Customized Titanium Implant for Chest Wall Reconstruction in Complex Poland Syndrome

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Summary: This report describes a new method for the surgical repair of the chest wall deformity encountered in complex Poland’s syndrome. In this report, we describe the use of a customized titanium implant that was used to replace the missing second through fifth ribs and to provide chest wall stabilization before breast reconstruction. This approach might be considered an alternative to autologous rib grafting in patients who have reached skeletal maturity.

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Received for publication September 19, 2013; accepted December 18, 2013.

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DOI: 10.1097/GOX.0000000000000047

CASE REPORT

A 16-year-old girl presented with right-sided Poland’s syndrome, manifested by absence of the pectoralis major and minor muscles and hypoplasia of the second through fifth ribs that resulted in a 5 cm by 4 cm right lung herniation through the defect. She also presented with sternal rotation toward the affected side, ipsilateral amastia and athelia, an abnormally high insertion point of the right rectus abdominis muscle, a missing serratus anterior muscle, and brachysyndactyly (Fig. 1).

A customized titanium implant (Biomet Inc., Warsaw, Ind.) was designed to replace the missing ribs and to fit the defect that would be created by sternal osteotomies to correct the malrotation (Fig. 2). To obtain a customized implant, preoperative planning consisted of three-dimensional thoracic computed tomography scan. The implant was then designed around an approximate position once the ribs and sternum were rotated into position. Using preop-
operative computer modeling, we estimated that with the implant in place the right lung volume would increase by 32% (\(\% = \frac{\text{Change in right lung volume}}{\text{preoperative right lung volume}} \times 100\) as measured from the scanned images = 332.23 cm\(^3\)/1036.14 cm\(^3\)).

At the time of surgery (Fig. 3), the involved ribs were circumferentially exposed and trimmed to fit the prosthesis without difficulty. Before final implantation, a 10 × 15 cm Gore-Tex patch was placed over the pleural defect to serve as a barrier between the right lung and the prosthesis. The implant was then covered with a myocutaneous latissimus dorsi flap which was also posteriorly attached to the inferior angle of the scapula to prevent its winging. Eight months after chest wall reconstruction, a tissue expander (Siltex Medium Height Contour Profile; Mentor Worldwide LLC, Santa Barbara, Calif.) was placed underneath the latissimus muscle on top of the titanium implant (Fig. 4). Implant/tissue expander exchange was completed 5 months after tissue expander implantation. At the time of expander/implant exchange, the implant was well covered by the capsule surrounding the expander. There was no obvious edge or surface of the titanium implant that appeared to place the implant (Siltex Round Moderate Classic Profile Gel-filled Breast Implant, Mentor Worldwide LLC) at risk for rupture or puncture. A routine chest x-ray at 16 months after placement of the titanium implant demonstrated no evidence of rib fracture or implant migration.

**DISCUSSION**

The surgical approach for the complex thoracic deformity in Poland’s syndrome partially depends on the patient’s age. It is recommended that children with severe deformities go through a 2-stage repair, with the first stage starting in early ages and limited to a thoracic cage. Thoracic cage repair should be considered at an early age when patients present with dyspnea or when the lack of structural support could result in scoliosis. The second stage, involving
a musculocutaneous flap, should be delayed until after puberty, especially in females because of breast development. Additional stages of reconstruction can include expanders, breast implants, nipple and areolar reconstruction, and fat grafting. Of note, in females with complex Poland’s syndrome, breast reconstruction only with an implant and a latissimus flap would likely not produce an adequate, symmetric outcome without a preceding reconstruction of the chest wall.1

The traditional technique used to repair severe thoracic cage anomalies involving the absence of the anterior ribs requires subperiosteal grafts from the contralateral fifth or sixth ribs or their cartilages. These grafts are then split, exposing the bone marrow and potentially resulting in better revascularization. The harvested grafts are secured medially to notches made in the sternum and laterally sutured to drill holes in the involved ribs. The harvested rib’s periosteum (or perichondrium) is left in situ to allow rib regeneration. A simultaneous transverse sternotomy is performed to reposition the sternum.6

The novel surgical approach taken on our patient was chosen to avoid several, potential complications known from the traditional technique. Among them, Sawin et al7 cite pneumothorax and intercostal neuralgia. Ohara et al9 report more serious complications associated with these grafts, such as chest wall deformity and thoracic scoliosis resulting from the weakened donor area. Other potential complications include lack of adequate fixation of the rib grafts, resorption, and residual or chronic pain

![Fig. 3. Intraoperative photographs showing the titanium implant in place (A) and after its coverage with a latissimus dorsi myocutaneous flap (B).](image)

![Fig. 4. Postoperative photographs, anterior and lateral view, with tissue expander in place.](image)
at the harvest site.\textsuperscript{8,9} Of note, the cost of a customized implant may be substantial. For our patient, the list price for the customized implant was $5310.00 for the sternal plate plus $12,340.00 for the chest wall/rib kit.

CONCLUSIONS

In summary, in patients with complex Poland syndrome who have reached skeletal maturity, reconstruction of the thoracic cage with a customized titanium implant should be considered. It avoids rib grafts and improves chest wall symmetry.

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