Posterior Sternoclavicular Joint Injury in the Pediatric Patient

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• The authors have no disclosures
Purpose

- Review the anatomy of the sternoclavicular (SC) joint and mechanisms of injury
- Review the clinical presentation and possible complications of posterior SC injury
- Consider the use of various imaging modalities in imaging assessment
- Describe methods of treatment
Posterior Sternoclavicular Injury

- **Two types in children and young adults:**
  - Medial clavicle physeal fracture with posteriorly displaced clavicular metaphysis
    - Most common injury until physeal fusion
    - Salter-Harris I or II
  - True posterior/retrosternal SC joint dislocation

- **Epidemiology:**
  - Rare
    - Ratio of anterior to posterior SC injury – 2.5:1 to 20:1
    - Only 1 case of posterior injury in a large series of 1603 shoulder girdle injuries
    - <1% of dislocations in the body

- **Significance**
  - Often easily overlooked on clinical and imaging assessment
  - Acute and delayed complications can occur if unrecognized and untreated
  - Can be lethal
Anatomy

- **Clavicle**
  - 1st long bone to ossify - 5 weeks GA
  - Last epiphysis to fuse - 21-31 years old

- **Sternoclavicular joint**
  - Overlies the upper mediastinum - great vessels, trachea, esophagus
  - Only true articulation between the upper extremity and axial skeleton
  - Diarthrodial, saddle shaped joint
  - Most unstable major joint in the body - <50% of the medial clavicle articulates with the manubrium
  - Ligaments provide joint stability

*Figure 1:* Axial cadaver section demonstrating the proximity of the SC joints to the upper mediastinal structures. Clavicle (C), sternum (S), right subclavian vein (RSV), right innominate artery (RIA), left carotid artery (LCA), left subclavian vein (LSV), left subclavian artery (LSA), trachea (Tr), esophagus (E) (Levinsohn EM. Clin Orthop Relat Res 1979;140:12-16)
**Anatomy**

- **SC (capsular) ligaments**
  - Thickenings of the anterior and posterior joint capsule
  - Major stabilizers of the SC joint
  - Posterior is thicker/stronger – may partially account for increased rate of anterior dislocation

- **Coracoclavicular ligament**
  - Extends from the medial first rib to the medial clavicle
  - Opposes the pull of the sternocleidomastoid muscle on the clavicle

- **Interclavicular ligament**
  - Connects the superomedial aspect of the clavicles with the capsule and upper sternum
  - Helps prevent lateral displacement of the clavicle

- **Intra-articular disk ligament**
  - Arises from the synchondral junction of the 1st rib and sternum and divides the SC joint into two
  - Helps prevent medial displacement of the clavicle

*Figure 2: Illustration of the basic anatomy of the SC joint.* (Nettles JL. J Trauma 1968;8:158-64)
Mechanism

• **Cause of injury**
  - MVA - most common cause (40%)
  - Sports injury - second most common cause (21%)
  - Falls, industrial accidents, miscellaneous trauma (39%)
  - Rarely can be spontaneous

• **Mechanism of injury**
  - Indirect
    • Force to the posterolateral shoulder
    • Clavicle levers on the first rib, transmitting a posterior force to the medial clavicle
    • Most common mechanism of injury
  - Direct
    • Force to the anteromedial aspect of the clavicle
    • Less common mechanism of injury - 1 in 4 to 1 in 9 cases
Clinical Presentation

• Signs and symptoms of injury
  – Pain localized to the SC joint, clavicle, and/or shoulder
  – Tenderness over the SC joint
  – Ipsilateral arm flexed at the elbow and supported across the chest by the other arm
  – Head tilt toward the ipsilateral side
  – Depression of the medial clavicle and/or swelling over the clavicle
  – Decreased range of motion due to pain

• Signs of secondary effect on the mediastinum
  – Dysphagia
  – Dyspnea
  – Dysphonia
  – Upper extremity weakness and/or paresthesia
  – Neck and upper extremity venous congestion
  – Decreased upper extremity pulse
  – Hypotension/shock

Figure 3: Signs of posterior SC injury. (Worman LW. J Trauma1967;7:416-23)
Figure 4: 15 year old male who sustained a direct force to the anterior upper right chest during wrestling. (a) Photo obtained during physical exam demonstrates depression of the medial right clavicle. (b) AP clavicle radiograph showing subtle superior displacement of the right clavicular head relative to the left. (c) CT chest without contrast showing a posteriorly displaced right clavicle Salter-Harris fracture with a tiny fracture fragment (arrow) anterior to the medial right clavicle.
Complications

· Mediastinal complications in ~25% of patients

· Acute
  – Great vessels – compression, laceration
  – Trachea – compression, tracheoesophageal fistula
  – Esophagus – compression, rupture
  – Lungs – pulmonary contusion, pneumothorax, hemothorax
  – Brachial plexus or recurrent laryngeal nerve injury

· Chronic
  – SC joint instability and/or osteoarthritis
  – Arterial stenosis or pseudoaneurysm
  – Venous congestion
  – Thoracic outlet syndrome
Radiography

**AP view**
- May show asymmetry of the medial clavicles
- Posterior SC injury is often occult

**Additional views**
- Serendipity – patient supine, 40 degree cranial tilt of the X-ray tube
- Hobbs – patient seated leaning over table, tube aimed downward toward the C-spine
- Heinig – patient supine, tube lateral to the patient tangential to one SC joint and parallel to the other, often images of both sides are obtained for comparison

*Figure 5: (a) Serendipity view (b) Hobbs view (Cope R. Skeletal Radiol 1993;22:233-8)*

*Figure 6: Heinig view (Lee FA. Radiology 1974;110:631-4)*
Obtaining an AP view and at least one additional view (typically serendipity at our institution) is recommended to increase sensitivity for detection
Figure 7: 14 year old male who fell onto his right shoulder during snowboarding. (a) AP view of the bilateral clavicles showing minimal inferior displacement of the medial right clavicle relative to the left. (b) Serendipity view much better demonstrating this inferior displacement.
Figure 8: 17 year old male who sustained an impact to the lateral left shoulder during a hockey game. (a) AP view of the left clavicle showing superior displacement of the left clavicle relative to the right. (b) Serendipity view of the left clavicle on which the clavicular displacement is occult.
CT

- CT for SC dislocation first described in 1979

Advantages
- Widely available and readily accessible in the acute setting
- Can identify SC dislocation that is occult on radiographs, or confirm a radiographic diagnosis
- If the epiphysis is at least partially ossified CT may help differentiate a medial clavicle Salter-Harris fracture from true SC dislocation, which may impact management
- Can be used to assess the vasculature if contrast is administered
- Can identify evidence of injury to other structures including the esophagus and trachea
- Intra-operative cone beam CT can be used to confirm the success of reduction

Disadvantages
- Ionizing radiation - limited coverage of just the SC joints minimizes radiation exposure
- If contrast is administered there is a small risk of reaction and/or nephrotoxicity
• Even if radiographs appear normal CT should be obtained if high clinical suspicion remains

• Use of IV contrast is recommended to assess the vasculature prior to reduction
Figure 9: 17 year old male who sustained a lateral impact to the left shoulder during a hockey game. (a) CT without contrast shows posterior displacement of the left medial clavicular metaphysis with the epiphysis seen anteriorly (arrow), compatible with displaced Salter-Harris fracture. (b) Intra-operative cone beam CT showing successful reduction of the fracture.
Figure 10: 13 year old male thrown onto his right shoulder during wrestling. (a) CT chest with contrast on bone window showing posterior right SC dislocation. (b) Same CT image on soft tissue window showing mass effect from the posteriorly dislocated clavicle on the distal left brachiocephalic vein (arrow).
MRI

· Advantages
  – No ionizing radiation
  – Excellent soft tissue contrast resolution
  – Osseous structures and unossified cartilage can be identified
  – Contrast can be administered to assess the vasculature
    • Low rate of contrast reaction
    • Low theoretical risk of nephrotoxicity
    • Newer contrast agents with a longer blood pool half-life (i.e. gadofosveset trisodium) may help optimize vascular assessment by allowing for extended vascular imaging
  – Patients with SC injury are typically teenagers who can remain still for MRI without sedation

· Disadvantages
  – Not always readily available in the acute setting
  – Difficulty monitoring the unstable patient (i.e. trauma patient with polyinjury)
  – More expensive than routine CT
MRI may play a more prominent role in the imaging of sternoclavicular joint injury in the future given its ability to simultaneously evaluate the bones, cartilage, soft tissue structures, and the vasculature without the use of ionizing radiation.
Figure 11: 16 year old male involved in a motorcycle accident who presented with right clavicle pain. The patient had multiple distracting injuries and posterior SC injury was missed on initial radiographs. (a) MRI/MRA chest showing posterior displacement of the medial right clavicle (solid arrow). Surrounding soft tissue edema and anterior callus formation (open arrow) are present. (b) CT without contrast showing the posterior dislocation and early callus formation.
Figure 12: 17 year old female who fell and landed on her right shoulder during a soccer game. Initial radiographs obtained at an outside hospital were interpreted as negative. The patient presented 3.5 weeks later with persistent medial right clavicle pain. (a) CT without contrast showing posterior dislocation of the right clavicular head with anterior callus formation (arrow). (b) MRI/MRA following repair showing improved alignment and post-surgical change.
Ultrasound (US)

• Reports of US use for posterior SC injury
  – Intra-operative assessment of closed reduction success
  – Diagnosis of closed reduction failure at clinic follow-up

• Advantages
  – No ionizing radiation
  – Real-time assessment in any imaging plane
  – Portable, with potential for use in the emergency department, operating room, or clinic.

• Disadvantages
  – Mediastinal structures cannot be assessed
  – Limited expertise for this indication
  – Limited literature on the use of this modality for this indication
Figure 13: (a) Side by side US images of the right (arrowhead) and left (solid arrow) medial clavicles in a patient with a posterior dislocation of the left SC joint. (b) Extended field of view US image demonstrating the relative positions of the right and left clavicular heads. The periosteal sleeve is seen anterior to the left clavicle (open arrows). Sternum (S). (Delganelo A. Skeletal Radiol 2012;41:857-60)
Management

• Controversial

• Closed reduction
  – Many advocate attempt at closed reduction if performed within 48 hours of injury
  – Successful closed reduction up to 10 days after injury has been described
  – Reported success ~40-60% in several adult series
  – Sedation or general anesthesia typically administered
  – Thoracic surgery should be on standby or in the operating room
  – Open reduction performed right away if unsuccessful

• Open reduction
  – Some advocate open reduction as first line therapy in pediatric patients due to the high rate of physeal fracture in this population and reported poor success of closed reduction in this setting
  – Many different methods
    • Internal fixation with plates, pins, wire – no longer recommended due to reports of multiple fatalities related to hardware migration
    • Tendon grafts
    • Suture fixation – performed at our institution
    • Medial clavicle resection – not recommended in pediatric patients
  – Thoracic surgery should be on standby or in the operating room
Figure 14 (left): Illustration of a commonly used closed reduction technique (the technique typically used at our institution). The patient is laid supine with a several centimeter thick sandbag between the scapulae. The ipsilateral arm is abducted and extended and traction is applied. The medial end of the clavicle may be grasped and pulled anteriorly with fingers or a towel clamp. (Salvatore JE. Clin Orthop Relat Res 1968;58:51-5)

Figure 15 (right): Intra-operative photo showing suture fixation of a clavicle Salter-Harris fracture with nonabsorbable suture. Clavicle (C), sternum (S). (Waters PM. J Pediatr Orthop 2003;23:464-9)
Summary

- Posterior SC injury is rare but associated with many complications
- It is often missed on initial radiographs
  - Obtain at least 2 views
  - Always assess medial clavicular alignment
- Obtain CT with contrast or MRI/MRA if there is high clinical suspicion regardless of radiographic findings
  - Can identify or confirm the diagnosis
  - Can evaluate for associated vascular or soft tissue injuries
- Prompt diagnosis can impact management and reduce morbidity
References:


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