Constrained (Rotator Cuff Substituting) Total Scapula Prosthesis Following Tumor Resection

James C. Wittig, MD
Jacob Bickels, MD
Kristen Kellar-Graney, BS
Martin Malawer, MD

Washington Cancer Institute, Washington DC
National Cancer Institute, NIH
Background

• Shoulder Girdle: 3rd most common site for sarcoma

• Most common tumors of the scapula:
  • Ewing’s sarcoma
  • Osteosarcoma
  • Chondrosarcoma
  • Metastatic Hypernephroma/Lung CA
  • Periscapular Sarcomas
Treatment

Limb-Sparing Resection

- Tikhoff-Linberg Type Resection (extraarticular total scapulectomy)
- Intra-articular Total Scapulectomy

Ewing’s Sarcoma

Clavicle

Glenoid

Classical Tikhoff-Linberg

Humeral Head
Anatomic Reconstruction

- Restores the scapula with a metallic endoprosthesis
- 23 pts total scapula resection; 15 prosthetic replacements
- Utilizes the remaining periscapular muscles for soft tissue reconstruction
- Restoration of both *Glenohumeral* and *Scapulothoracic* mechanisms
- Restores *Muscle Force Couples*
Scapular Design

- Non-Constrained Components (Earlier Versions; n=12)

Modular Proximal Humerus

Superior Border

Axillary Border

Non-Constrained Components

Dacron Tape

Gore-tex Aortic Graft

Sutured to Scapula Neck

Capsular Reconstruction
Gore-tex aortic graft
Non-Constrained
10 yr Follow-UP

Non-Constrained
10 yrs post-op
Excellent elbow flexion
Constrained Component

Why Designed??
- Improve stability
- Mechanically restore rotator cuff function more efficiently (gore-tex elastic)
- Ease surgical reconstruction

Prevents Superior Humeral Migration!

Forces Dissipated
Angular Acceleration Improved
Constrained Components

Body
• Down-sized
• Holes for myodesis
• Vacant area

Glenoid
• Bipolar hip
• Captured polyethylene liner
Constrained Total Scapula

Constrained Glenoid

***SNAP FIT DESIGN***
Motion

Holes for Myodesis of Periscapular Muscles
Purpose

- To describe the indications and surgical technique for total scapular prosthetic reconstruction following tumor resection

- Report preliminary functional results and complications with constrained total scapula reconstruction
Indications

Muscle Force Couples

• Required: Periscapular Muscles and Axillary Nerve
  • Trapezius
  • Deltoid
  • Latissimus
  • Rhomboids
  • Serratus Anterior
Patient Demographics

- Three Patients (all males)
- Ages: 13 yrs, 16 yrs, 26 yrs
- Follow-up: 7 mos, 15 mos, 20 mos

**Diagnoses:**

- Recurrent High Grade OS – Scapula Neck
- Ewing’s Sarcoma
- Undifferentiated HG Soft Tissue Sarcoma—Subscapularis with invasion of the Scapula

***All received induction chemo

- Function assessed according to MSTS System
Patient Demographics

- 26 y.o. male
- Navy S.E.A.L.
- 9x7x11 cm mass
- Anterior surface of scapula/subscapularis
- High grade undifferentiated sarcoma
- Multiple pulmonary nodules
- DOD at 7 mos post-op
Extensive Necrosis Post-Chemo
Ewing’s Sarcoma

- 17 y.o. male with a Ewing’s sarcoma of the right scapula
- Good response to induction chemo
- Complete resolution of soft tissue component
- AWD at 15 mos
Pre-Chemo MRI

Ewing's Pre-Chemo
Post-Chemo CT

Ewing's
Post Chemo CT
Complete Response
Recurrent Osteosarcoma

- 13 y.o. boy
- Telangiectatic OS of proximal humerus
- Tx in Macedonia with intraarticular resection and recon with fibula
- Local recurrence along inferior scapular neck
- Failure of hardware
- ANED at 20 months
Surgical Procedure

- Resection: combined anterior and posterior approach
- Neurovascular bundle explored and mobilized
- Tumor explored
- Required muscles preserved, when feasible
Reconstruction

- Prosthesis placed close to midline
- **Pocket between Serratus Anterior and Rhomboids**
- All other periscapular muscles transferred and tenodesed
- Latissimus mobilized
- Proximal humerus snapped into place (Gore-tex)
- Entire prosthesis covered with soft tissue
Soft Tissue Reconstruction

Prosthesis Placed Between Serratus Anterior and Rhomboids
Muscle Force Couples

Soft Tissue Reconstruction

- Cranial portion of trapezius
- Deltoids
- Caudal portion of trapezius
- Rhomboids rotated to cover prosthesis
- Triceps
- Latissimus dorsi
Entire Prosthesis Covered

Soft Tissue Reconstruction

- Trapezius
- Deltoid
- Triceps
- Latissimus dorsi

The entire prosthesis is covered!
Intraoperative View

Arm

Trapezius

Latissimus
Intraoperative View

Deltoid
Trapezius
Latissimus
Rhomboids
Postoperative AP

Post-op AP Radiograph
Postoperative Lateral
Postoperative Axillary

Post-op Axillary Radiograph
Postoperative Function

MSTS Score: 24-27/30 (Consistent Results)
Pain: 5  (All pain free)
Hand Dexterity: 5 (Normal)
Emotional Acceptance: 5 (All enthused)
Lifting Ability: 3-4 (Normal at side of body)
Hand Positioning: 3-4  (Hand above shoulder)
Function/Activities: 3-4 (Athletic restrictions)
Function

- All shoulders stable
- Functional hand and elbow
- Scapular protraction, retraction and elevation intact (Assist in stabilizing extremity when carrying objects)
- No complications
13 y.o.:
6 mos post op
Normal elbow flexion
Some FF of Shoulder
1 yr post-op
Cosmesis Good
Trap Function Good
Strong Biceps
Hercules!!!
Conclusions

• Total scapula prosthetic reconstruction appears to be a safe and reliable method for anatomically reconstructing the shoulder girdle following total scapulectomy

• The following periscapular muscles must be preserved for soft tissue coverage and reconstruction of the muscle force couples (Deltoid, Trapezius, Rhomboids, Serratus Anterior, Latissimus) and axillary nerve
Conclusions

• It permits reconstruction of the glenohumeral and scapulothoracic mechanisms, both functionally important
• Constrained components ease reconstruction
• Further follow-up is necessary to determine if the constrained versions provide an improvement in function over non-constrained versions
Reconstruction Options

Non Anatomic Methods
- Glenohum and Scapulothor Mechanisms Not Reconstr
- No Recon—Flail Shoulder
- I.M. Rod or Spacer
- Attach Humerus to Clavicle or Rib

Problems:
- Unstable Extremity
- Poor Lifting Ability
- Remaining Periscapular Muscles Not Utilized
- Chronic Traction Neuropraxia
- Pain
- Frequent Complications
- Hardware Failure
Indications

- Primary high grade and select low grade scapula sarcomas
- Periscapular soft tissue sarcomas invading the scapula
- Select metastatic carcinomas with extensive scapular destruction and a soft tissue component, especially radioresistant lesions