The Chest Wall:
A CT Guided Anatomic Atlas and Review of Common Incidental Findings for the Cardiothoracic Radiologist

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World Congress of Thoracic Imaging
June 2017
Disclosures

There are no disclosures pertinent to this presentation
Introduction

• The chest wall muscular anatomy is an aspect of chest CT that can be often overlooked by the cardiothoracic radiologist

• Goals:
  • Review the normal chest wall anatomy on CT
  • Highlight the common normal variations in chest wall anatomy and shape
  • Focus on a few conditions which may distort the normal anatomy
  • Review common chest wall surgeries, including their indications and imaging appearance on CT
KEY:
1. Pectoralis major
2. Pectoralis minor
3. Subscapularis
4. Teres Major
5. Teres Minor
6. Supraspinatus
7. Infraspinatus
8. Latissimus Dorsi
9. Trapezius
10. Long Head of Triceps
11. Deltoid
12. Serratus Anterior
13. Rhomboid
14. Erector Spinae
15. Levator Scapulae
16. Sternocleidomastoid
17. Rectus Abdominis

NOTES:
• **Sternocleidomastoid (16)**
  • Divides neck into anterior and posterior triangles
  • Will often see a portion of the SCM as it attaches to its origin on the manubrium

• **Platysma**
  • Not visualized here, but can be seen on chest CTs as a broad sheet of thin muscle covering the anterior neck
NOTES:

- **Deltoid (11)**
  - Largest shoulder muscle, will commonly see on chest CTs with patient’s arms elevated
  - Innervated by the axillary nerve (C5-6)

- **Levator Scapulae (15)**
  - Connects pectoral girdle to the cervical spine (originates on C1-4 transverse processes)
NOTES:

• Teres Major (4)
  • Will often be confluent with the latissimus dorsi (8)
  • Assists in medial shoulder rotation and shoulder adduction

• Teres Minor (5)
  • Part of the rotator cuff, assists in external rotation
  • Can be difficult to differentiate with infraspinatus in younger, thinner patients

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NOTES:

- **Supraspinatus (6)**
  - The most commonly ruptured rotator cuff muscle
  - Can degenerate in elderly patients leading to instability in the glenohumeral joint

- **Infraspinatus (7)**
  - Assists in laterally rotating the arm
  - Innervated by suprascapular nerve (C5 and C6)
NOTES:

- **Pectoralis Major (1)**
  - Covers much of the anterior chest, inserts on the lateral lip of the bicipital groove of the humerus

- **Pectoralis Minor (2)**
  - Divides the axillary artery into 3 parts
  - Divides axillary lymph nodes into levels
    - I: below inferior edge of p. minor
    - II: underneath/posterior to p. minor
    - III: above/mediad to p. minor
NOTES:

- **Rhomboid (13)**
  - Quadrilateral shaped, helps retract scapula
  - Innervated by dorsal scapular nerve, injury can lead to a winged scapula

- **Long Head of Triceps (10)**
  - Arises from infraglenoid tubercle of the scapula
  - Extends distally anterior to the teres minor and posterior to the teres major
  - Acts in extending forearm; long head stabilizes humeral head in abduction

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NOTES:

• Erector Spinae (14)
  • From lateral to medial:
    • Iliocostalis
    • Longissimus
    • Spinalis
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NOTES:
- **Subscapularis (3)**
  - Part of the rotator cuff
  - Inserts on the lesser tuberosity of the humerus and assists in internal rotation
NOTES:
- **Trapezius (9)**
  - Diamond shaped, superficial muscle of the posterior neck/back
  - Innervated by CN XI (accessory nerve)
  - Acts to elevate, rotate and retract the scapula

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NOTES:

- **Latissimus Dorsi** (8)
  - Assists in adduction, internal rotation, and extension of the glenohumeral joint
  - Innervated by thoracodorsal nerve
    - Important to preserve this nerve in surgical flaps involving the lattisimus
    - Arises from posterior cord of brachial plexus

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### NOTES:

- **Serratus Anterior (12)**
  - Draws scapula anteriorly against chest wall
  - Consists of 8 interdigitations of muscles
  - Originates from ribs 1-8 and inserts on medial border of scapula
  - Innervated by the long thoracic nerve
    - Injury to this nerve results in winged scapula

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NOTES:

- **Rectus Abdominis (17)**
  - Paired muscles separated by the linea alba
  - Attaches to the costal cartilages of ribs 5-7 and the xiphoid process of the sternum
  - Dual blood supply from the superior and inferior epigastric vessels
  - Can be used for muscle flaps in the chest
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Variant Anatomy: Sternalis

- Muscle band extending from the jugular notch to the inferior aspect of the sternum
- Lies adjacent to the medial edge of the pectoralis major
- Can be mistaken for a pathologic lesion
- Found in ~5% of the population
Variant Anatomy: Sternalis

- Muscle band extending from the jugular notch to the inferior aspect of the sternum
- Lies adjacent to the medial edge of the pectoralis major
- Can be mistaken for a pathologic lesion
- Found in ~5% of the population
- Often seen on mammography
  - Typically visible in the medial aspect of the breast on cranio-caudal (CC) view
Variant Anatomy: Pectus Excavatum

- Congenital chest wall deformity with a concave depression of the sternum
  - Most common chest wall deformity (90%)

- Males > Females

- Associations:
  - Marfan syndrome
  - Ehlers Danlos syndrome
  - Noonan syndrome

- Haller index used to quantify severity
  - Maximal transverse diameter (A) / narrowest AP length of chest (B)
  - normal = 2.5, significant if >3.25

- On chest radiograph can result in:
  - Silhouetting/blurring of right heart border
  - Increased density in right inferomedial lung
Variant Anatomy: Pectus Carinatum

• Also known as “pigeon chest”

• Less common than pectus excavatum

• Two patterns:
  • Chondrogladiolar
    • More common
    • Involves mid and lower portions of sternum
  • Chondromanubrial
    • Involves upper portion of sternum (manubrium)
    • More inferior body of sternum is deviated posteriorly

• Treatment
  • Ravitch procedure
    • Open surgery, more invasive
  • Reverse Nuss procedure
Conditions to Note: Poland Syndrome

- Congenital unilateral absence of pectoralis major and minor muscles
- Causes a unilateral hyperlucent hemithorax on radiographs
- Rare and usually sporadic, not familial
- Spectrum of disease can result in aplasia or hypoplasia of the muscles
  - Can also see effects in overlying breast or nipple
- Consider the condition “amastia” instead if there is just absence of breast tissue
  - Can be seen after chest wall irradiation during childhood or after excision of pre-pubertal breast bud
- Absent left pectoralis major and minor muscles
- More inferiorly, breast tissue was also aplastic

[Image of a CT scan of the chest with an arrow pointing to the left pectoralis major muscle]
Conditions to Note: Poliomyelitis

- Once common but now rare disease secondary to infection by poliovirus

- Most infected patients have no serious symptoms, but ~1% develop paralysis from destruction of motor neurons

- Two forms:
  - Paralytic
    - Lower limbs more affected than upper limbs
  - Non-paralytic

- Note the extensive fatty muscle atrophy in the left hemithorax involving the pectoralis muscles, subscapularis, trapezius, and latissimus
- NOT to be confused with Poland Syndrome!
Conditions to Note: Facioscapulohumeral Muscular Dystrophy (FSHD)

- Autosomal dominant form of muscular dystrophy
  - In >95% cases, associated with an abnormality in chromosome 4

- Initially affects facial muscles, scapula, and upper arms
  - Weakness often asymmetric

- Symptoms may develop in early childhood

- Studies have shown it most commonly affects:
  - Trapezius and serratus anterior
  - Followed by less commonly the latissimus and pectoralis major

- MRI can potentially be used to differentiate FSHD from other forms of muscular dystrophy

- Note the prominent atrophy of the right serratus anterior as well as the surrounding shoulder girdle muscles
Conditions to Note:
Elastofibroma Dorsi

- Benign soft tissue tumor located in the infrascapular region, deep to the serratus anterior and latissimus dorsi
- When unilateral, may be more commonly right sided
  - Bilateral involvement is overall more common (~55-60%)
- Frequently shows mild-moderate FDG uptake on PET-CT
- Seen commonly in older females
  - Mean age of diagnosis 65-70 years
- Bilateral soft-tissue masses with attenuation similar to the serratus anterior overlying it
Common Surgeries: Nuss Procedure

- a.k.a. minimally invasive repair of pectus excavatum (MIRPE)
- First reported in 1987 by D. Nuss
- Concave stainless steel bar inserted underneath sternum through two small incisions
- Postoperative testing may show improvement in pulmonary function tests and increased exercise tolerance
- Bar displacement is a possible complication
  - Seen post-trauma (i.e. car accident)

- Imaging pre- (top) and post-repair
Common Surgeries: Eloesser Flap

- Single stage procedure
- For treatment of severe pleural empyema
- Described in 1935 by Leo Eloesser
  - Initially used to treat tuberculous empyema
- U-shaped incision with resection of multiple posterolateral ribs
  - U-shaped flap is folded into pleural space, creating a constant communication
- Open communication necessitates prolonged wound care and dressing changes

Illustration: Denlinger, “Eloesser Flap Thoracostomy Window”
Common Surgeries: Eloesser Flap

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• Note the contiguous skin flap extending into the pleural space
Common Surgeries: Clagett Flap

- Three-stage procedure for treatment of severe empyemas
  - versus single stage for Eloesser
- Resection of posterolateral lower ribs with formation of open window
  - No skin flap; allows for granulation tissue to form and line the cavity
- Second step is antibiotic irrigation
- Third step is closure

• Note the lack of an obvious contiguous skin flap extending into the cavity
Common Surgeries: Mastectomy

- **Simple Mastectomy**
  - Removal of breast tissue alone, including areola/nipple
  - Residual chest wall thickness will vary depending on the thickness of the patient’s subcutaneous fat

- **Modified Radical Mastectomy**
  - Various forms exist
  - Defined as removal of breast tissue with axillary node dissection, in addition to partial removal of pectoralis major/minor
  - Can also just remove the pectoralis major fascia, in which case it can be indistinguishable from simple mastectomy on imaging

- Simple mastectomy (top) showing preserved pectoralis muscles
- Modified radical mastectomy (bottom) with arrow pointing to partially resected pectoralis major
Common Surgeries: Mastectomy

- **Radical Mastectomy**
  - Removal of the breast/nipple/areola, axillary nodes, and chest muscles
    - *Pectoralis major and minor*
  - Once the standard, but now less commonly performed due to existence of less invasive procedures
  - Small amount of residual pectoralis major may be seen at its costal attachment (*yellow arrow*)
    - Should not be misinterpreted as recurrent tumor

Common Surgeries: Implant Reconstruction

- Two main surgical planes for implant placement:
  - Subglandular
  - Retropectoral

- Examples of retropectoral to the right:
  - Implant lies under the pectoralis major (arrow)

- Retropectoral first introduced in 1968 by Dempsey and Latham

- Benefits of retropectoral:
  - Decreased incidence of capsular contracture
  - Improved breast contour
  - Plane of dissection is less invasive
  - Improved visibility of the breast tissue on mammography
Conclusion

- While focusing on the lungs, cardiovascular organs or osseous structures of the thorax, the overlying chest musculature may be easily overlooked.

- Cardiothoracic radiologists should be experts on the normal chest wall anatomy as well as the potential variants and anatomic/structural abnormalities which are commonly encountered in everyday practice.

- One of the biggest impacts we have as cardiothoracic radiologists is the precision and accuracy by which we describe a pathologic process, especially when it involves the chest wall.
References

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