# Prosthetic Reconstruction of the Chest Wall

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**KEYWORDS**

• Chest wall • Biologic mesh • Prosthetic mesh • Methylmethacrylate • Osteosynthesis

**KEY POINTS**

- Less than one-third of patients undergoing chest wall resection will require prosthetic reconstruction.
- Prosthetic reconstruction should be limited to resections larger than 5 cm, including 4 or more ribs, including the sternum, and/or located on the lateral or infero-anterior chest wall.
- A variety of materials are available for reconstruction, including synthetic and biological meshes, flexible and rigid patches, and metal osteosynthesis systems.
- The prosthesis should be carefully sized and implanted in order to create a tight closure to avoid billowing and paradoxic motion with respiration.
- Prosthetic chest wall reconstruction can be completed with excellent functional and cosmetic results.

## INTRODUCTION

Resection of the chest wall is at times necessary for several conditions, including neoplasms, congenital defects, radiation injuries, and complicated infections. Such resections often result in large defects of the chest wall, which can lead to skeletal instability, altered respiratory mechanics, and significant cosmetic defects. Reconstruction of these large defects of the chest wall can present an arduous challenge for even the most experienced surgeons.

Overall, there are 6 objectives to reconstruction of the chest wall (**Box 1**). The surgical approach to chest wall reconstruction can be divided into 2 phases completed in single stage surgery:

- Restoration of skeletal integrity
- Soft tissue coverage/reconstruction

Here, the authors review the indications, alloplastic materials available (synthetic, biological, and metallic), and surgical technique for prosthetic reconstruction of the skeletal chest wall. Further discussion of autologous flap reconstruction, however, is completed elsewhere in this issue.

## INDICATIONS FOR RECONSTRUCTION

Thoughtful consideration should be given when determining which patients require skeletal reconstruction. Careful consideration regarding chest wall stability and integrity is of paramount importance as, in the case of large defects, this may have a substantial impact on postoperative respiratory mechanics and quality of life.[1–3] In fact, most patients who undergo limited resections will not require any prosthetic reconstruction for stabilization. Typically, resections involving 2 to 3 ribs, or less, do not require stabilization of the chest wall. Soft tissue reconstruction alone is all that is needed in these situations. However, larger defects (>5 cm) including 4 or more ribs will typically require skeletal reconstruction with either biological, alloplastic, or synthetic materials.[4] Location of the defect must also be carefully considered. Defects located under the scapula posteriorly or the pectoralis major muscle anteriorly typically do not require prostheses as these structures provide sufficient coverage and rigidity. Similarly, posterior chest wall resections adjacent to the spine typically do not require reconstruction for

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**Box 1**
**Objectives of chest wall resection**

- Restoration of chest wall rigidity
- Prevention of lung herniation
- Avoiding contraction of the chest wall
- Prevention of trapping of the scapula, particularly when resection involves ribs 5 and 6
- Protect underlying mediastinal organs after sternal resection
- Good cosmetic result

stability. On the other hand, lateral or infero-anterior resections, along with resections of the sternum, will typically require prosthetic reconstruction both for stability as well as coverage of vital intrathoracic structures given the relative lack of major muscle coverage in these areas.

The impact of chest wall resection on pulmonary function remains somewhat controversial. The available literature on this topic is limited to mostly retrospective data, clouded by varying degrees of pulmonary resection required and limitations from selection bias. Certainly, smaller resections will have little effect on pulmonary function. Traditional teaching suggests that larger resections can result in flail segments and paradoxic respiration. There is little available literature to support or refute this teaching, though it does make some degree of physiologic sense. Rigid stabilization of the chest wall in this setting may result in decreased postoperative ventilator requirement, improved pulmonary function, and less discomfort.[5–7] In fact, one study examining long-term results of full-thickness chest wall resection did not identify a difference in preoperative and postoperative pulmonary function after chest wall resection with prosthetic reconstruction and a potentially greater reduction in postoperative pulmonary function if no prosthesis was used.[1]

## PROSTHETIC MATERIALS AVAILABLE

The first reported use of a metal prosthesis was in 1909.[8] With significant advances and refinement, a variety of materials are now available to the surgeon for prosthetic chest wall reconstruction, including biologic, alloplastic, and synthetic materials (**Box 2**). The ideal prosthetic material for chest wall reconstruction should have the following characteristics.

- Rigid enough to abolish paradoxic chest wall motion
- Malleable enough to allow for appropriate contouring
- Physically and chemically inert
- Allows for tissue in-growth
- Radiolucent
- Sterile and resistant to infection
- Inexpensive

**Box 2**
**Materials used for chest wall reconstruction/ stabilization**

*Synthetic mesh*

- Methylmethacrylate
- Polyglactin (Vicryl, Ethicon, Inc, Somerville, NJ)
- Nylon
- Polypropylene (Marlex, Davol & Bard, Cranston, RI, and Prolene, Ethicon Inc, Somerville, NJ)
- Polytetrafluoroethylene (Dualmesh, W.L. Gore & Associates, Flagstaff, AZ)
- Silastic
- Silicone

*Bioprosthetic materials*

- AlloDerm (LifeCell Corporation, Branchburg, NJ)
  - Cadaveric human dermis
- Surgisis (Cook Biomedical, Bloomington, IN)
  - Porcine small intestine submucosa
- Permacol (Covidien, Norwalk, CT)
  - Porcine dermis
- XenMtrix (Davol Inc, Warwick, RI)
  - Porcine dermis
- Strattice (LifeCell Corporation, Branchburg, NJ)
  - Porcine dermis
- Tutopatch (RTI Surgical, Alachua, FL)
  - Bovine pericardium
- Veritas (Baxter, Deerfield, IL)
  - Bovine pericardium
- SurgiMend (Integra Life Sciences, Plainsboro, NJ)
  - Bovine dermis

*Osteosynthesis systems*

- Stratos (MedXpert GmbH, Heitersheim, Germany)
  - Titanium
- MatrixRIB Fixation (DePuy Synthes, West Chester, PA)
  - Titanium
- Stainless steel bars