ORIGINAL PAPER

MINIMALLY INVASIVE SURGERY IN PECTUS EXCAVATUM FOR CHILDREN, ADOLESCENTS AND ADULTS

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Abstract

We retrospectively studied a group of 39 patients admitted in the "Marie Curie" Emergency Pediatrics Hospital of Bucharest in a period of 10 years, suffering from congenital disorders of the thorax. Out of this large group, 32 patient were admitted with Pectus Excavatum. The goal of our study is to demonstrate the advantages of minimally invasive surgery for this type of malformation. We included 39 patients in our study, ages from 0- 24 years old, diagnosed with chest malformations, of which 32 had pectus excavatum associated or not with other pathologies. Minimally invasive surgery was the main choice with great results. Most of the patients had no symptoms, therefor they sought medical care for esthetic reasons. Minimally invasive surgery is efficient, with small complication rate, proving to be the best option.

Keywords*: pectus excavatum, males, Nuss technique, Lorenz bar, aesthetical, social*

Introduction

Congenital disorders of the chest are a large group of pathologies, the most common congenital disorders known. The incidence goes up to 1 per 300 new born males in most studies, with rare symptoms. These patients usually seek medical care for associated pathology or for emotional and aesthetic implications. There for Pectus Excavatum (PE) tends to be underdiagnosed, neglected, and mistreated.

In modern societies the treatment for Pectus Excavatum is now minimally invasive with the tendency towards new and futuristic solutions, in order to decrease the postsurgical complications.

Pediatric Orthopedics Clinic from Marie Curie Hospital Bucharest was the first clinic in witch minimally invasive surgery was performed for these patients in Romania.

Sunken chest or funnel chest as it is called the Pectus Excavatum is the most frequent malformation of the chest, more than 90% of all congenital chest malformations. It is the anterior deformation of the chest wall by plugging the sternum but not the manubrium sterni and the first two ribs. We still don't know why it occurs despite many hypothesis of anarchic growth of rib cartilages. Usually it is associated with connective tissue and muscle malformation, Marfan's, Ehlers Danlos Syndromes, scoliosis or mitral valve prolapse.

Symptoms include shortness of breath, recurrent respiratory infections, chest pain, tachycardia, fatigue, dizziness and fainting. For these patients is mandatory to perform chest X

Ray, CT Scan, MRI Scan, heart Ultrasound, EKG and functional lung tests. These tests will evaluate the actual degree of the deformity by performing the Haller Index and will establish the proper treatment for each patient. The Haller Index is a mathematical ratio between the transverse and anterior-posterior diameters of the chest measured by chest CT Scan (Figures 1, 2).

Figure 1 - Pectus Excavatum – Clinical presentation.

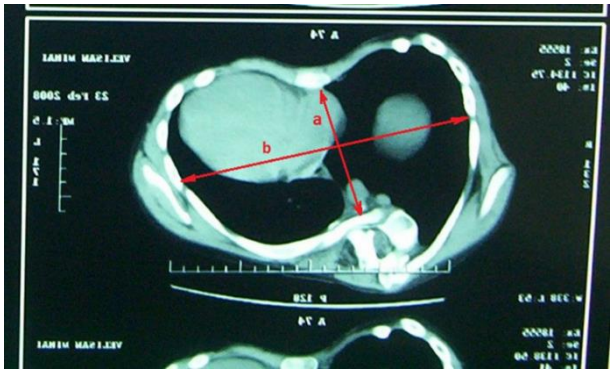

Figure 2 - Haller Index

In 2008 Robert Kelly and his colleagues set a standard for optimal surgery in Pectus Excavatum. The moment of surgery and the indication is dictated by the presence of two or more of the following criteria:

- specific symptoms
- history of progressive deformities
- paradoxical movement of the chest in deep exhalation
- Haller index > 3.25
- cardiac compression
- compression of the vena cava or pulmonary veins
- respiratory dysfunction
- cardiac dysfunction
- history of surgical treatment for the same pathology
- severe cosmetic deformity

The Nuss procedure is the actual standard for the treatment of Pectus Excavatum. It is minimally invasive, relatively easy to learn and reproduce. The alternative is the historical Ravitch technique, an open surgery developed in 1949. This technique needs large cartilage resections, sternal sectioning, xiphoid resection and sternal repositioning.

The Nuss technique involves implanting a titanium bar in the retrosternal space and twisting it at 180 degrees. The result is an anterior mobilization and fixing of the sternum in physiological position. Surgery is performed under general anesthesia with oro-tracheal selective intubation of right lung.

After measurement and modeling of the Lorenz bar (Figure 3), the skin is tunneled side up in the most elevated points noted. The thoracoscope is then introduced through the right lateral incision. The thoracic cavity is inspected (Figure 4). Next step is to introduce the dissector into the right thorax and progress with the dissection into the mediastinum towards the left thorax (Figure 5). The dissector passes from one incision to another and a twine is attached to it and retracted through the retrosternal tunnel performed. Using the twine a Lorenz bar will be placed in the thorax with the concavity upwards and then twisted 180 degrees. Next, one or two stabilizer bars will be placed laterally to stabilize the bar in the final position (Figure 6). Postop chest X-ray is mandatory to control the position of the bar and the potential remaining pneumothorax (Figure 7).

Among the postoperative complications we can encounter hemothorax, pneumothorax, implant allergy, displacement of the assembly, cardiac perforation, pericardial collections, pericarditis, hypercorrection, pneumonia, pleural collections, and death [1-16].

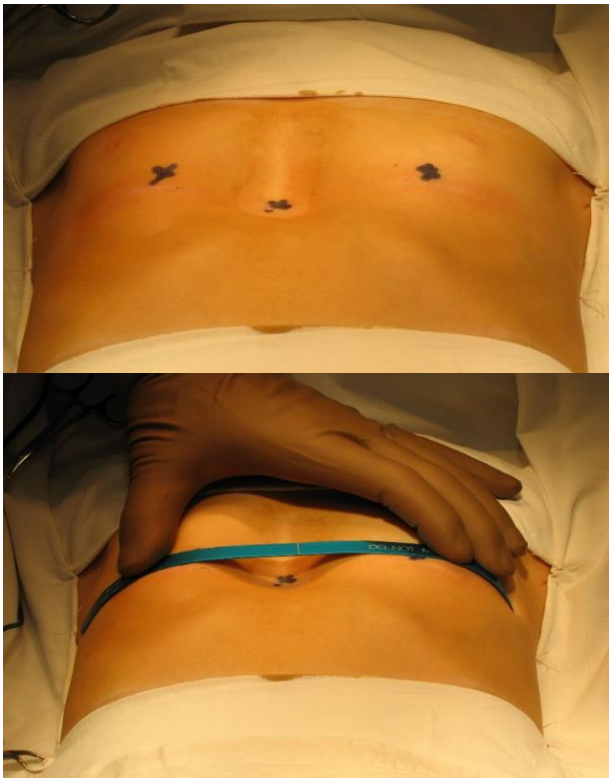

Figure 3 - Measurement and modeling of the Lorenz bar

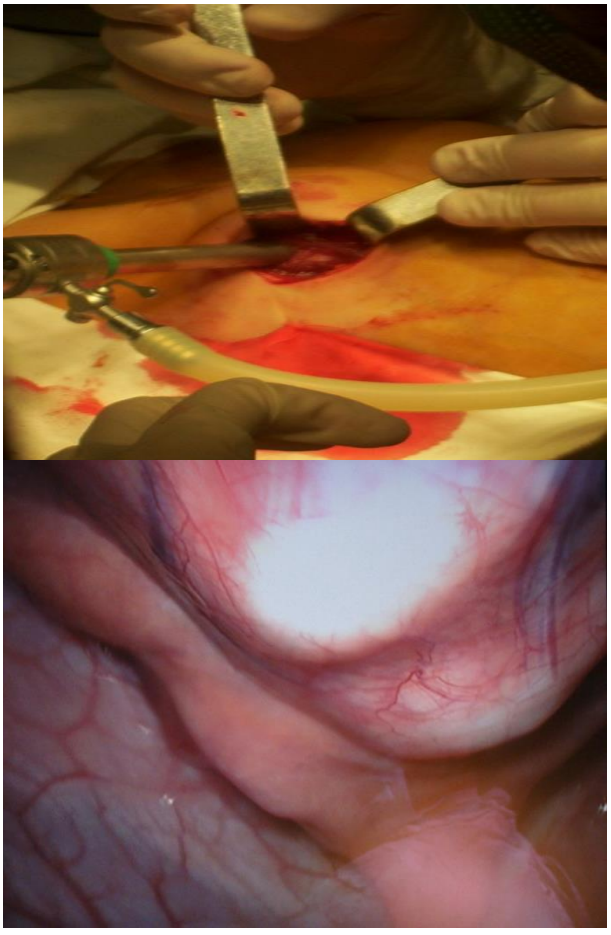

Figure 4 - Incision and introduction of the thoracoscope. Inspection of the thoracic cavity

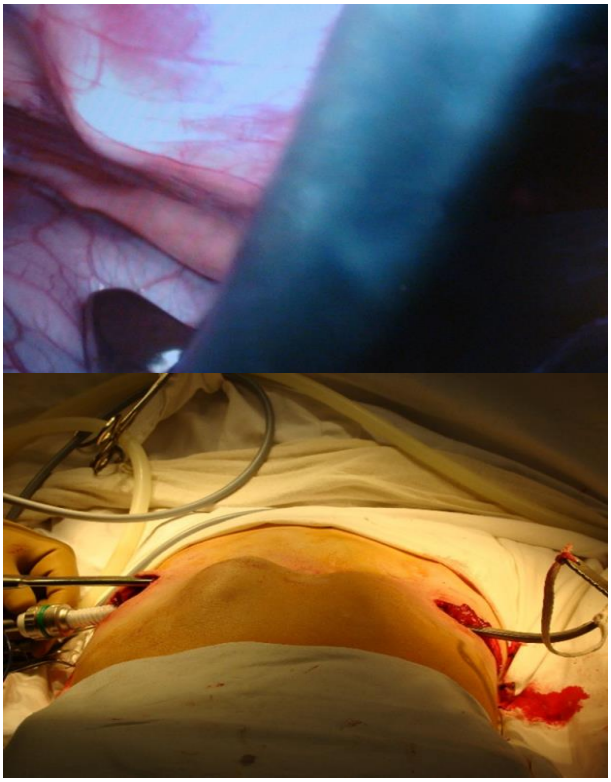

Figure 5- Retrosternal dissection

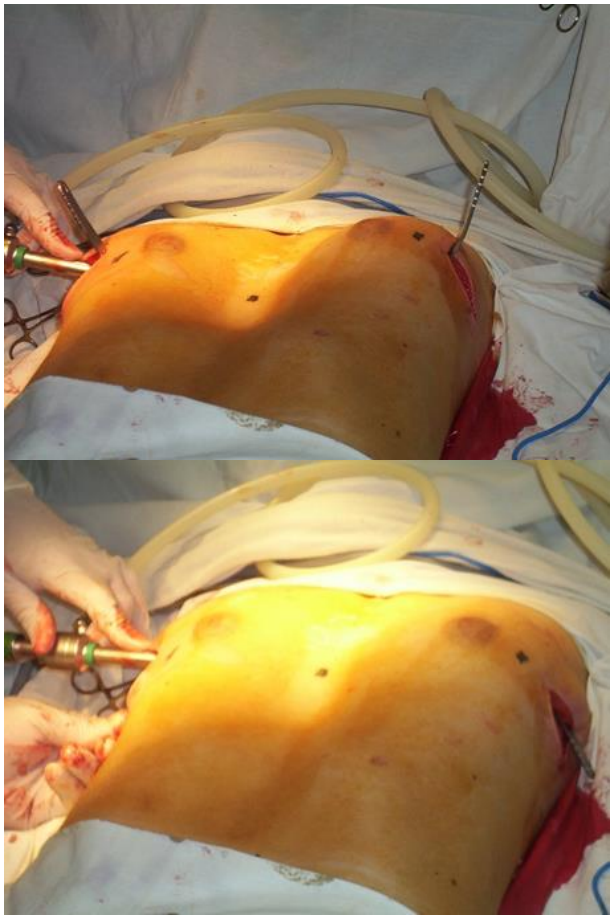

Figure 6 - Introducing the implant with the concavity upwards and twisting to 180 degrees

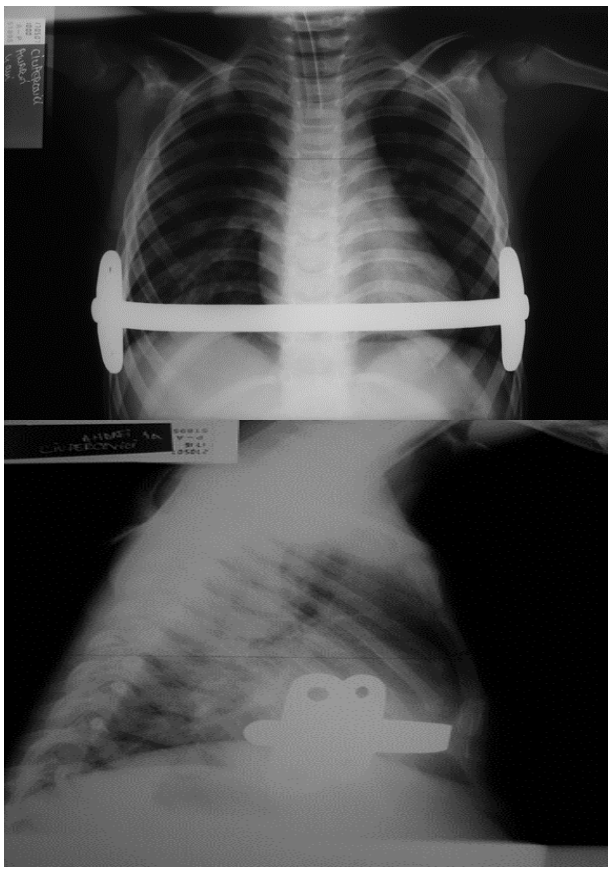

Figure 7 - Post-surgical X- ray control

Materials and methods

We are publishing a retrospective study on a period of 10 years (2004-2013). The study group includes 39 patients with chest deformity admitted and treated. Out of these 39 cases, 32 cases had Pectus Excavatum in different clinical presentations, with different surgical attitudes.

Data was gathered from patients' charts and the clinic's photo and video database.

Criteria for admission included: admission and treatment in the Orthopedics Clinic of „Marie Curie" Emergency Pediatrics Hospital of Bucharest, age between 0-24 years, with the diagnosis of chest wall malformation.

Results

In the 10 year period we found a total of 55 charts. In these charts we discovered 29 single admissions and 10 patients with multiple admissions. Minimal admission time was 1 day, maximal admission time was 44 days with an average of 13.49 days (Table 1).

Total patient admission	**55**
Total patients	39
Single admission	29
Multiple admissions	10

Table 1 – Number of patients

The minimal age was 2 months, the maximal age was 24 years with an average of 15.48 years.

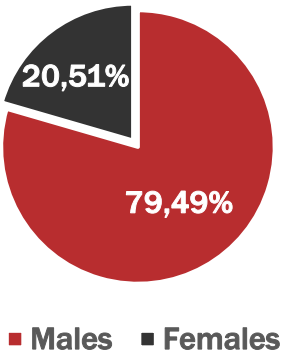

Figure 8 – Patients distribution by sex

In our study, 31 patients were males and only 8 patients were females, confirming the overall male/female ratio from the literature (Figure 8).

Type	**Number**	**Percent**
PE	25	79.4%
PE + THORACIC HYPOTROFIA	1	
PE + CERVICAL EXTRA RIB	1	
PE + CIFOSCOLIOSIS	2	
MARFAN SYNDROME	2	
PC	5	12.8%
MIXT THORACIC MALFORMATIONS	1	2.6%
CLEFT STERNUM	1	2.6%
CERVICAL RIB	1	2.6%
TOTAL	39	100%

Table 2 – Number of patients

The study group, as mentioned, was represented in majority by Pectus Excavatum, as a single pathology or in association with other malformations (Table 2). The clinical presentation for Pectus excavatum was vast as expected. This can be seen easily in the next chart (Figure 9).

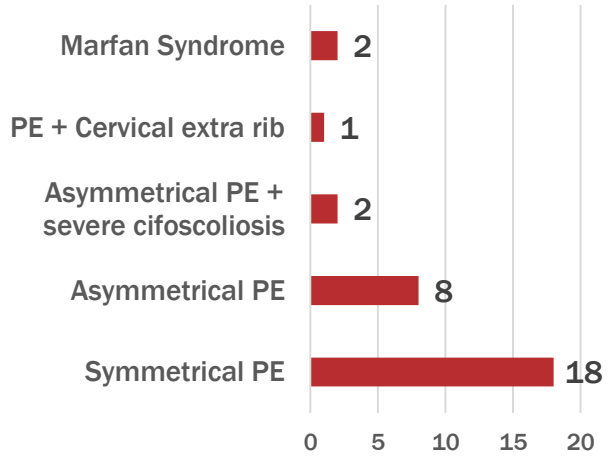

Figure 9 – Patients distribution by clinical presentation

SYMPTOMS	Number	Percent
No symptoms	25	80.66%
Shortness of breath	1	3.22%
Fatigue	4	12.90
Progressive loss of physical endurance	1	3.22%
Total	31	100%

Table 3 – Patients distribution by symptoms

The majority of patients with Pectus Excavatum had no symptoms. When present, symptoms included shortness of breath and fatigue, and in one case, progressive loss of physical endurance.

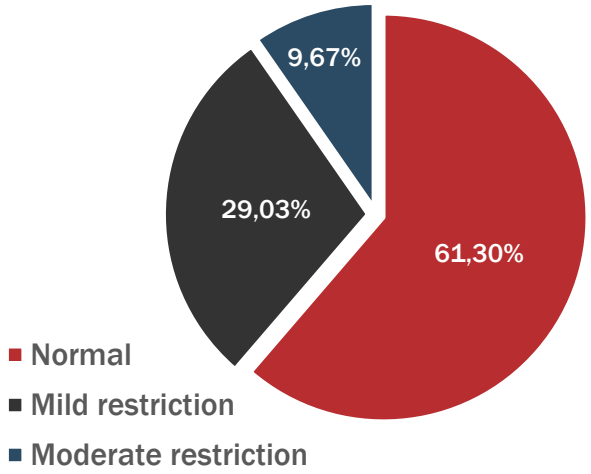

Figure 10 – Patients distribution by respiratory test results

The respiratory test showed no restriction in the majority of cases, with no severe restriction encountered.

Cardiac Ultrasound was performed, 14 patients had normal cardiac ultrasonography, 1 case had right atrium compression, right ventricle compression and severe pulmonary stenosis,

1 case had mitral valve prolapse and 4'th degree mitral regurgitation. 15 patients had no cardiac ultrasonography.

CT Scan was also performed. 2 patients had symmetrical PE, 1 patient with right pleural collection, 1 patient with pneumothorax, 1 patient with enclosed pleural collection and left cardiac mobilization and 26 patients without CT scans.

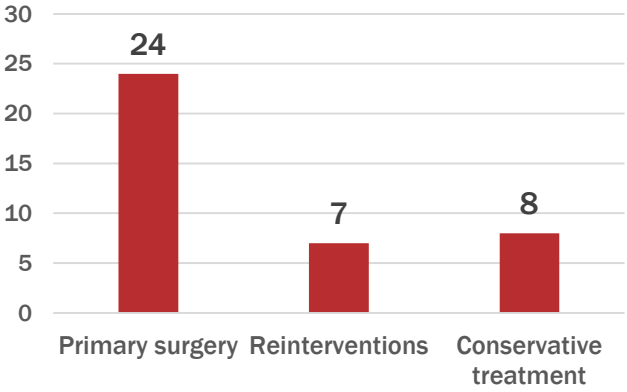

Figure 11 – Patients distribution by tratament

From the total of 32 patients admitted with Pectus Excavatum, 24 were operated and 8 were treated conservatively. Out of the 24 operated, 7 needed re-interventions (Figure 11).

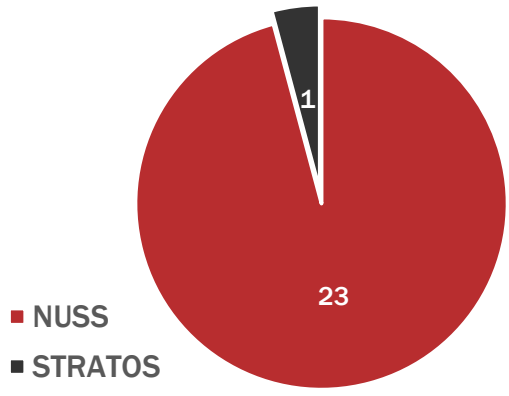

Figure 12 – Patients distribution by primary surgery

As expected, the great majority of cases were operated minimally invasive using the Nuss technique, and only one using an open technique (Figure 12).

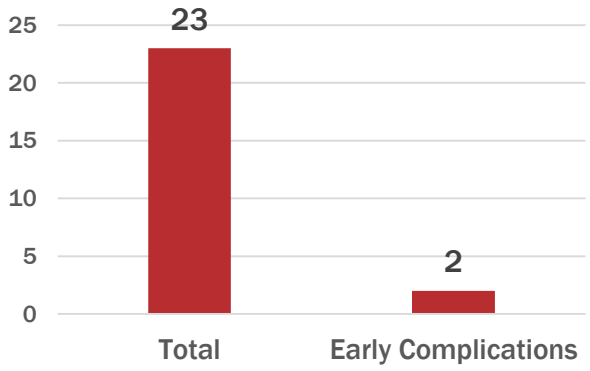

Figure 13 – Patients distribution by early complications after NUSS

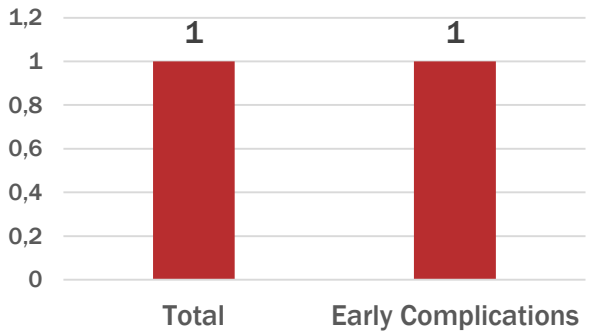

Figure 14 – Patients distribution by early complications after STRATOS

Early post-operatory complications were encountered. After minimally invasive surgery we had two wound infections that needed correction (<10%), meanwhile after Stratos implants we encountered right pleural collection and wound infection (Figure 13,14).

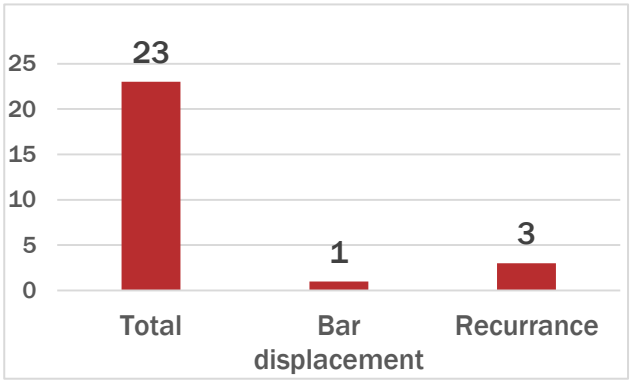

Figure 15 – Patients distribution by late complications after NUSS

Late post-operative complications were encountered only in the Nuss group. We encountered one bar displacement and three recurrences, all while still in the learning curve (Figure 15).

After NUSS	Number
Bar repositioning	2
Bar extraction	1
Bar repositioning and Stratos correction	1
Wound correction	2
Total	6

Table 4 – Patients distribution by complications after NUSS

After STRATOS	Number
Wound and Stratos correction	1
Total	1

Table 5 – Patients distribution by complications after STRATOS

To summarize the overall re-interventions, after the Nuss technique we found two bar repositioning, one bar extraction, one bar repositioning and Stratos correction and one wound correction. After the open technique we encountered a wound and Stratos correction (Table 4,5).

Discussions

Pectus Excavatum is the most common chest wall malformation in children, adolescents and adults.

It is still a real challenge to diagnose and treat these patients because usually they have no symptoms. The moment of presentation varies from newborn to adult, as the clinical presentation may vary from single malformations to complex presentations, each situation imposing a different attitude.

These days the treatment tends toward the minimally invasive surgery because there is no major incisions or bone resections, bleeding is minimal, operative times are short, physical recovery is faster as is the social recovery, the aesthetic results are great and the admittance period is short.

In our study only 74% of the Pectus Excavatum patients had surgical indications. The surgical technique used in most cases was NUSS. The very few complications were

resolved quickly and effectively, with a very good overall result.

Conclusion

Minimally invasive surgery for Pectus Excavatum proves to be very effective. Therefor treatment should be standardized and performed in highly specialized clinics where minimally invasive surgery is at its best.

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