



USC University of
Southern California

Pectus Deformities 101: When and How they Matter

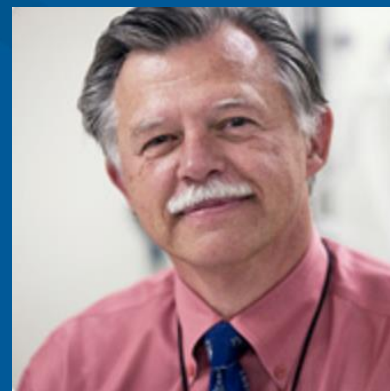
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Disclosures

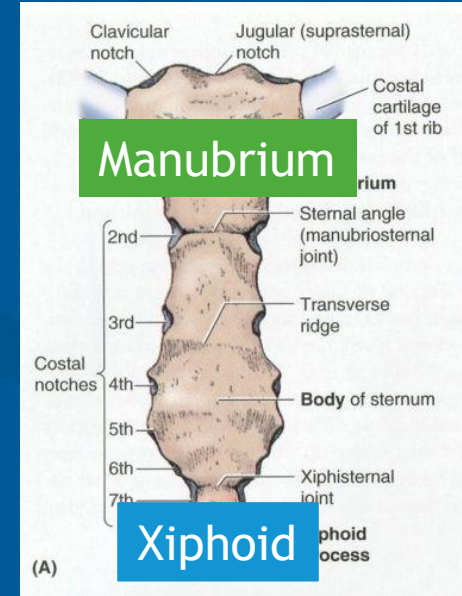
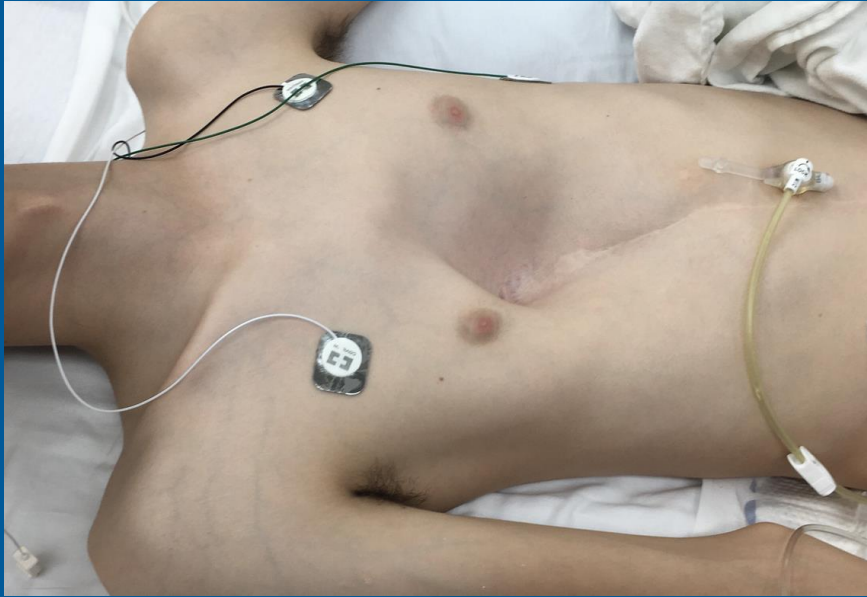
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Lindsay M. Andras MD - Eli Lilly (c); Nuvasive, Biomet & Medtronic (d); SRS, POSNA, JPO (e); Orthobullets (f)





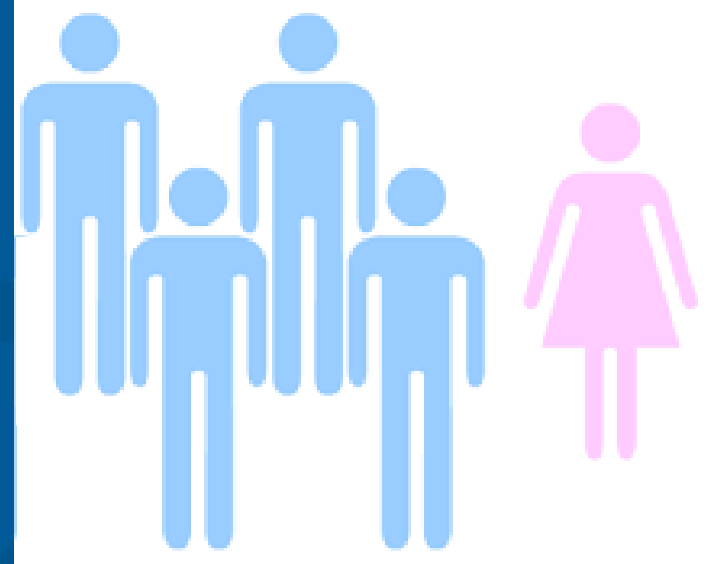
Pectus Excavatum



Sternal depression typically beginning over the midportion of the manubrium and progressing to the xiphoid process

Pectus Excavatum

- 80-90% anterior chest wall disorders
- 1 in every 300 to 1000 live births
- Approx. 4x more common M:F



Pectus Excavatum

- Usually sporadic
- May be associated with:
 - Marfan syndrome
 - Ehlers Danlos syndrome
 - Osteogenesis Imperfecta
 - Spinal Muscular Atrophy
 - Noonan syndrome



Pectus Excavatum: Etiology



- Abnormal rib growth
- Abnormal cartilage development
- Response to pulmonary conditions

Pectus Excavatum: Natural History

1/3 of cases
present in infancy



Some spontaneous
improvement (rare);
After 6 no improvement

During adolescent growth spurt: 1/3 worsen & 2/3 stable

Pectus Excavatum: Clinical Significance

Severity of chest wall defect

Cardiopulmonary morbidity

Psychosocial Impact/
Cosmetic Concerns



Pectus Excavatum: Symptoms

- Exercise Intolerance: 82%
- Chest Pain: 68%
- Poor Endurance: 67%
- Shortness of Breath: 42%



Nuss et al. Adv Pediatr 2008
Bay et al. J Pediatr Surg 1970

Pectus Excavatum: Evaluation

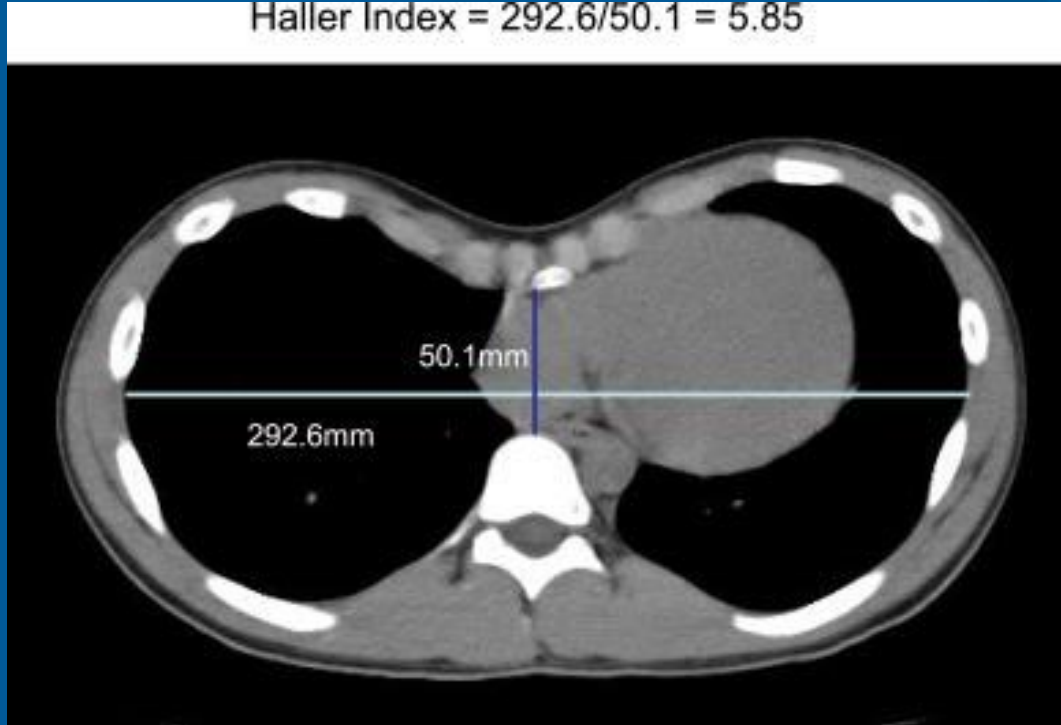
Sternal tilt



Pectus Excavatum: Evaluation

Pectus Severity Index (Haller Index) = $\frac{\text{lateral diameter of the chest}}{\text{sternum to spine distance}}$

Haller Index = $292.6/50.1 = 5.85$



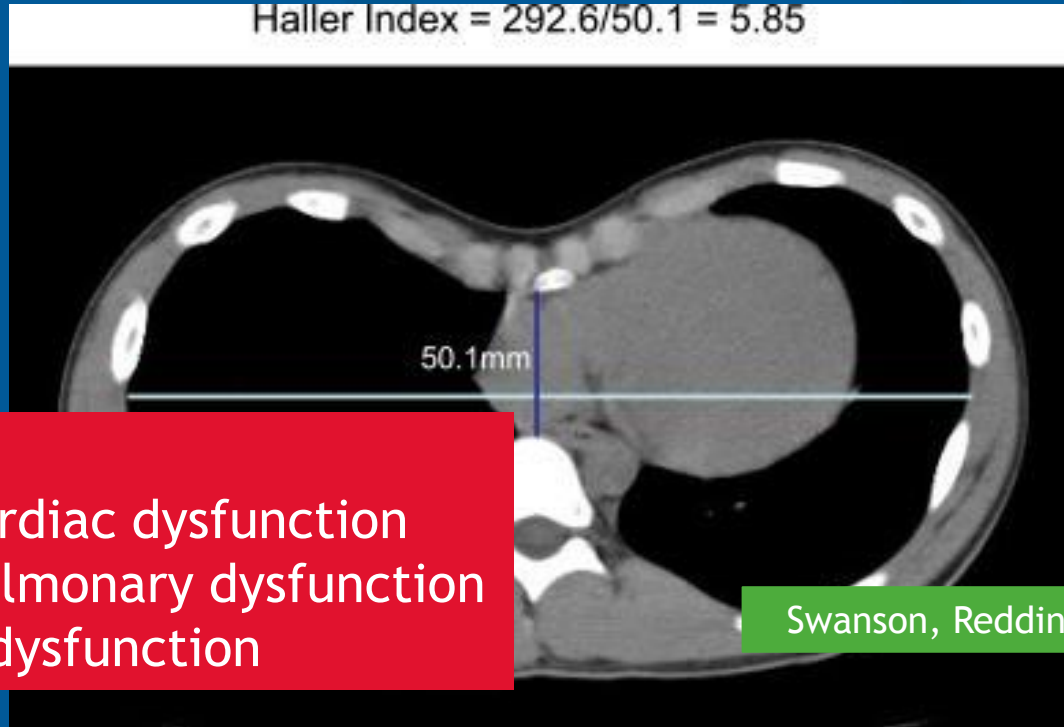
Normal PSI:
 ≤ 2.5

Pectus Excavatum PSI:
 > 2.5

Surgical Pectus
Excavatum PSI:
 > 3.25

Pectus Excavatum: Evaluation

Pectus Severity Index (Haller Index) = $\frac{\text{lateral diameter of the chest}}{\text{sternum to spine distance}}$



Mean PSI:

- *3.6 isolated cardiac dysfunction
- *4.4 isolated pulmonary dysfunction
- *4.9 combined dysfunction

Swanson, Redding et. Al. Am J Surg 2012

Pectus Excavatum: Evaluation

Mild PE:

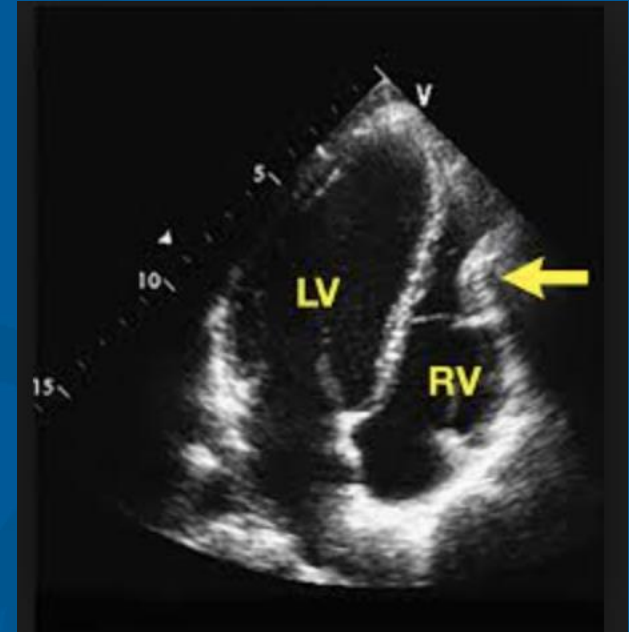
- * Cardiopulmonary function typically normal
- * Cosmetic concerns indication for referral



Pectus Excavatum: Evaluation

Moderate to Severe PE:

- * CT to evaluate the severity of PE
- * Pulmonary Function testing
- * Cardiac evaluation/Echocardiogram
 - Functional systolic murmur 18%
 - Bundle Branch Block 16%
- * +/- Exercise Testing



Kelly et al. Semin Pediatr Surg 2008
Fonkalsrud et al. World J Surg 2009

Pectus Excavatum & Scoliosis

- 10-39% of patients with PE have associated scoliosis
- Tauchi et al. *Eur Spine J* 2018
 - 20 patients with both Pectus Excavatum & scoliosis who had surgery for scoliosis
 - 8 AIS, 10 syndromic, and 2 NMS
 - 11/20 patients had worsening of Haller index
 - Preop 4.8- \rightarrow Postop 5.3
 - 9/11 had syndromic/NMS



Pectus Excavatum & Scoliosis

10-39% of patients with PE have associated scoliosis



Pectus Excavatum & Scoliosis Surgery



Multiple reports in the literature of severe hypotension in the prone position during spine surgery in P.E. patients

- * Alexianu et. al. *Anesth Analg* 2004
- * Bafus et. al. *J Spinal Disord Tech* 2008
- * Galas et. al. *Congenital Heart Dis* 2009



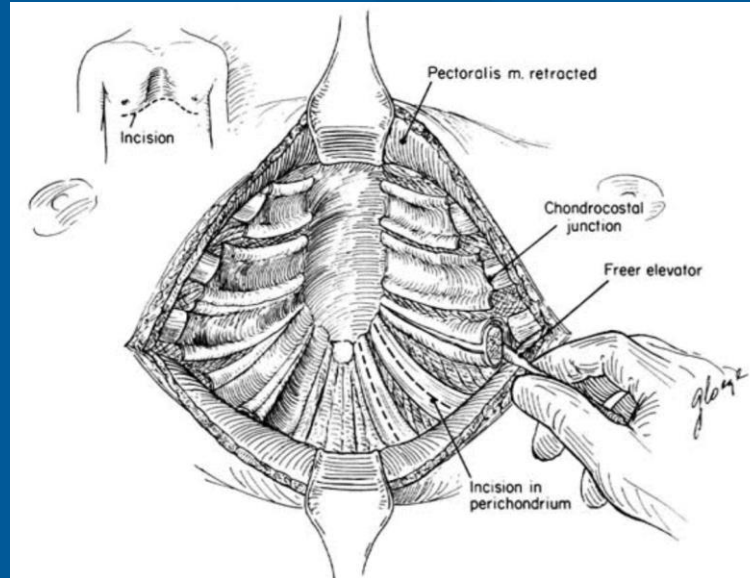


No pressure on the
central portion of
the chest

Consider
intraoperative
TEE

Pectus Excavatum : Treatment

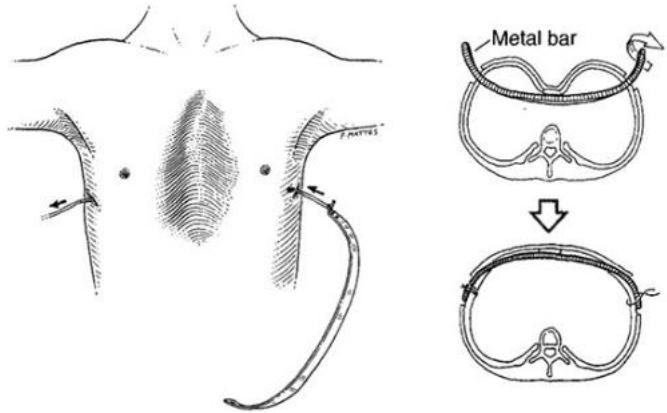
Open Repair (Ravitch): cartilaginous repair of ribs



Pectus Excavatum : Treatment

Minimally Invasive Repair (Nuss): insertion of bar

Late childhood or early adolescence



Pectus Excavatum : Treatment

Aronson et al. World J Surg 2007

- At 6 months after bar insertion the TLC, FRC, VC, and FEV(1), increased and prior to bar removal the FRC increased
- At 6 months after Nuss bar removal, none of the lung function variables showed any significant change compared to the preoperative values

Pectus Excavatum : Treatment

Chen et al. J Cardiothoracic surg 2012

- * Meta Analysis of 23 studies
- * Similar improvement in pulmonary function at 1 yr after Nuss or Ravitch
- * Long term follow up favored the Nuss procedure

Pectus Carinatum

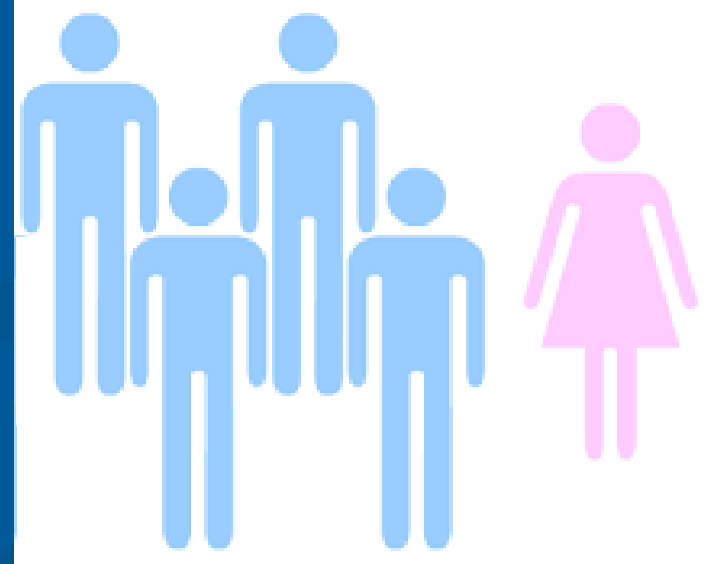
Protrusion of the anterior chest wall

- * Latin for “chest with a keel”
- * Chondrogladiolar prominence:
 - “ chicken breast”
 - most common
 - middle and lower sternum arch forward
 - costal cartilage is concave/depressed



Pectus Carinatum

- 1 in every 1500 live births
- Approx. 4x more common M:F
- Familial incidence
(25% of patients report affected family members)



Pectus Carinatum: Etiology



- Abnormal rib/sternum growth
- Abnormal anterior cartilage growth
- Biomechanical abnormalities in costal cartilage

Pectus Carinatum

- >90% diagnosed after age 11
- Can worsen dramatically during adolescent growth spurt
- Spontaneous improvement does not occur
- Isolated pectus carinatum: most have no associated morbidity

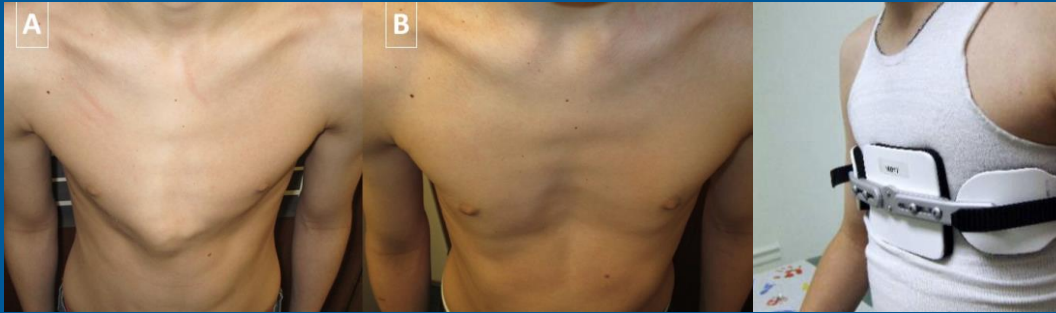
11 yo w/Morquio syndrome



If fusing longer
consider extending
neck so patient could
have trach if needed

Take care if doing an occipitocervical fusion to avoid longer fusions so it will not prevent airway access

Pectus Carinatum: Bracing



Improvement in approx 90%

Flexible deformity-> less pressure, correct more quickly
but need longer wear hours (recommend 20 hours/day)

Stiffer deformity->higher pressure, correct more slowly
but shorter wear hours (recommend 8 to 12 hours)

Lee et al. J Pediatr Surg 2013
Wahba et al. J Pediatr Surg 2017.
Banever et al. Laparoendosc Adv Surg Tech 2006.
Lee et al. Eur J Cardiothorac Surg 2008.

Pectus Carinatum: Surgery

Rare

Reserved for severe cases where bracing was ineffective or patient unable to tolerate

Essentially same techniques as PE reconstruction

Take Home Points

- Consider referral if Haller Index >3 , symptoms of exercise intolerance, dyspnea or bothered by cosmetic deformity
- If patient has severe PE and is having scoliosis surgery position prone so there is no pressure on sternum- be prepared for hypotension- consider intraoperative TEE
- Pectus carinatum is predominantly cosmetic and often responds well to bracing
- Avoid long cervical fusion with severe pectus carinatum, or put in some extension to allow airway access