



## Customized silicone implant for the correction of acquired and congenital chest wall deformities: A valuable option with pectus excavatum



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### ABSTRACT

**Background:** Surgical remodeling and correction of congenital and acquired chest wall deformities (CWD) is undertaken many times for cosmesis. Although reportedly minimally invasive, commonly used Nuss procedure for correction of pectus excavatum (PE) is not without complications. Nuss procedure is also not suitable for complex deformities and Poland syndrome cases. Insertion of custom-made silicone implants for the reconstruction of defects has been adopted from adult plastic reconstructive surgery as primary repair of CWD or rescue procedure for recurrence of PE after recurrence or residual deformity.

**Methods:** We present our experience with CWD reconstruction in children with customized silicone prosthesis made from a surgically implantable liquid silicone rubber (NuSil MED-4805, Ca).

**Results:** Since 2006 we treated 26 patients with CWD: six were children (age <17 years, median 14.6) with PE. Implants were custom made for each patient's chest. The implants were inserted under general anesthesia. Postoperatively all patients were fully satisfied with the cosmetic result and subjective patient satisfaction remained excellent at follow-up in all the children. Only one child developed postoperative complications (seroma).

**Conclusions:** Customized silicone implant for PE in the pediatric age is an alternative therapeutic method, as primary or rescue treatment, with equally good cosmetic outcome, fewer significant complications, less postoperative pain and a faster recovery.

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Chest wall deformities (CWDs) can be congenital and acquired. Congenital CWD may manifest any time between birth and early adolescence. Acquired CWDs typically follow thoracic surgery or radiotherapy. The most common congenital CWD is pectus excavatum (PE) which varies in severity from mild, asymptomatic deformity to very severe one with cardiac or pulmonary compression causing obstructive dysfunctions as well as psychosocial effects [1]. Pectus excavatum is corrected surgically: for nearly 50 years the open Ravitch procedure was the main treatment superseded by the minimally invasive Nuss procedure in the 1990s [2]. Both procedures are not free from risks, and, regardless of the approach, recurrence rate can vary from 2% to 37% [3].

A less invasive surgical option for CWD is the use of custom-made silicone implant to improve appearance. This approach involves the use of a silicone implant inserted subcutaneously to 'fill in' and therefore improve the appearance of the deformity. This technique has been adopted in adult patients as primary repair of CWD or rescue procedure for recurrence of PE after Nuss bar removal. This procedure is obviously suitable for patients with CWD which present mainly cosmetic issues and in whom the cardiorespiratory functions are not compromised by the defect. This technique in fact does not change the shape of the

bony component of the chest wall and thereby does not relieve the impairment of the cardiorespiratory function in severe constrictive cases.

We describe our experience with silicone implants in a series of 26 patients with congenital and acquired CWD. Six of the patients were under 16 while three patients were young adult (age between 17 and 21 years): to the best of our knowledge, this is the largest report of a series of children with PE who have undergone treatment by insertion of a silicone implant.

### 1. Materials and methods

Between 2006 and 2013 twenty-nine cases of CWD were referred for silastic implant insertion consideration. All patients had asymptomatic deformities. However, the negative psychosocial effects caused by the CWD prompted the referral to us. All therapeutic options, surgical and conservative, were discussed: the decision to proceed to implant insertion was reached from the patients after the open and informed discussion. Three patients were excluded: one with PE and one with Poland's syndrome were in fact treated with fat transfer, while one patient with complex large PE was considered not suitable for prosthesis implantation. Twenty-six patients were eventually treated with silastic implant insertion: median age of the entire group of patients was 25 (14–40 years). The patients had different acquired or congenital chest wall deformities (Table 1). The most common deformity was congenital PE (18 patients).

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**Table 1**

Patients demographics and defect types.

CWD type	Number of patients	Gender	Children (<17 years old)	Complications
Pectus excavatum	18	11 M 7 F	6 All male	2 patients had seroma
Poland's syndrome	6	M	–	–
Infection related defect following breast implants	1	F	–	–
Radiotherapy induced deformity	1	F	–	–
Total number	26			

Six patients with PE were children under 17 years of age (median 14.6, all boys and postpubertal). Two children had moderate recurrence following removal of the Nuss bar, while 4 other boys elected to have a chest wall implant as a primary procedure and alternative to the Nuss operation. The children were initially assessed by the Thoracic Service of a tertiary pediatric hospital before being referred to the Plastic and Reconstructive Department of the local adult hospital. In our institution we offer the Nuss procedure to postpubertal children (>13 years) and remove the bar after two years.

The children within the PE group did not have cardiorespiratory symptoms related to their chest wall deformity: routine assessment with echocardiogram and pulmonary function test was performed in all with normal results.

We do not perform routine radiological assessment with computer tomography in children with asymptomatic, mild to moderate PE, and normal cardiorespiratory work out. We usually obtain a baseline, pre-operative assessment of the PE with plain radiography, sparing those children from the potential risks associated with ionizing radiations.

Silicone implants were custom made for each patient's chest. A copy of the chest wall defect and the surrounding area was obtained by taking an impression: this can be done by laser scanning, 3D photography or by conventional means using dental impression materials (cement plaster). In female cases where the defect is under breast tissue, a CT scan was required to identify the underlying defect.

A rapid prototype model was produced once chest wall impression was obtained digitally, or, if conventionally taken, by a cast produced in cement plaster (Figs. 1 and 2).

Most of our cases have had customized silicone implants constructed by using an anterior chest wall cast produced in cement plaster which is our preferred method.

A wax model of the prosthesis is then generated on the plaster cast model of the anterior chest wall defect. The wax prosthesis is then placed on the patient chest for the initial evaluation and corrections. The waxed master model is flashed, the wax is boiled out and the cocoon is injected with fluid implant grade silicone rubber (NuSil Med 4805, Nusil, California). The capsular contracture is prevented by roughening the surface before injecting the silicone. Finally the implant is sterilized by gas (ethylene oxide) before insertion.

The implants were inserted under general anesthesia into a subcutaneous pocket created from a low chest transverse incision away from the deformity (Fig. 3). The subcutaneous position reduces postoperative pain significantly and allows discharge as day-case.

The implant was then fixed to the pectoralis muscles and rectus fascia with Prolene sutures and the incision closed. A suction drain was left in situ if considered necessary by the surgeon at the time.

## 2. Results

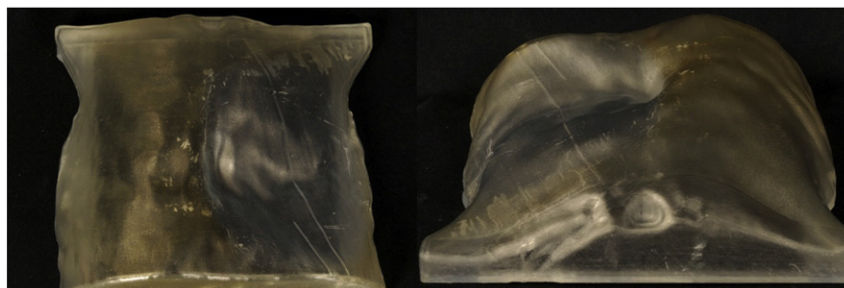
The procedure was performed uneventfully in all patients and the mean surgical time was 60 min. All children were discharged home on postoperative day 1 with simple analgesia. Either boy who had previously undergone a Nuss procedure reported a significant reduction in postoperative pain. The entire PE group (adult and children) had been able to return to full activities much quicker (two weeks) than would be expected with a Nuss procedure. Two patients with PE, including a child, required aspiration under local anesthetic of a seroma followed by compression dressings. No other complications were reported in the other patients. None of the patients in our study experienced displacement or malposition problems.

Following the procedure all patients were fully satisfied with the cosmetic result (Fig. 4) and subjective patient satisfaction remained excellent at follow-up (median 2 years, range 6 months–6 years) in all the patients of both adult and pediatric group.

## 3. Discussion

Surgical remodeling of the chest skeleton is the principle behind correction of the most common congenital CWD. Pectus excavatum is the most common congenital CWD occurring in 1 in 400 to 1 in 1000 children. Pectus excavatum varies in severity from mild, asymptomatic deformity to very severe deformity which can cause cardiac or pulmonary compression giving symptoms of dyspnea on exertion, chest pain with or without exertion, and lack of endurance. The condition is often noticed at birth but rapid bone growth in the early teenage years often worsens the cosmetic appearance of the deformity and leads to presentation to a specialist at this age. The Ravitch procedure was the main treatment to correct PE deformity until the minimal invasive Nuss bar insertion supplanted it.

The open Ravitch procedure involves major surgery with high risks of morbidity and complications, while not all pediatric thoracic centers are able to provide the thoracoscopic assisted Nuss bar insertion. Furthermore, the same minimally invasive procedure is not free from operative risks, being associated with considerable postoperative pain,



**Fig. 1.** Prototype model of chest wall deformity (asymmetric PE) created with digital scanning.

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