CHAPTER 13

TRUNK RECONSTRUCTION

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I. ABDOMINAL WALL ANATOMY

A. Layers of the Abdominal Wall (Figure 1)
   1. Skin
   2. Subcutaneous tissue
   3. Scarpa's fascia
      a. Superficial fascial system
      b. Approximated during layered closure of abdominal wall to prevent contour irregularities within the scar
   4. Lateral Musculature
      a. External Oblique
         i. Muscle fibers run inferomedially
            (a) Inferomedially= same direction as your hands in pockets
      b. Internal Oblique
         i. Muscle fibers run superomedially
         ii. Neurovascular bundles lie between the internal oblique and transversus abdominis
            (a) Abdominal wall supplied by ventral rami of T7-L4
      c. Transversus Abdominis

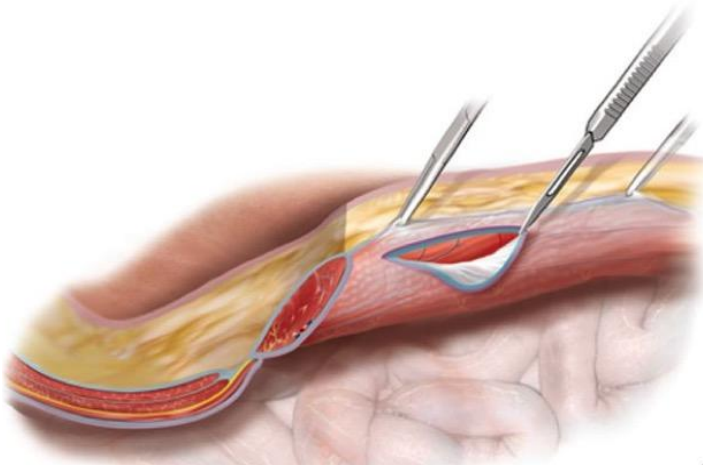

Figure 1. Abdominal wall anatomy
From Petro C, et al. Permissible Intraabdominal Hypertension following Complex Abdominal Wall Reconstruction. Plast Reconstr Surg 2015;136(4):868-881.

   5. Medial Musculature

a. Rectus abdominis
    i. Above the arcuate line
        (a) Anterior rectus sheath composed of external oblique fascia and internal oblique fascia above the arcuate line
        (b) Posterior rectus sheath composed of internal oblique fascia (splits to contribute to anterior and posterior rectus sheaths) and transversus abdominis fascia
    ii. Below the arcuate line
        (a) Anterior rectus sheath composed of external oblique fascia, internal oblique fascia, and transversus abdominis fascia
        (b) No posterior rectus sheath (layers behind the rectus abdominis muscle at this level are the transversalis fascia and parietal peritoneum)
6. Transversalis Fascia
7. Parietal peritoneum

B. Zones of the Abdominal Wall
1. Huger zones: used to delineate anatomic regions of perfusion
    a. Zone 1: region between xiphoid, pubic symphysis, and linea semilunaris
        i. Perfused by the deep inferior epigastric arteries
    b. Zone 2: region between anterior superior iliac spines bilaterally, pubic symphysis, and groin creases
        i. Perfused by superficial circumflex femoral arteries, external pudendal arteries, and superficial inferior epigastric artery
    c. Zone 3: region lateral to rectus muscles
        i. Perfused by intercostal perforators

II. GOALS OF RECONSTRUCTION

A. Provide protection for intra-abdominal viscera
B. Repair and prevent herniation with strong fascial support
C. Prevent recurrence and restore abdominal wall function by maintaining innervation allowing for proper contractility

III. COMMON ABDOMINAL WALL PATHOLOGY REQUIRING RECONSTRUCTION

A. Tumor resection
B. Infection (ex. necrotizing fasciitis)
C. Trauma
D. Recurrent ventral wall hernias
E. Congenital abdominal wall defects (gastroschisis, omphalocele)

IV. RECONSTRUCTIVE ALGORITHIM – ABDOMINAL WALL RECONSTRUCTION

A. Primary closure without prosthetic material
    1. Use for defects that are <3cm
B. Primary closure + prosthetic
    1. Use for defects under tension upon closure
        a. Retro-rectus mesh placement leads to lowest risk of infection compared to other mesh placement locations
            i. If mesh becomes infected or if patient presents with wound concerning for underlying infection, mesh must be removed to eradicate the infection; antibiotics alone are not enough when prosthetic materials are in place
    2. Prosthetic Materials (used in non-contaminated tissue beds):
        a. Many different types are used based on surgeon preference (examples below)
            i. Polypropylene
                (a) Advantages: allows fibrous ingrowth, incorporates into adjacent tissues
                (b) Disadvantages: can erode into bowel and cause fistulas
            ii. PTFE
                (a) Advantages: does not incorporate completely into tissues, so easy to remove if needed
                (b) Disadvantages: does not allow for fluid egress and can lead to wounds
    3. Biologic Materials (used in contaminated tissue beds):
        a. Materials revascularize and incorporate nicely into surrounding tissues, leading to lower risk of contamination
        b. Examples include Alloderm® (Lifecell), Strattice™ (Lifecell), Permacol™ (Medtronic)
C. Components separation + prosthetic
    1. Use for wide defects in which fascia cannot be closed primarily without further release
        a. Release of external oblique at linea semilunaris enables medial transposition of rectus muscle along with internal oblique and transversus abdominis muscles
            i. Advancement attainable: 10 cm in epigastrium, 20 cm at umbilicus and 6 cm in suprapubic region
D. Tissue Expansion
E. Pedicled muscle and myocutaneous flaps (when synthetic mesh and fascial separation are contraindicated)
    1. Antero-lateral thigh (ALT)
    2. Tensor fascia lata
    3. Gracilis
    4. Rectus femoris
    5. Propeller flaps (flaps pedicled on a particular perforator)
F. Free flaps

G. Split thickness skin and/or synthetic mesh directly over bowel (in emergency situations as temporizing measure to facilitate closure; often requires further reconstructive surgery)
H. VAC use can be integrated into the treatment of patients with compromised wound healing
    1. Cases of enteric fistula formation have been associated with the VAC; paradoxically, however, VAC has also been used successfully for the management of fistulae

V. CHEST WALL ANATOMY

A. Skin and subcutaneous tissue
B. Bony structures
    1. Sternum (composed of manubrium, body, xiphoid)
    2. Ribs (12 total)
        a. True ribs (1-7): articulate directly with sternum
        b. False ribs (8-12): articulate with costal cartilages instead of sternum directly
    3. Clavicles
    4. Thoracic vertebrae
C. Musculature
    1. Pectoralis major
        a. Pedicle: thoracoacromial artery, intercostal arteries
    2. Pectoralis minor
    3. Serratus anterior
        a. Pedicle: serratus branch of thoracodorsal artery, lateral thoracic artery
        b. Accessory muscle of respiration
    4. Intercostal muscles
        a. External intercostals: fibers run inferomedially
        b. Internal intercostals: fibers run superomedially
            i. Neurovascular bundles run between the internal and innermost intercostals
        c. Innermost intercostals: fibers run transversely
    5. Diaphragm
        a. Innervated by C3,4,5 nerve roots
D. Pleura
    1. Parietal pleura
    2. Visceral pleura

VI. GOALS OF RECONSTRUCTION

A. Rigid airtight cavity
B. Protection of the thoracic and abdominal contents
C. Optimization of respiration

D. Obliteration of dead space for intrathoracic defects
E. Stable soft tissue coverage
F. Aesthetic reconstruction (whenever possible)
G. Control of infection
H. Removal of foreign bodies

III. COMMON CHEST WALL PATHOLOGY REQUIRING RECONSTRUCTION

A. Trauma
B. Tumor resection
C. Infection (osteomyelitis after cardiac surgery)
D. Congenital anomalies

IV. RECONSTRUCTIVE ALGORITHIM – ACQUIRED CHEST WALL DEFORMITIES (Table 1)

Size of the defect	• Some authors advocate skeletal reconstruction when the defect is four ribs or more[98,99] • Others use the actual size of the defect and believe that defects more than 5 cm in diameter are more likely to benefit from prosthetic reconstruction[92,100] • Soft tissue–only reconstruction is often considered adequate for smaller defects
Location of the defect	• Defects in the anterior (and anterolateral) chest wall require stability reconstruction more often than posterior chest wall because they more mobile and have stronger impact on the respiratory function[101] • Prosthetic stability reconstruction is thought to be required less often in the posterior chest wall than in the anterolateral chest wall because the scapula and its surrounding muscle attachment provide more stability in the former • Small (<5-cm) posterior defects under the scapula or above the fourth rib can often be closed with soft tissue, without reconstructing the skeletal component[97]
Condition of the chest wall	• Radiation leads to chest wall stiffness and fibrosis; therefore, muscle flaps alone often provide enough stabilization for large irradiated defects without causing flail segments[102]

Table 1. Considerations during chest wall reconstruction
From Althubaiti, G, et al. Abdominal wall and chest wall reconstruction. Plast Reconstr Surg 2014;133(5):688e-701e.

A. Remove all foreign bodies including prosthetic materials and sternal wires that commonly harbor biofilm in these settings
B. Primary closure (if possible)
C. Wound vac
    1. Improves respiratory mechanics while patient is undergoing serial debridement prior to definitive coverage
D. Reconstruction of bony defects
    1. Important to reconstruct defects that are >5cm or include removal of 4 contiguous ribs to protect vital structures and improve mechanics of breathing
        a. Alloplastic Materials
            i. Ex. polypropylene, methyl methacrylate, titanium plate fixation
            ii. Pros: no donor site morbidity; rigidity of construct allows for restoration of respiratory dynamics

iii. Cons: foreign bodies increase likelihood of infection requiring explantation; presence of radiation injury also increases complications related to use of prosthetic devices

b. Autologous Materials
   i. rib grafts, free tissue transfer
   ii. Pros: use of autologous tissue allows for incorporation into surrounding wound bed and minimizes likelihood of infection related to foreign bodies
   iii. Cons: donor site morbidity

E. Autologous reconstruction (Figure 2)
1. Loco-regional pedicled flaps
   a. Pectoralis major flap (advancement and turnover flaps possible)
   b. Latissimus dorsi
   c. Rectus abdominis (cannot perform if ipsilateral internal mammary vessels have been used in cardiac surgery cases)
   d. Serratus anterior
   e. Omentum

V. RECONSTRUCTIVE ALGORITHIM FOR CONGENITAL CHEST WALL DEFORMITIES

A. Poland's Syndrome
1. Etiology
   a. Due to kinking of the subclavian artery at week 6 of gestation leading to hypoplasia of the vessel
2. Components
   i. Absence of sternal head of pectoralis major
   ii. Hypoplasia of breast or nipple
   iii. Deficiency of subcutaneous fat and axillary hair
   iv. Bony abnormalities of anterior chest wall
   v. Syndactyly or hypoplasia of ipsilateral extremity
   vi. Shortening of forearm
   b. Treatment
      i. For adolescents, can place subcutaneous tissue expander and perform serial expansions to minimize deformity throughout adolescence
      ii. Once fully developed, consider latissimus dorsi pedicled flap with implant reconstruction or other method of breast reconstruction
         (a) Can use innervated ipsilateral latissimus to recreate anterior axillary fold

B. Pectus Excavatum
1. Depression of the sternum that can lead to cardiovascular/respiratory abnormalities and/or cosmetic deformities
2. Treatment
   a. Consultation and collaboration with pediatric surgery team is critical
   b. Repositioning of sternum to normalize contour
      i. Sternal osteotomies for repositioning

(a) May require a posterior strut for support
(b) Nuss procedure utilizes steel bars for support instead

c. Implantable prostheses can also be used for cases without cardiovascular compromise to restore normal contour to the chest wall

C. Pectus carinatum
1. Excessive protrusion of the sternum
2. Treatment
a. Reconstruction planned in conjunction with pediatric surgery team
b. Repositioning of the sternum and abnormal costal cartilage to restore normal contour

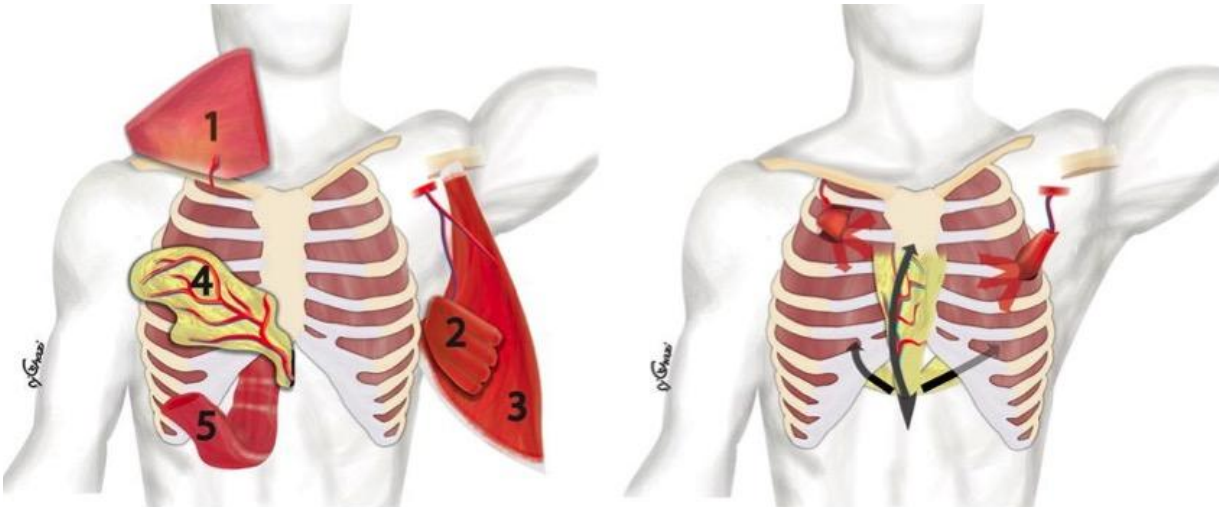

Figure 2. Common Pedicled Flaps for Chest Wall Reconstruction. (Left) Pedicled flaps commonly used to fill intrathoracic dead space: pectoralis major muscle (1), serratus anterior muscle (2), latissimus dorsi muscle (3), omental (4), and rectus abdominis muscle (5) flaps. (Right) The pectoralis major muscle flap is useful for filling upper chest defects. The latissimus dorsi muscle flap is more useful for filling lateral defects. The omental flap can be passed over the ribs or through the diaphragm.
From Althubaiti, G, et al. Abdominal wall and chest wall reconstruction. Plast Reconstr Surg 2014;133(5):688e-701e.

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