

A 3-Year Experience of a Minimally Invasive Technique for Correction of Pectus Excavatum in Croatia

Mirko Žganjer, Irenej Cigit, Ante Čizmić and Anto Pajić

Department of Pediatric Surgery, Children's Hospital Zagreb, Zagreb, Croatia

ABSTRACT

The aim of this study was to assess the early results of a three-year experience with the minimally invasive correction of pectus excavatum, which requires no cartilage incision or excision, and no sternal osteotomy. Since 2001 we have performed 35 minimally invasive pectus excavatum procedures at our hospital. A convex steel bar is inserted under the sternum through small bilateral incisions, and removed after 2 years when permanent remodeling had occurred, the bar is removed. Complications were pneumothorax in 5 patients (only 1 required a thoracostomy tube, the other 4 resolved spontaneously), pneumonia in 3 patients, and bar displacement in 1 patient. The mean follow-up was 3 months to 3 years. Initial excellent results were maintained in 28 patients (normal postoperative chest), good results in 5 patients (mild residual pectus) and poor in 2 patients (severe recurrence requiring further treatment). Poor results occurred because the steel bar was too soft in 1 patient, and the sternum too soft in 1 patient with Marfan's syndrome. Our early results with the minimally invasive technique without cartilage incision and resection or sternal osteotomy showed that the procedure is effective with excellent preliminary results.

Key words: pectus excavatum, minimally invasive surgery, children

Introduction

In children with a chest wall deformity it should be possible to remodel the chest wall without cartilage incisions, cartilage resection or sternal osteotomy.^{1–8} By inserting a convex steel bar under the sternum through a small lateral thoracic incisions without cartilage resections or sternum osteotomy, it is possible to correct even a severe degree of pectus excavatum¹. This report presents our experience with minimally invasive procedure over a three-year period.

Subjects and Methods

From 2001 to 2004, 35 patients with pectus excavatum had minimally invasive surgery. There were 26 boys and 9 girls and a sex ratio of 3:1. All pectus excavatum patients underwent an exercise and posture program and preoperative follow-up at 6 months intervals.

The indication for reconstructive surgery was based on the severity of the defects in 20 patients (57.1%). The

severity of pectus excavatum those patients were defined clinically without clinical signs and symptoms. Other 15 patients (42.9%) had clinical signs and symptoms listed in Table 1. The age of the patients at the time of surgery varied from 8 to 21 years with the maximum number of patients ranging from the 10 to 16^{3,4}.

Patients underwent evaluation by case history and physical examination, chest X ray, complete blood count, PT, PTT and urinalysis. All patients had cardiology and pulmonology examinations. Computed tomography (CT) scans were performed on 8 patients to document the severity of the deformity⁸.

Surgical technique

Before 2001 our technique included anterior thoracic incision, resection of cartilage and insertion of a steel bar². Since 2001 a steel bar has been inserted through a lateral thoracic incision without sternal osteotomy and cartilage resections. Before operative surgery the patient's chest was measured and the correct length steel

TABLE 1
CLINICAL SIGNS AND SYMPTOMS IN EXAMINED PATIENTS

Symptom	N of patients	%
Exercise intolerance and dyspnea	5	33.3%
Chest pain with exercise	5	33.3%
Arrhythmia	3	20.0%
Asthma	1	6.7%
Marfan's syndrome	1	6.7%

bar selected and bent with the bar bender. One day before operative procedure all patients were given cefazolin. The operation was performed under endotracheal anesthesia and epidural block (for postoperative pain control). The patient was positioned with both arms abducted. When patient was in good position the previously bent steel was molded to contour to the anterior chest wall curvature. A transverse incisions was made in each lateral chest wall in middle axillary lines. A skin tunnel was raised anteriorly and a thoracostomy was performed at the top of the ridge with curved Kelly clamp. The incidence of major complications of the procedure has been reduced by video-assisted thoracoscopy during placement of the pectus bar. A tunnel was created through the mediastinum under the sternum until it emerged on the opposite side. Two strands of umbilical tape were pulled through the mediastinum. One strand was then used to guide for the previously prepared steel bar and the bar was passed under the sternum with the convexity facing posteriorly. When the bar was in position, it was turned around 180 degrees and raising sternum and anterior chest wall into a new and good position. We placed two bars in reoperation of only one 21 year old patient where steel bar was too soft. The bar was secured with one stabilizer and heavy sutures to the lateral chest wall muscles in children under 14. The bar was secured in older children with 2 stabilizers. In 35 patients undergoing minimally invasive pectus repairs, single bars were used in 65% (23 patients) and double in 35% (12 patients). Before closing the incisions, positive expiratory pressure (4 to 5 cm H₂O) was added to prevent pleural air trapping. The wounds were closed in layers. The chest radiogram was obtained to check for pneumothorax. For the first few days patients were kept well sedated to prevent displacement of the bar. Regular activity was permitted after 2 months. Two years after the operative treatment the bar was removed under general anesthesia.

Results

Out of 35 patients who had minimally invasive operations, 4 patients were under 10 year old, 19 patients were between 10 and 14 years old, 11 patients were be-

tween 14 and 16 years old. One patient was 21 year old. The length of hospitalization varied from 6 to 15 days (average 8 days). Blood loss was minimal, average 25 ml, and none of the patients required transfusion. Complications in 35 minimally invasive procedure patients included pneumothorax in 5 cases. In 4 patients pneumothorax was small and it resolved spontaneously. In one patient tube thoracostomy was responded. Postoperative pneumonia developed in 3 patients and that patients responded to supportive care (physical therapy and ceftriaxon). In one patient steel bar was too soft and it was necessary to remove steel bar and reimplantant 2 bars. We have had 1 patient with bar displacement and it was necessary additional fixation. In patient with Marfan's syndrome sternum was not strong enough and

TABLE 2
COMPLICATIONS AMONG STUDIED PATIENTS

Pneumothorax	Resolved spontaneously	5
	Required thoracostomy	1
Pneumonia	Physical and antibiotic therapy	3
Reoperation needed	Bar displacement	1
	Required 2 bars	1
	Marfan's patient requiring open repair	1

collapsed above and below the metal bar. It was necessary to reoperation by cartilage resection and sternal osteotomy^{5,6} (Table 2).

Discussion

Since 2001 minimally invasive procedure has become the standard in our hospital for treatment pectus excavatum. Before 2001 we used cartilage resections, sternal osteotomy and fixation of the sternum in normal position. The old procedure was also successful but operating time was longer, there was increased blood loss, rib growth was sometimes impaired, scars over thorax is visible and duration of hospitalization is longer. The advantages of this minimally invasive procedure are numerous: there is no anterior chest wall incision, the scars are invisible, operating time is short, there is minimal blood loss and early return to normal activity. The minimally invasive endoscopic pectus repair is safe and effective and currently our procedure of choice for pectus excavatum. Endoscopic visualization facilitates the safe creation of the retrosternal tunnel.

Our early results with the minimally invasive technique without cartilage incision and sternal resection or sternal osteotomy showed that the procedure is effective with excellent preliminary results⁷.

REFERENCES

1. FONKALSRUD, E. W., *World J. Surg.*, 27 (2003) 502. — 2. HO-SIE, S., T. SITKIEWITCZ, C. PETERSEN, P. GOBEL, K. SCHAARSCHMIDT, H. TILL, *Eur. J. Pediatr. Surg.*, 12 (2002) 235. — 3. NUSS, D., D. P. CROITORU, R. E. KELLY Jr., M. J. GORETSKY, K. J. NUSS, T. S. GUSTIN, *Eur. J. Pediatr. Surg.*, 12 (2002) 230. — 4. HALLER, J., A. Ann. Thorac. Surg., 60 (1995) 88. — 5. ARN, P. H., L. R. SCHERER, J. A. HALLER Jr., R. E. PYERITZ, *J. Pediatr.*, 115 (1989) 230. — 6. PARK, H. J., C. S. LEE, W. YOUM, K. R. LEE, *Ann. Thorac. Surg.*, 77 (2004) 289. — 7. CROITORU, D. P., R. E. KELLY, M. J. GORETSKY, M. L. LAWSON, B. SWOVELAND, D. NUSS, *J. Pediatr. Surg.*, 37 (2002) 437. — 8. SIGALET, D. L., M. MONTGOMERY, J. HARDER, *J. Pediatr. Surg.*, 38 (2003) 544.

M. Žganjer

Children's Hospital Zagreb, Department of Pediatric Surgery, Klaićeva 16, 10000 Zagreb, Croatia
e-mail: mirko.zganjer@zg.htnet.hr

TROGODIŠNJE ISKUSTVO U LIJEČENJU LJEVKASTOG PRSNOG KOŠA POŠTEDNOM OPERATIVNOM METODOM U HRVATSKOJ

SAŽETAK

Cilj ove studije je bila procjena ranih rezultata trogodišnjeg iskustva u liječenju ljevkastog prsnog koša poštednom operativnom metodom, koja ne zahtijeva izrezivanje hrskavica niti rezova prsne kosti. Od 2001. godine operirali smo 35 djece poštednom operativnom metodom u našoj bolnici. Savijena metalna pločica postavi se ispod prsne kosti kroz male postranične rezove. Savijena pločica se postavi tako da su krajevi pločice okrenuti prema van, a savijeni dio je unutar prsnog koša, te se zatim pločica okrene za 180 stupnjeva. Nakon 2 godine, kada se ispravi deformitet prsnog koša, pločica se izvadi. Od komplikacija smo zabilježili 5 bolesnika sa zrakom u prsnoj šupljini (1 je zahtijevao kirurško liječenje, 4 su se povukla spontano), upalu pluća smo zabilježili kod 3 pacijenta i pomak pločice kod jednog pacijenta. Prosječno smo pratili bolesnike između 3 mjeseca i 3 godine. Početni odlični rezultati su bili kod 28 bolesnika (normalni izgled prsnog koša), dobri rezultati kod 5 pacijenata (manje naznačeni deformitet) i loši kod 2 pacijenta (jaki deformitet koji je zahtijevao novi operativni zahvat). Loši rezultati su nastali kod jednog bolesnika, jer je pločica bila previše slaba, a kod jednog jer je bolovao od Marfanove bolesti. Rani rezultati ove metode, bez izrezivanja hrskavica rebra i bez rezova na prsnoj kosti, su pokazali izvrsne rane rezultate.