normal life when they suddenly developed chest pain. In patient 1 (17 y, male), the bar slid out of the stabilizer on the left side due to material break of the locking rivet 10 months postoperatively, which led to intrathoracic bar dislocation. In patient 2 (20 y, male) Intrathoracic dislocation of the bar and attached stabilizer was diagnosed on the right side (Image 1) 13 months post MIRPE.

RESULTS

Both patients were safely reoperated. In patient 1, we performed thoracoscopic bar replacement in original MIRPE technique. There was no obvious organ laceration. In patient 2, the displaced bar was removed via a thoracoscopic-assisted open approach according to patient´s choice. Slight atelectasis of the right lower lung lobe resolved with forced inspiration. In this patient, intensive intercostal stripping was noted as a potential reason for dislocation. We had not seen cases of intrathoracic bar displacement in our previous cohort using long bars.

CONCLUSIONS

We hypothesize that short bars predispose to intrathoracic dislocation, because of diminished extrathoracic bearing surface and support. Intercostal stripping may play an additional role in the pathomechanism. In order to minimize the tendency to erode through the intercostal space, wider stabilizers supported by more than one rib, and using less curved bars may be advisable. Also, stabilizers should be placed close to the point of chest wall penetration, and bars should be long enough for the free end to cover at least two ribs.