DISTANT RESULTS OF PECTUS EXCAVATUM SURGICAL TREATMENT

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SUPERVISOR: PhD. ARTŪRAS KILDA

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SUMMARY


From all the possible external thoracic malformations, about 90% are related with the Sternum Deformity and the cartilages that joint it to the ribs. Pectus Excavatum (PE) is the one with the highest rate of incidence.

In our study we wanted to determine the demographic, early results post procedure and technical differences of PE treatment using the Nuss Procedure between the Paediatric Surgery Clinic of the Kaunas University Hospital in Lithuania and the Department of Thoracic Surgery in Guandong General Hospital in Guangzhou, China by doing a review of their cases of PE treated with the Nuss Procedure.

In order that we could check the differences or similarities we set 9 different parameters divided in three groups (according to each one of the objectives) and ran a “chi-squared test” to see if the discrepancies were statistically significant.

Objectives:

1. To determine the differences in the different demographic groups.
2. To determine the early results post Nuss Procedure (using the Haller Index).
3. To determine the different technical differences between the two clinics.

Methods:

The databases of both groups of patients, Lithuania (n=30) and China (n=639) were compared using non-parametric statistics, Pearson’s “chi-squared test”, mean and standard deviation of values.

Research results:

The results revealed that patients coming from China have a higher Haller Index (mean in Lithuania: 3.6 ± 0.2, mean in China: 4.3 ± 1.7) and age values (mean in Lithuania: 12.5 ± 3.4, mean in China: 15.3 ± 5.8) while the sex distribution was the same for both countries. The outcomes of repair showed no statistically significant differences. The main technical differences were: China had a higher number of bars used per patient and Lithuania had a longer time of operation (mean time in Lithuania: 67.5 ± 19.6 min, mean time in China: 64.3 ± 41.7 min).

Conclusions:

There are differences in the demographic groups, and in the technical differences, but the outcomes of repair are not significantly different.
ACKNOWLEDGEMENTS

I would like to thank my supervisor, Doctor Artūras Kilda who has helped me all the time when I needed him.

I would like to thank Ferrán Mateo Rueda, CEO and Director of the Dialnet Foundation, who helped me to get more information and more scientific articles related to the Pectus Excavatum and its treatment.

I would like to thank Zhang DK, Tang JM, Ben XS et al. for writing the article “Correction of 639 pectus excavatum cases via the Nuss procedure” and letting me use it for comparison for my thesis.

I would like to thank the Clinic of Paediatric Surgery of the Kaunas University Hospital for letting me use their tools to access the data I needed for my research.

CONFLICTS OF INTEREST:

The author reports no conflicts of interest.
ETHICS COMITEE CLEARANCE

The ethics committee in the bioethics centre at Lithuanian University of Health Sciences allows the medical student Pau Mateo Ramos, from VI course, on 2015-12-21 by his request Nr. BEC-MF-164, to proceed with his scientific research “DISTANT RESULTS OF PECTUS EXCAVATUM SURGICAL TREATMENT” which consist on: medical cases review and comparison.

All the research will be under the supervision of Dr. Artūras Kilda, from Paediatric Surgery Clinic.

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETAS
BIOETIKOS CENTRAS

Medicinos akademijos (MA) 2015-12-21 Nr. BEC-MF-164
Vienisius studijų programa – MEDICINA
VI k. stud. Pau Mateo Ramos

DEL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinas (MA) vieniusiu studijų programos – MEDICINA

Bioetikos centro vadovo pavadautojas

doc. E. Pečius
### abbreviations list

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CT</td>
<td>Computerized Tomography</td>
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<tr>
<td>CXR</td>
<td>Chest X-Ray</td>
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<td>HI</td>
<td>Haller Index</td>
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<tr>
<td>MD</td>
<td>Medical Doctor</td>
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<td>MIRPE</td>
<td>Minimal Invasive Repair of Pectus Excavatum</td>
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<tr>
<td>PC</td>
<td>Pectus Carinatum</td>
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<tr>
<td>PE</td>
<td>Pectus Excavatum</td>
</tr>
<tr>
<td>PS</td>
<td>Poland Syndrome</td>
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<tr>
<td>VI</td>
<td>Vertebral Index</td>
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TERMS

- **Haller Index**: A formula that is the transversal chest dimension divided by the sternovertebral distance.

\[
HI = \frac{\text{distance 1}}{\text{distance 2}}
\]

Distance 1: transversal chest dimension, Distance 2: sternovertebral distance.

- **Vertebral Index**: A formula that is the vertebral body length divided by the sum of the vertebral body length plus the sternovertebral distance and everything multiplied by 100.

\[
\text{vertebral index (VI)} = \frac{v}{v + c} \times 100
\]

V: vertebral body length, C: sternovertebral distance.
INTRODUCTION

From all the possible external thoracic malformations, about 90% are related with the Sternum Deformity and the cartilages that joint it to the ribs. These sternum deformities are the PECTUS EXCAVATUM (PE) in which the sternum is hollow and the PECTUS CARINATUM (PC) in which the sternum protrudes.

The current treatment of choice for the PE is the Nuss Procedure, that was invented by Dr. Donald Nuss in the year 1987 and he developed it in Virginia, United States of America at Children’s Hospital of The Kings Daughter’s.

There were no clinical evidence on comparative studies of the same procedure between two different clinics and, being this a quite innovative procedure, it is important to determine the differences in the surgical approach on different Hospitals.

The aim of the present study is to determine the differences in the treatment of Pectus Excavatum using the Nuss Procedure between the Paediatric Surgery Clinic of the Kaunas University Hospital, Lithuania and the Department of Thoracic Surgery in Guandong General Hospital in Guangzhou, China by doing a review of their cases of PE treated with the Nuss Procedure and to determine whether who is getting better results for the patients and if we can learn anything from each other.
AIMS AND OBJECTIVES OF THE THESIS

Aim:
The aim of the present study is to determine the differences in the treatment of *Pectus Excavatum* using the Nuss Procedure between the Paediatric Surgery Clinic of the Kaunas University Hospital, Lithuania and the Department of Thoracic Surgery in Guandong General Hospital in Guangzhou, China by doing a review of their cases of PE treated with the Nuss Procedure.

The subjects were 30 patients with PE treated with the Nuss Procedure from the Paediatric Surgery Clinic of the Kaunas University Hospital, Lithuania and 639 patients with PE treated with the Nuss Procedure from the Department of Thoracic Surgery in Guandong General Hospital in Guangzhou, China.

Objectives:

1. To determine the differences in the different demographic groups.
2. To determine the early results post Nuss Procedure (using the Haller Index).
3. To determine the different technical differences between the two clinics.
LITERATURE REVIEW

From all the possible external thoracic malformations, about 90% are related with the Sternum Deformity and the cartilages that joint it to the ribs. These sternum deformities are the *PECTUS EXCAVATUM* (PE) in which the sternum is hollow and the *PECTUS CARINATUM* (PC) in which the sternum protrudes. The rest are infrequent sternal malformations, like *Ectopia Cordis, Ribs Agenesis, Pectoral Muscle Hypoplasia, Poland’s Syndrome, Thoracic Dysplasia, Vertebral Malformations* etc.

1. Definitions

   a. Pectus Excavatum (PE) or “funnel chest” is by far the most common congenital chest wall deformity, that sums up for over 90% of all chest wall deformities, with a male to female ratio of 4:1. (1). PE consists of an anterior depression of the chest, symmetrical or not, combined with a dorsal deviation of the sternum and the third to the seventh ribs or costochondral cartilages. Unfortunately, nowadays the etiology of this pathology is still unknown and some recent study results remain inconsistent. The hypotheses on the pathogenesis of the PE are based on intrinsic factors (cartilage metabolism) and/or extrinsic ones (bone development disorder) (2). It has major psychological and aesthetic, aside from functional, consequences (3).

   b. Pectus Carinatum (PC) or “pigeon chest” is the second most commonly seen chest wall deformity. PC is also sporadic and is less common than PE. It also affects males fore than females, and is characterized by anterior angulation of the sternum and protrusion of the costal cartilage (5).
c. Poland Syndrome (PS) is a rare congenital anomaly characterized by hypoplasia of the breast and nipple, insufficient subcutaneous tissue, absence of the costosternal portion of the pectoral major muscle, lack of the pectoral minor muscle, aplasia or deformity of the axillary and mammary region and unilateral brachysyndactyly. This syndrome was reported by Alfred Poland in 1841 (6).

2. Diagnosis of Pectus Excavatum

a. The main symptoms of Pectus Excavatum include fatigue, shortness of breath, chest pain and tachycardia.

b. The diagnostic techniques include simple chest x-rays (CXR) in a postero-anterior and lateral projections, computerized tomography (CT) and simple cardiological and respiratory studies (3).

c. For assessment of indications for surgically corrective treatment, radiological examination is of great significance. Even in cases of moderate chest wall deformation with no signs of chest organ compression, indications for surgery can be determined by size of deformation seen on chest radiograph or CT (7).

(8). The preoperative clinical appearance of PE and assessment by CT.
3. Correction of Pectus Excavatum

a. Pectus Excavatum was described for the first time in 1594 by Baubinus (9). The very first attempt to fix it was done in the year 1911 by the German surgeon Ludwig Meyer, but the modern era of correction did not start until 1949, where Ravitch published his first paper (10). Several modifications were later published and the modified Ravitch technique was the standard technique for correction of PE until the work and creation by Nuss concerning minimal invasive repair of pectus excavatum (MIRPE) was presented in 1998 (11).

4. Surgical procedure

a. All patients are anaesthesized with general intravenous anaesthesia and undergo tracheal intubation. The place with deepest point of depression is marked, the thorax of the patient is measured (12) and the Nuss steel bars (Walter Lorenz, US) are bent into a curved or convex shape to form the support frame.

(12) Image showing how the thorax is measured and how the place with the deepest point of depression is marked.

b. A transverse incision of approximately 2.0-2.5cm long is made in each lateral chest wall between the anterior axillary and the medial axillary lines, in line with the deepest point of the depression. After dissecting the subcutaneous tissues and muscles using an electroscalpel, blunt dissection is carried out along the rub surface until reaching the deepest point using a finger.
c. A right pleural artificial pneumothorax is created with careful videothoracoscopic guidance, an introducer is inserted into the right thoracic cavity from the right lateral incision, advanced across the mediastinum immediately under the depressed sternum until it emerges on the left side.

(12) Image showing how blunt dissection is carried under videothoracoscopic guidance.

d. Then the surgeon and the assistant lift the introducer, press the flared costarum several times to shape it, insert a 28F chest tube via the introducer, insert one end of the bent Nuss bar which has been shaped according to the patient’s chest conour, pulled back the chest tube so one end of the Nuss bar would emerge through the chest wall.

(12) Image showing the bar, emerging from both ends.
e. The Nuss bar is then turned over, and the right side is secured through a fixation bar while the left side was sutured to the lateral chest wall muscles and rib periosteum.

(12) Image showing how the bar is fixated.

f. The lung is extended and deflated before suturing the wounds in layers. (13)
RESEARCH METHODOLOGY AND METHODS

- **Research planning (organization)**

  The research was divided in 4 stages:
  
  1. Collection of literature and theoretical knowledge of problem.
  2. Creating design of investigation. Collecting permissions and data.
  3. Collecting more data.
  4. Statistical analysis, results and presentation preparing.

- **The Object of Study**

  Two groups of patients, one group from Lithuania (n=30) and the other one from China (n=639) that had undergone the surgical repair of Pectus Excavatum through Nuss Procedure.

- **Participant selection (population, sample)**

  There were two groups of patients:
  
  1. 30 patients with PE treated with the Nuss Procedure from the Paediatric Surgery Clinic of the Kaunas University Hospital.
  2. 639 patients with PE treated with the Nuss Procedure from the Department of Thoracic Surgery in Guangdong General Hospital in Guangzhou, China.

- **Research methods**

  This research was an observational case study. The statistical analysis was performed using “Excel for Mac 2011” software. Data was analysed using $\chi^2$ test.

- **Methods of data analysis**

  Different parameters were measured on each patient (using their medical case) and then the databases were created. Mean of each parameter and standard deviation were performed, and in addition Pearson’s “chi-squared test” was used to compare some of the parameters.
RESULTS AND THEIR DISCUSSION

To organize the results three groups are made according to the objectives of the research:

1. Determine differences between different demographic groups:
   a. Sex
   b. Age
   c. Pre operative Haller Index (HI).

2. Determine early results post Nuss Procedure:
   a. Outcomes of repair (Excellent, good, fair and poor).
   b. Follow up of patients

3. Determine technical differences:
   a. Duration of operation.
   b. Number of bars used.
   c. Fixation of bars inside of the body.
   d. Duration of bars inside of the body.
1. DIFFERENCES BETWEEN DIFFERENT DEMOGRAPHIC GROUPS.

Parameter 1.A. Sex distribution.

Some authors like Molik KA. et al. confirm that the ratio incidence is of male to female ratio of 4:1 (1), while other authors like Hebra A. agree that the ratio incidence is 3:1 (14).

Since apparently the ratio was different between Lithuania and China we presented this hypothesis: “The higher prevalence of girls with PE depends on the country.”

Applying the $\chi^2$ test we obtained a result of 3,279. Having a p value of 0.95 ($p=0.95$) and having a degree of freedom of 1 ($v=1$) we found a critical value of chi of 3,841. And since $3,279 \leq 3,841$ we can conclude that there is no statistical significance, this means that it doesn’t matter the country of origin, the prevalence of boys with PE is always higher.
Parameter 1.B. Age distribution.

- **Mean age in Lithuania**: 12.5 ± 3.4 years.
- **Mean age in China**: 15.3 ± 5.8 years.

While in China the range of age was broader than in Lithuania, we wanted to check if the age difference was country-dependant. That is why we came up with this hypothesis: “The patients with PE are treated in a younger age in Lithuania.”

<table>
<thead>
<tr>
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<th>Lithuania</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 to 5</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>6 to 12</td>
<td>12</td>
<td>134</td>
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<tr>
<td>13 to 18</td>
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<td>325</td>
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<td>19 to 25</td>
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<td>26 to 49</td>
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<tr>
<td>Total</td>
<td>30</td>
<td>639</td>
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</table>

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<tr>
<th>Age Distribution</th>
<th>Lithuania</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 to 5</td>
<td>1,30</td>
<td>27,69</td>
</tr>
<tr>
<td>6 to 12</td>
<td>6,54</td>
<td>139,45</td>
</tr>
<tr>
<td>13 to 18</td>
<td>15,38</td>
<td>327,61</td>
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<tr>
<td>19 to 25</td>
<td>5,51</td>
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<td>26 to 49</td>
<td>1,25</td>
<td>26,74</td>
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<tr>
<td>Total</td>
<td>30</td>
<td>639</td>
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</table>

Applying the $\chi^2$ test we obtained a result of 13,672. Having a p value of 0.95 ($p=0.95$) and having a degree of freedom of 4 ($v=4$) we found a critical value of chi of 9,488. And since 13,672 is not ≤ 9,488 we can conclude that there is statistical significance and thus, we can confirm that the patients in Lithuania are treated in a younger age than in China.
Parameter 1.C. Pre operative Haller Index (HI).

This will be divided in 4 groups according to Zhang DK et al (10)

1. Mild PE (HI<3.2)
2. Moderate PE (HI 3.2 - 3.5)
3. Severe PE (HI 3.6 - 6.0)
4. Extremely severe PE (HI >6.0)

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<tr>
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<th>Lithuania</th>
<th>China</th>
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<tbody>
<tr>
<td>Mild</td>
<td>0%</td>
<td>12%</td>
</tr>
<tr>
<td>Moderate</td>
<td>43%</td>
<td>18%</td>
</tr>
<tr>
<td>Severe</td>
<td>57%</td>
<td>61%</td>
</tr>
<tr>
<td>Extremely Severe</td>
<td>0%</td>
<td>9%</td>
</tr>
</tbody>
</table>

- **Mean HI in Lithuania:** $3.6 \pm 0.2$ of Haller index.
- **Mean HI in China:** $4.3 \pm 1.7$ of Haller index.

As a first appearance the patients coming from China had higher value of Haller index. We wanted to check if this was statistically significant and therefore we rose up this hypothesis: “The patients coming from China have higher value of Haller Index”.

### OBSERVED

<table>
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<tr>
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<th>Severe</th>
<th>Extremely Severe</th>
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<tr>
<td>Lithuania</td>
<td>0</td>
<td>13</td>
<td>17</td>
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<td>China</td>
<td>75</td>
<td>114</td>
<td>393</td>
<td>57</td>
<td>639</td>
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<tr>
<td>Total</td>
<td>75</td>
<td>127</td>
<td>410</td>
<td>57</td>
<td>669</td>
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### EXPECTED

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<tbody>
<tr>
<td>Lithuania</td>
<td>3,36</td>
<td>5,69</td>
<td>18,38</td>
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<td>China</td>
<td>71,63</td>
<td>121,30</td>
<td>391,61</td>
<td>54,44</td>
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<td>Total</td>
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Applying the $\chi^2$ test we obtained a result of 16,116. Having a p value of 0.95 ($p=0.95$) and having a degree of freedom of 3 ($\nu=3$) we found a critical value of chi of 7,815. And since 16,116 is not $\leq$ 7,815 we can conclude that there is statistical significance and thus, we can confirm that the patients in China on the moment of undergoing the procedure have a higher value of Haller Index.

2. EARLY RESULTS POST NUSS PROCEDURE.

Parameter 2.A. Outcomes of repair.

To evaluate the outcome, 4 criteria are considered:

1. Chest X-Ray showed no sternum depression.
2. The morphology of chest wall is symmetric, without depression.
3. The patient and their families are satisfied.
4. The thorax appears full with good extension and elasticity.

Ranking of the outcome:

1. Excellent - if 4 criteria apply.
2. Good - if 3 criteria apply.
3. Fair - if 2 criteria apply.
4. Poor - if 1 criteria applies.

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<th>Outcomes of Repair</th>
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3. The patient and their families are satisfied.
4. The thorax appears full with good extension and elasticity.

Ranking of the outcome:

1. Excellent - if 4 criteria apply.
2. Good - if 3 criteria apply.
3. Fair - if 2 criteria apply.
4. Poor - if 1 criteria applies.

<table>
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<th>Outcomes of Repair</th>
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<td>Fair</td>
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<tr>
<td>Poor</td>
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Applying the $\chi^2$ test we obtained a result of 16,116. Having a p value of 0.95 ($p=0.95$) and having a degree of freedom of 3 ($\nu=3$) we found a critical value of chi of 7,815. And since 16,116 is not $\leq$ 7,815 we can conclude that there is statistical significance and thus, we can confirm that the patients in China on the moment of undergoing the procedure have a higher value of Haller Index.

2. EARLY RESULTS POST NUSS PROCEDURE.

Parameter 2.A. Outcomes of repair.

To evaluate the outcome, 4 criteria are considered:

1. Chest X-Ray showed no sternum depression.
2. The morphology of chest wall is symmetric, without depression.
3. The patient and their families are satisfied.
4. The thorax appears full with good extension and elasticity.

Ranking of the outcome:

1. Excellent - if 4 criteria apply.
2. Good - if 3 criteria apply.
3. Fair - if 2 criteria apply.
4. Poor - if 1 criteria applies.

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<th>Fair</th>
<th>Poor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>28</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>China</td>
<td>504</td>
<td>105</td>
<td>28</td>
<td>2</td>
<td>639</td>
</tr>
<tr>
<td>Total</td>
<td>532</td>
<td>107</td>
<td>28</td>
<td>2</td>
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<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuania</td>
<td>23,85</td>
<td>4,79</td>
<td>1,25</td>
<td>0,08</td>
<td>30</td>
</tr>
<tr>
<td>China</td>
<td>508,14</td>
<td>102,20</td>
<td>26,74</td>
<td>1,91</td>
<td>639</td>
</tr>
<tr>
<td>Total</td>
<td>532</td>
<td>107</td>
<td>28</td>
<td>2</td>
<td>669</td>
</tr>
</tbody>
</table>

Applying the $\chi^2$ test we obtained a result of $3.870$. Having a p value of $0.95 (p=0.95)$ and having a degree of freedom of $3 (v=3)$ we found a critical value of chi of $7.851$. And since $3.870 \leq 7.851$ we can conclude that there is no statistical significance, therefore concluding that the outcomes of repair are equal in both countries.

**Parameter 2.B. Follow up of patients.**

- **In Lithuania:** 1,3,6,12 and 24 months after each operation (Nuss procedure and eliminatio corporis alieni)
- **In China:** 1,3,6 and 12 months after each operation (Nuss procedure and eliminatio corporis alieni)

We failed to find information about the tests performed in China every time a patient goes to a follow up consultation. According to Kilda A et al. (15) for postoperative follow-up they think it is more rational to apply the Vertebral Index (VI) but not widely used indexes, including HI, frontosagital index, pectus index and CT index.
3. TECHNICAL DIFFERENCES.

Parameter 3.A. Duration of operation.

- **Average time of operation duration in Lithuania:** 67.5 ± 19.6 min.
- **Average time of operation duration in China:** 64.3 ± 41.7 min

Both clinics showed very similar times on operation, with their averages only being 2.2 minutes different. In China there was a maximum time of 310 minutes because one patient with Marfan’s syndrome underwent atrial septal defect and ventricular septal defect closure, and replacement of the ascending aorta and aortic valve (Bentall operation) simultaneously. (13).
Parameter 3.B. Number of bars used.

In the cases we got from Lithuania all the patients underwent the repair with the usage of only one bar, since in China there were 484 patients with 1 bar, 153 with 2 bars and 2 with three bars. We wanted to check if “The number of bars used depends on the country of origin.”

<table>
<thead>
<tr>
<th></th>
<th>Bars used in Lithuania</th>
<th>Bars used in China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Bar</td>
<td>100%</td>
<td>75.70%</td>
</tr>
<tr>
<td>2 Bars</td>
<td>0%</td>
<td>24%</td>
</tr>
<tr>
<td>3 Bars</td>
<td>0</td>
<td>0.30%</td>
</tr>
</tbody>
</table>

Applying the $\chi^2$ test we obtained a result of 9.471. Having a p value of 0.95 ($p=0.95$) and having a degree of freedom of 2 ($\nu=2$) we found a critical value of chi of 5.991. And since 9.471 is not $\leq$ 5.991 we can conclude that there is statistical significance and thus, we can confirm that the usage of one bar or more depends on the country where the patients are operated.
Parameter 3.C. Fixation of bars inside of the body.

- **In Lithuania:** one side to a fixation bar, the other side was fixed with non resorbable sutures to the lateral chest wall muscles and rib periosteum.
- **In China:** one side to a fixation bar, the other side was fixed with non resorbable sutures to the lateral chest wall muscles and rib periosteum.

In both clinics the technique for the fixation of the bars inside of the body of the patients was exactly the same.

Parameter 3.D. Duration of bars inside of the body.

![Duration of bars inside of the body](chart)

- **Average time in Lithuania:** $725 \pm 56.4$ days $\approx 2$ years
- **Average time in China:** $\approx 3$ years (*not enough data was found*).

Since we failed to find exact time of the bars inside of the body for the patients of China and we only got an approximate number, we can’t be clinically sure, but, there’s an indication that patients in Lithuania have the bar inside of the body for less time than patients in China.
CONCLUSIONS

The main objectives of this thesis were to determine whether there were or not demographic, early post operative and technical differences between the two clinics, one in Lithuania and the other in China.

We confirmed that the sex distribution of the patients had no statistical significance but, on the other hand, the age and the pre operative HI depended on the country of origin. Both age and pre operative HI values were higher in the patients coming from China. As it had been stated before (16,17) the Nuss method is preferably used in children and adolescents rather than in adults. The maximum age of the patients in Lithuania was 18 years old while in China was 49.

The outcomes of the repair were not statistically different and the follow up procedures were almost the same (in Lithuania patients were checked also 24 months after the first and second operations).

On the technical differences between the two clinics we found more discrepancy; while the duration of operations and the way of fixating the bars inside of the body was similar, the usage of bars and the duration of them inside of the body was different. China, following the same pattern as other surgeons like Hank K. Pilegaard (18) used in more than 24% of the patients more than 1 bar while Lithuania prefers to stick to one bar, and in comparison with China, the outcomes of operation don’t vary.

The Nuss procedure has been accepted and it is a very popular technique nowadays. As Puri B, et al. stated before, the principal advantage of the minimally invasive repair for pectus excavatum (MIPRE) technique is based on the fact that there was no need for an anterior chest wall incision, pectoralis muscle flap resection of rib cartilage or to perform sternal osteotomy (19).

Our study was conducted between two centres, but as some authors would state (20, 21) the comparisons between techniques require well-designed and well-conducted, multicentre studies, with methodological quality higher than the ones of the currently available observational studies.

The final statement is that there exist differences in the demographic groups, and in the technical differences, but the outcomes of repair are not significantly different.
LITERATURE LIST