

Acromioclavicular and Sternoclavicular Injuries

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Goals and Objectives

- **Review AC and SC anatomy**
- **Review AC and SC imaging**
- **AC joint injuries**
 - **Nonoperative indications and management**
 - **Operative indications and management**
- **SC joint injuries**
 - **Nonoperative indications and management**
 - **Operative indications and management**

AC Joint Anatomy

- **Diarthrodial joint**
 - Medial acromion
 - Lateral clavicle
- **Ligaments**
 - **AC – Primarily anterior to posterior stabilizers**
 - Superior is the strongest
 - **CC**
 - Trapezoid
 - Conoid
 - Vertical stabilizers
 - Stronger than AC

AC Joint Anatomy

- **Average dimensions of AC joint**
 - 9 x 19mm
- **Innervation – Branches of:**
 - Axillary
 - Suprascapular
 - Lateral pectoral

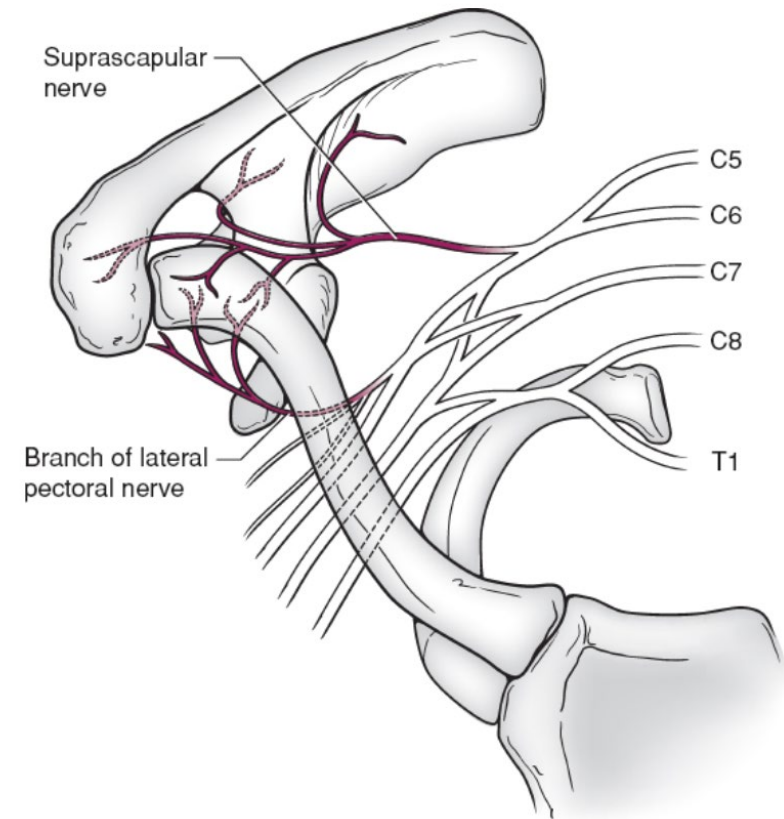


Image from: Corey Edgar. (2019) 'Acromioclavicular and Sternoclavicular Joint Injuries', In: Tornetta P, Ricci W, Ostrum R, McQueen M, McKee M, Court-Brown C, (eds). *Rockwood and Green's Fractures in Adults, 9th ed.* Philadelphia: Wolters Kluwer

History / Mechanism:

- **Direct impact to the superior shoulder**
- **Downward force vector**
- **Sports injuries (hockey player checked into the boards)**
- **Fall from height**
- **Equestrian injuries**
- **Motor vehicle crashes**

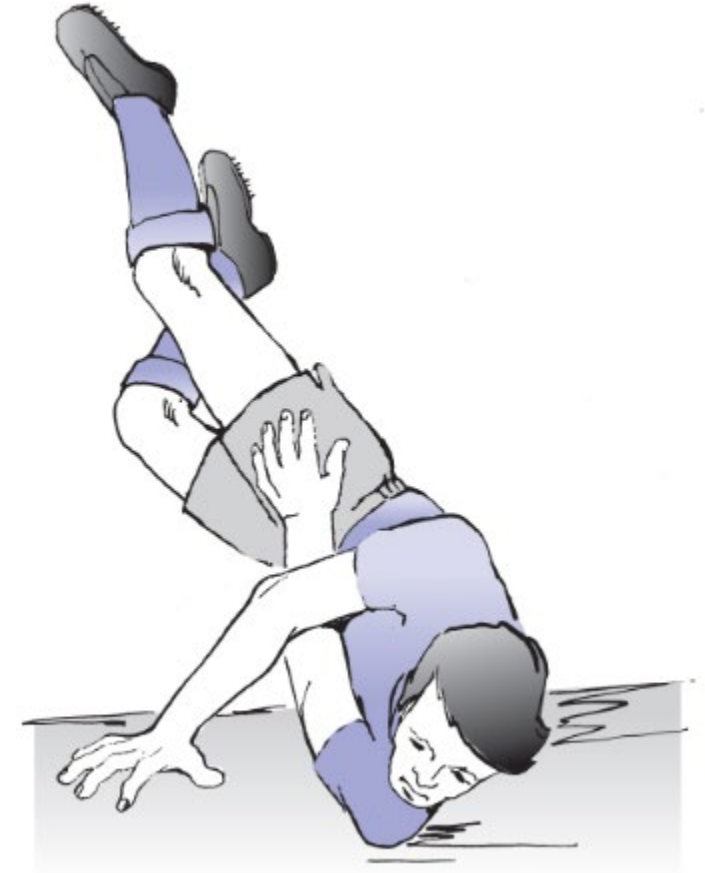


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Physical Examination

- **Inspect skin to evaluate for open injury or threatened skin**
- **Evaluate distal motor and sensory function**
- **Evaluate distal extremity perfusion/pulses**
- **Attempt to evaluate ROM**
 - **May be too painful in acute injury**
- **If unilateral, compare to contralateral side**
- **Palpation**

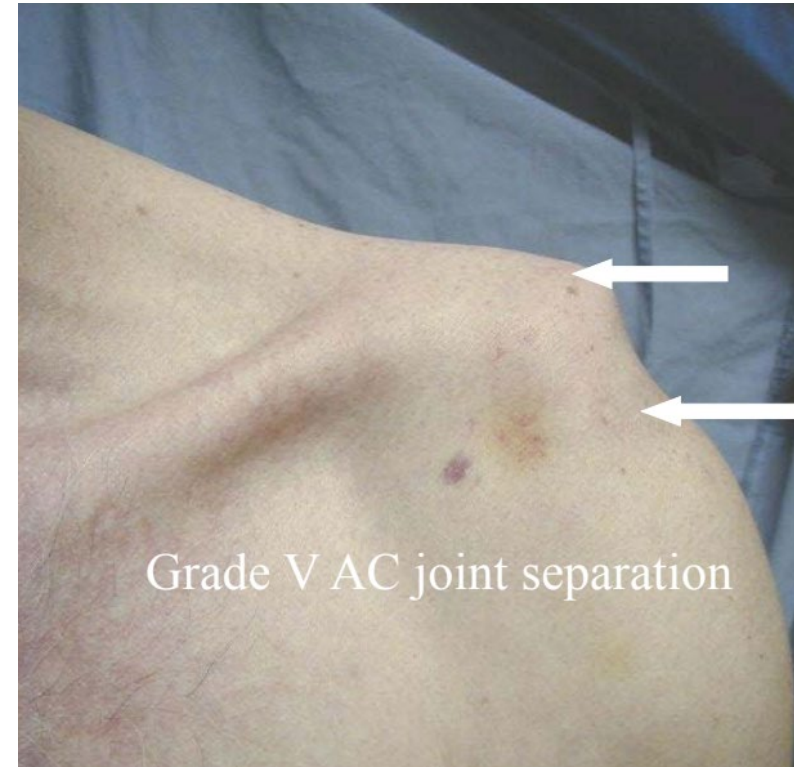
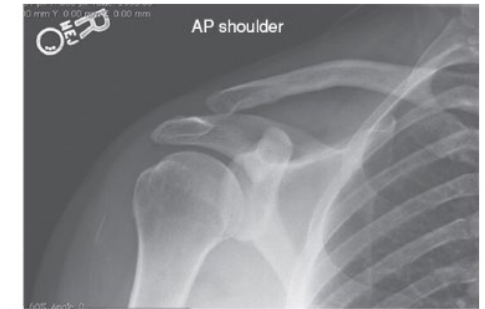
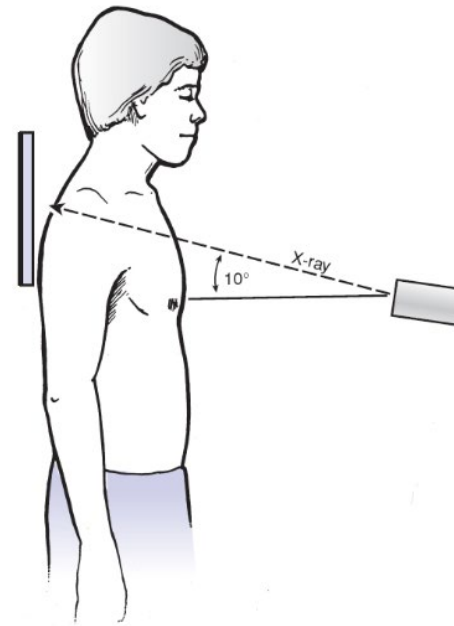


Image courtesy of Prof. Michael D. McKee, MD, FRCS(C)

Radiographs

- AP
- Zanca view
 - AP centered on the AC joint with 10-15 degrees of cephalic tilt



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Radiographs

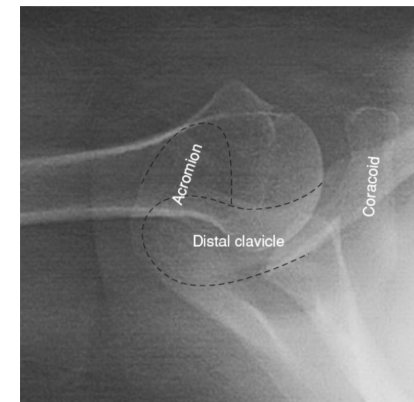
- **Stress view**

- Sit or stand upright with 10-pound weight in ipsilateral hand
- Rarely used



- **Axillary lateral**

- Evaluate for posterior displacement
- Beware, normal x-rays may mimic posterior clavicle subluxation



First two images courtesy of Prof. Michael D. McKee, MD, FRCS(C)

Next image from: Corey Edgar. (2019) 'Acromioclavicular and Sternoclavicular Joint Injuries', In: Tornetta P, Ricci W, Ostrum R, McQueen M, McKee M, Court-Brown C, (eds). *Rockwood and Green's Fractures in Adults, 9th ed.* Philadelphia: Wolters Kluwer

Classification

- **Allman and Tossy**
 - **Initially classified 3 types (I, II and III)**
- **Rockwood**
 - **Added types IV, V and VI**
- **Inter- and intra-observer agreement on classification poor**
 - **Especially types III-V**

Allman FL Jr. Fractures and ligamentous injuries of the clavicle and its articulation. JBJs 49A: 774-784, 1967.

Rockwood CA Jr and Young DC. Disorders of the acromioclavicular joint, In Rockwood CA, Matsen FA III: The Shoulder, Philadelphia, WB Saunders, 1990, pp. 413-476.



Type I

- Sprain of acromioclavicular ligament
- AC joint intact – normal x-rays
- Coracoclavicular ligaments intact
- Deltoid and trapezius muscles intact

Type II

- AC joint disrupted
- Sprain of the coracoclavicular ligaments
- < 50% Vertical displacement on x-ray
- CC ligaments intact
- Deltoid and trapezius muscles intact

Type III

- AC ligaments and CC ligaments all disrupted
- AC joint dislocated and the shoulder complex displaced inferiorly
- CC interspace greater than the normal shoulder(25-100%)
- Deltoid and trapezius muscles usually detached from the distal clavicle



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Type III variants

- “Pseudo-dislocation”
 - Intact periosteal sleeve
- Physeal injury
- Coracoid process fracture

Type IV

- AC and CC ligaments disrupted
- AC joint dislocated and clavicle displaced posteriorly into or through the trapezius muscle
- Deltoid and trapezius muscles detached from the distal clavicle



Type V

- AC ligaments disrupted
- CC ligaments disrupted
- AC joint dislocated and gross disparity between the clavicle and the scapula (100-300%)
- Deltoid and trapezius muscles detached from the distal half of clavicle

Type VI

- AC joint dislocated and clavicle displaced inferior to the acromion or the coracoid process
- AC and CC ligaments disrupted
- Deltoid and trapezius muscles detached from the distal clavicle

Treatment of Type I and II

- **Nonsurgical**
- **Rest, ice and protection**
- **Sling**
 - **1-2 weeks**
 - **Important to instruct patient to move distal joints to avoid stiffness**
- **Return to sports as pain allows**
- **Specialized braces generally not helpful**

Surgical indications Type II

- **Chronic Pain after nonoperative treatment**
- **Multiple techniques**
 - **Distal clavicle excision**
 - **Reconstruction of the coracoclavicular ligaments**
 - **Various techniques**
 - **Possible additional fixation (hook plate)**

Treatment of Type III

- **Controversial**
- **Nonsurgical management usually indicated**
- **Consider surgical treatment**
 - **Throwing athletes**
 - **Overhead workers**

Treatment of Type III

- **Surgical treatment**
 - **No significant difference with functional outcome**
 - **50% loss of reduction with follow up**
 - **10% infection rate**
 - **No significant improvement in cosmesis (bump vs scar)**

Treatment of Type III – V: Meta-Analysis

- **Systematic review and meta-analysis**
- **19 studies, 954 patients**
- **Better cosmetic outcome with surgery**
- **Better radiographic outcome with surgery**
- **Constant scores favored surgery**
 - **Small difference, may not be clinically relevant**
- **Nonsurgical group: faster return to work, lower implant complications, fewer infections, no difference in DASH, return to sport, osteoarthritis on x-rays or need for surgery after failed management**



Treatment of Type III – V: Randomized Clinical Trial

- **Multicenter randomized clinical trial**
- **80 patients, 40 each group**
- **Complete AC separation (III, IV and V)**
 - **No attempt to subclassify into specific types!**



Treatment of Type III – V: Randomized Clinical Trial

- **Hook plate vs nonsurgical treatment**
 - **Better DASH scores at 6 weeks and three month in non-op group**
 - No difference at 6 months, 1 year and 2 years
 - **Better Constant scores in nonop group at 6 weeks, 3 months and 6 months**
 - No difference at 1 year and 2 years
 - **Both groups improved to good or excellent results at 2 year follow up**



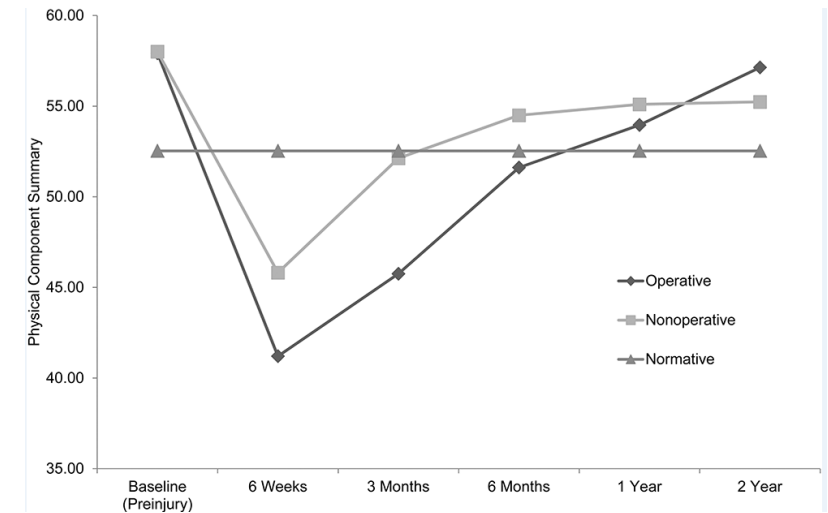
Treatment of Type III – V: Randomized Clinical Trial

- **Significantly higher reoperation in operative group**
- **Implant removal average time 8.2 months**
- **DASH scores better for non-op pts at 6 wk and 3 mo, no diff thereafter**
- **Constant scores better in non-op pts 6 wk, 3 and 6 mo, no diff thereafter**
- **Radiographs outcomes better with surgery at all time points ($P < 0.001$)**
- **2 years: 4/22 surgical vs 1/20 non-op had arthritic changes ($p = 0.36$)**
- **76% non-op back to work at 3 months vs 43% surgical ($p = 0.004$)**
 - **No difference at 1 year**
- **Over-reduction (narrowing) of the A-C joint was the most common cause of mechanical failure after surgery**



Treatment of Type III - V

- Follow up to above study
- Assessed health related quality of life
- Mostly type III injuries in both groups
- Physical health scores
 - Better in non-op group at 3 months then no difference through 2 years
- Mental health scores
 - No difference at any time point
- Physical health recovered to norms at 6 months in nonop, 1 year in operative group
- Mental health recovered to norms at 3 months with surgery, 6 months without surgery



Options for surgical treatment

- **Over 50 described in the literature**
- **Primary AC joint fixation**
- **Primary CC ligament reconstruction**
 - **Usually allograft, often with augmentation**
- **Distal clavicle excision**
- **Dynamic muscle transfers**

Weaver-Dunn Procedure

- The distal clavicle is excised.
- The CA ligament is transferred to the distal clavicle.
- The CC ligaments are repaired and/or augmented with a coracoclavicular screw or suture.
- Repair of deltotrapezial fascia
- Original series described 28% failure rate¹
- Modifications of the technique lead to improvements
 - 89% satisfactory results²
 - All type III, mix of acute and chronic patients
 - 27/27 return to work and sport, high satisfaction³
 - All type III, all chronic dislocations

From Nuber GW and Bowen MK, JAAOS, 5:11, 1997

Weaver JK, Dunn HK. Treatment of acromioclavicular injuries, especially complete acromioclavicular separation. J Bone Joint Surg Am. 1972 Sep;54(6):1187-94. PMID: 4652050.

Rokito AS, Oh YH, Zuckerman JD. Modified Weaver-Dunn procedure for acromioclavicular joint dislocations. Orthopedics. 2004 Jan;27(1):21-8. PMID: 14763525.

Galasso O, Tarducci L, De Benedetto M, et al. Modified Weaver-Dunn Procedure for Type 3 Acromioclavicular Joint Dislocation: Functional and Radiological Outcomes. *Orthop J Sports Med.* 2020;8(3) PMID: 32215276



ORIF with hook plate

- Biomechanical strength most similar to that of intact AC and CC ligaments¹
- Can have high rates of removal
- Concern for damage to rotator cuff
- Possible impingement
- Can have loss of reduction after removal
- Be careful not to over-reduce
 - Pain, stiffness and early failure²

1) McConnell, Alison, Yoo, Daniel, J BSc, MD, et al. Methods of Operative Fixation of the Acromio-Clavicular Joint: A Biomechanical Comparison. *J Orthop Trauma*. 2007;21(4):248-253. doi:10.1097/BOT.0b013e31803eb14e.

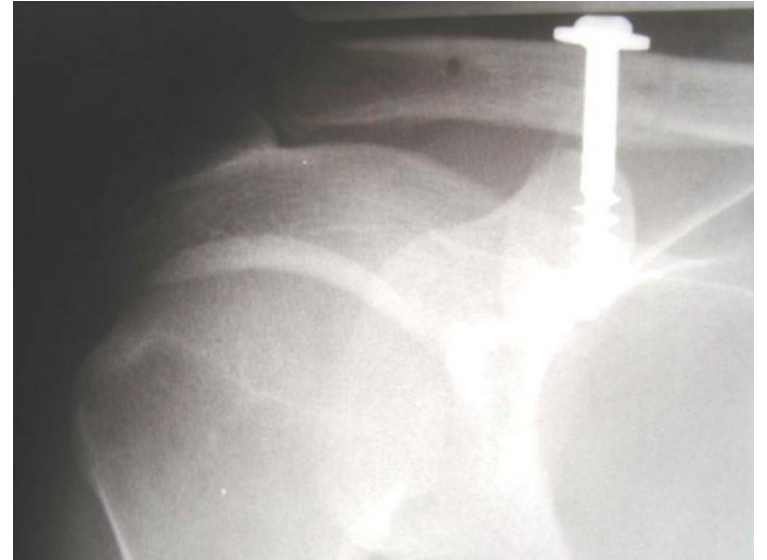
2) Canadian Orthopaedic Trauma Society. Multicenter Randomized Clinical Trial of Nonoperative Versus Operative Treatment of Acute Acromio-Clavicular Joint Dislocation. *J Orthop Trauma*. 2015 Nov;29(11):479-87. doi:10.1097/BOT.0000000000000437. PMID: 26489055.



Clinical Image from Prof. Michael D. McKee, MD, FRCS(C)

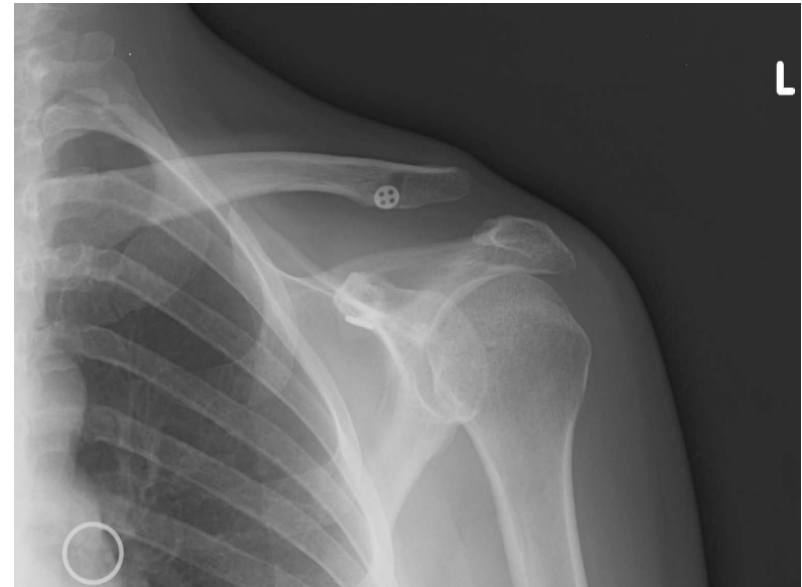
Bosworth screw

- Biomechanically stronger than hook plates
- Can be done open vs percutaneously
- Can be used to augment suture tape or other constructs



Suture button

- Reports of high failure rates
- Cook, et. Al, JSES 2012.
 - 10 repairs
 - 9 consecutive patients
 - 80% failure
 - Average of 7 weeks
 - All active-duty military



Images from Prof. Michael D. McKee, MD, FRCS(C)

Cook JB, Shaha JS, Rowles DJ, Bottoni CR, Shaha SH, Tokish JM. Early failures with single clavicular transosseous coracoclavicular ligament reconstruction. J Shoulder Elbow Surg. 2012 Dec;21(12):1746-52. doi: 10.1016/j.jse.2012.01.018. Epub 2012 Apr 21. PMID: 22521387.

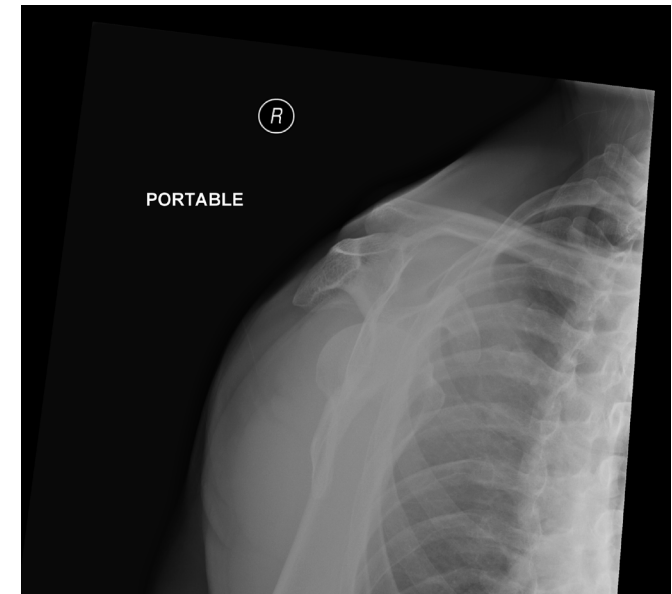
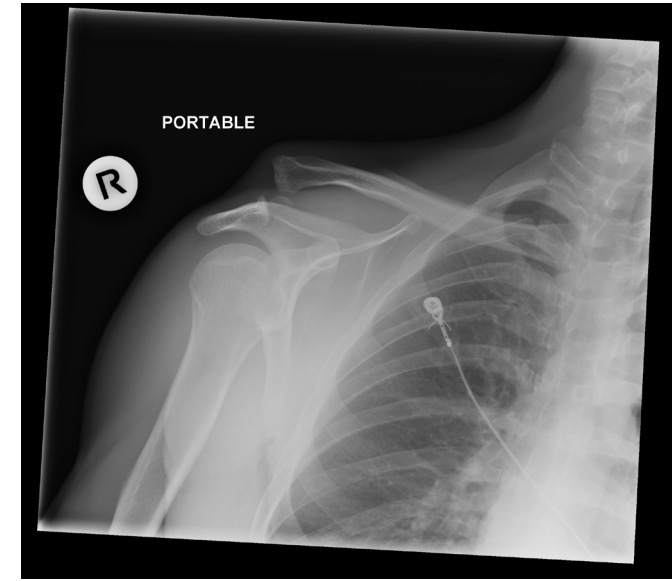
Suture Button – meta-analysis

- **Suture button vs hook plate**
- **8 studies**
 - **204 suture button patients**
 - **195 hook plate patients**
- **Suture button**
 - **Better constant scores – may not be clinically significant**
 - **Lower VAS**
- **No difference: operative time, reduction quality, complication, loss of reduction**



Suture Button – Case Example

- **48yo RHD M assault victim**
 - **Fell directly on to R shoulder**
- **Works occasionally in construction**
- **Homeless**
- **½ ppd tobacco**
- **Cocaine**
- **Methamphetamine**
- **Marijuana**



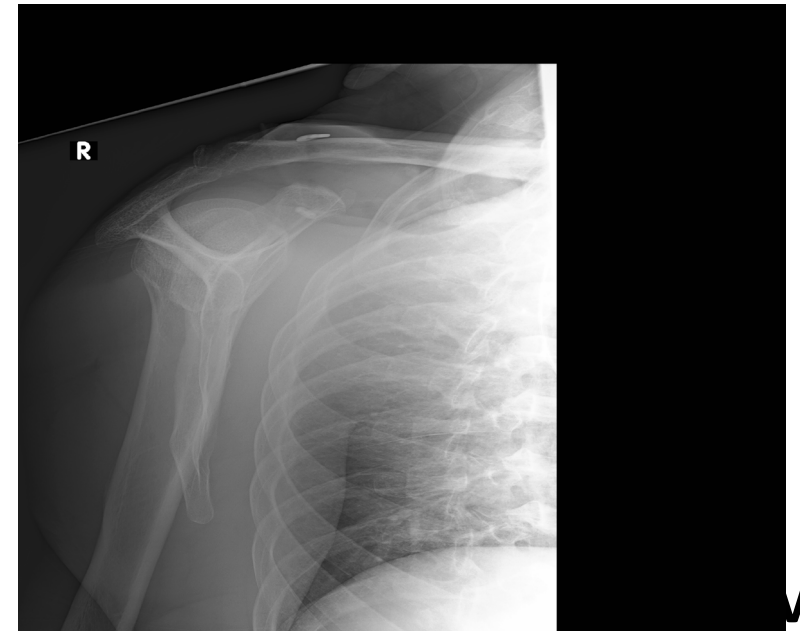
Suture Button – Case Example

- CRPP



Suture Button – Case Example

- **Incidental follow up at 15 months after fall from height**
- **Good maintenance of reduction on x-rays**
- **No clinical f/u as we weren't reconsulted**



Relative indications for surgical treatment

- **Chronic dislocations with:**
 - Pain
 - Concern with cosmetic deformity
 - Weakness

Outcomes of various treatments

- **Modified Weaver-Dunn may lead to good functional results in patients with symptomatic chronic type III dislocations¹**
- **Suspensory loop fixation may lead to better Constant-Murley scores vs hook plates and less post-operative pain vs hook plates²**
 - **Majority of studies (27/36) included type III injuries**
- **Suture button fixation vs Bosworth screw³**
 - **Prospective, Randomized Trial. 34 pts each group**
 - **No difference in radiographic outcomes**
 - **No significant differences in Constant scores, Oxford Shoulder scores. DASH excellent in both groups.**
 - **No need for second surgery with suture button fixation**

Galasso O, Tarducci L, De Benedetto M, et al. Modified Weaver-Dunn Procedure for Type 3 Acromioclavicular Joint Dislocation: Functional and Radiological Outcomes. *Orthop J Sports Med.* 2020;8(3) PMID: 32215276

Arirachakaran A, Boonard M, Piyapittayanun P, et al. Post-operative outcomes and complications of suspensory loop fixation device versus hook plate in acute unstable acromioclavicular joint dislocation: a systematic review and meta-analysis. *J Orthop Traumatol.* 2017;18(4):293-304.

Darabos N, Vlahovic I, Gusic N, Darabos A, Bakota B, Miklic D. Is AC TightRope fixation better than Bosworth screw fixation for minimally invasive operative treatment of Rockwood III AC joint injury? *Injury.* 2015 Nov;46 Suppl 6:S113-8. PMID: 26632500.



Rehab protocol for surgical treatment

- **Sling for 4-6 weeks**
 - **Encourage PROM during that time**
- **No pushing, pulling, reaching**
- **AROM starts at 6 weeks**
- **Strengthening starts at 8 weeks**
- **Return to contact sports at 16-20 weeks after removal of implants if planned**



ORIF with hook plate and CC ligament transfer

Reconstruction of
Chronic Acromio-Clavicular Dislocation

McKee, Michael, MD, FRCS. Operative Fixation of Chronic Acromioclavicular Joint Dislocation With Hook Plate and Modified Ligament Transfer. J Orthop Trauma. 2016;30:S7-S8. doi:10.1097/BOT.0000000000000580.



Sternoclavicular Joint Injuries

Sternoclavicular joint - Anatomy

- **Diarthrodial joint**
- **Saddle shaped with poor congruence**
- **Intra-articular disc**
 - **Divides SC into 2 separate joint spaces**
- **Costoclavicular ligament (rhomboid ligament)**
 - **Short, strong**
 - **Anterior and posterior fasciculi**

Sternoclavicular joint - Anatomy

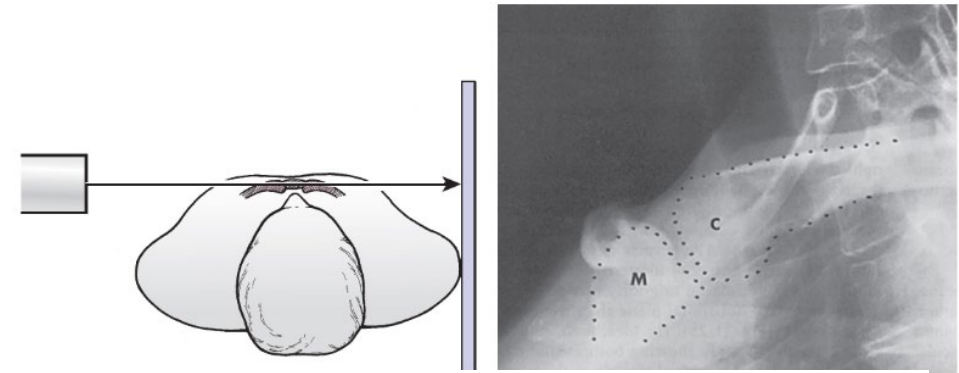
- **Interclavicular ligament**
 - Connects superomedial aspects of each clavicle to
 - Capsular ligaments
 - Upper sternum
- **Capsular ligament**
 - Covers anterior and posterior aspects of the joint
 - Thickenings of the capsule
 - Anterior is the stronger of the two

Sternoclavicular joint - Anatomy

- **Epiphysis of the medial clavicle**
 - Last ossification center to appear in the body
 - Ossifies at age 18-20
 - Does not unite with clavicle until the 23rd – 25th year

Sternoclavicular joint – Plain Radiographs

- **Heinig view**



- **Hobbs view**

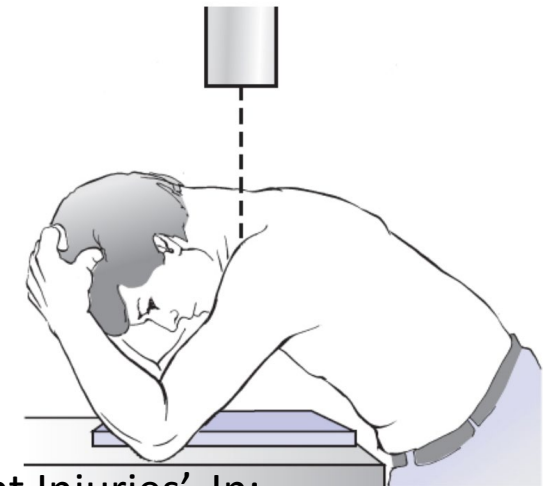


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Sternoclavicular joint - Imaging

- **CT Scan**
 - **Current gold standard for diagnosis**
 - **Also allows for evaluation of associated soft tissue injuries**

Sternoclavicular joint – Treatment

- **Anterior dislocations**
 - **Non-surgical treatment usually recommended**
 - NSAIDs/pain control
 - Immobilization for comfort
 - Closed reduction maneuvers often unsuccessful
 - Direct pressure over medial clavicle may lead to reduction
 - Often can't be maintained
 - Functional results thought to be generally good
 - Can lead to cosmetic deformity

Sternoclavicular joint – Treatment

- **Anterior dislocations**
 - **Recent literature has questioned nonoperative treatment in active, young patients**
 - **Pain with activity and inability to return to throwing sports¹**
 - **Decreased function reported by 42% of patients²**
 - **Risk of post-traumatic arthritis^{3,4}**
 - **Noticeable cosmetic deformity^{3,4,5}**

Savastano AA, Stutz SJ. Traumatic sternoclavicular dislocation. *Int Surg.* 1978;63:10–13

De Jong KP, Sukul DM. Anterior sternoclavicular dislocations: a long-term follow-up study. *J Orthop Trauma.* 1990;4:420–423.

Robinson CM, Jenkins PJ, Markham PE, et al. Disorders of the sternoclavicular joint. *J Bone Joint Surg Br.* 2008;90:685–696.

Yeh GL, Williamson GR Jr. Conservative management of sternoclavicular injuries. *Orthop Clin North Am.* 2000;31:129–203.

Källicke T, Andereya S, Westhoff J, et al. Anterior sternoclavicular dislocation caused by indirect compression trauma. *Eur J Trauma.* 2003;29:327–330.



Sternoclavicular joint – Treatment

- **Posterior dislocations**
 - **Careful physical examination**
 - Vascular compromise
 - Difficulty swallowing
 - Stridor
 - Hoarseness
 - **If reduction required, have Thoracic Surgeon on standby or transfer to center with Thoracic Surgery available**
 - **Attempt closed reduction**
 - Roll/bump between scapulae
 - Abduction/Adduction with traction
 - Percutaneous towel clip or pointed reduction forceps with anterior force

2018 Meta-analysis

- **38 articles reviewed, 26 quantitative**
- **No level I, II or III studies. Expert opinion and case series only**
- **4 questions**
 - **What is the expected outcome without treatment?**
 - **What are the indications for closed reduction?**
 - **What are the indications for open reduction?**
 - **Is there a need for availability of cardiothoracic surgery for open reduction?**



2018 Meta-analysis

- **Non-reduced anterior dislocations**
 - 38-42% complication rates (pain, activity limitation, arthritis)
- **No posterior dislocations were left unreduced**
- **Thus, closed reduction should be attempted for all dislocations**
 - Successful 38% of the time in a series of 21 posterior SC dislocations
- **Indications for open treatment:**
 - Irreducible posterior dislocation is an indication for open reduction
 - Irreducible anterior dislocation in young, active patients may be a relative indication
- **None of the 35 reported cases of open reduction (anterior or posterior) required the intervention of cardiothoracic surgery**
 - However, recommended by 18 articles that they are available
- **Additionally, high rate of hazardous wire migration when K-wires were used to fix joint.**



Open treatment options

- **Figure of 8 suture tape**
- **Allograft reconstruction**
- **Autograft reconstruction**
- **Trans-articular plating**



OTA Video

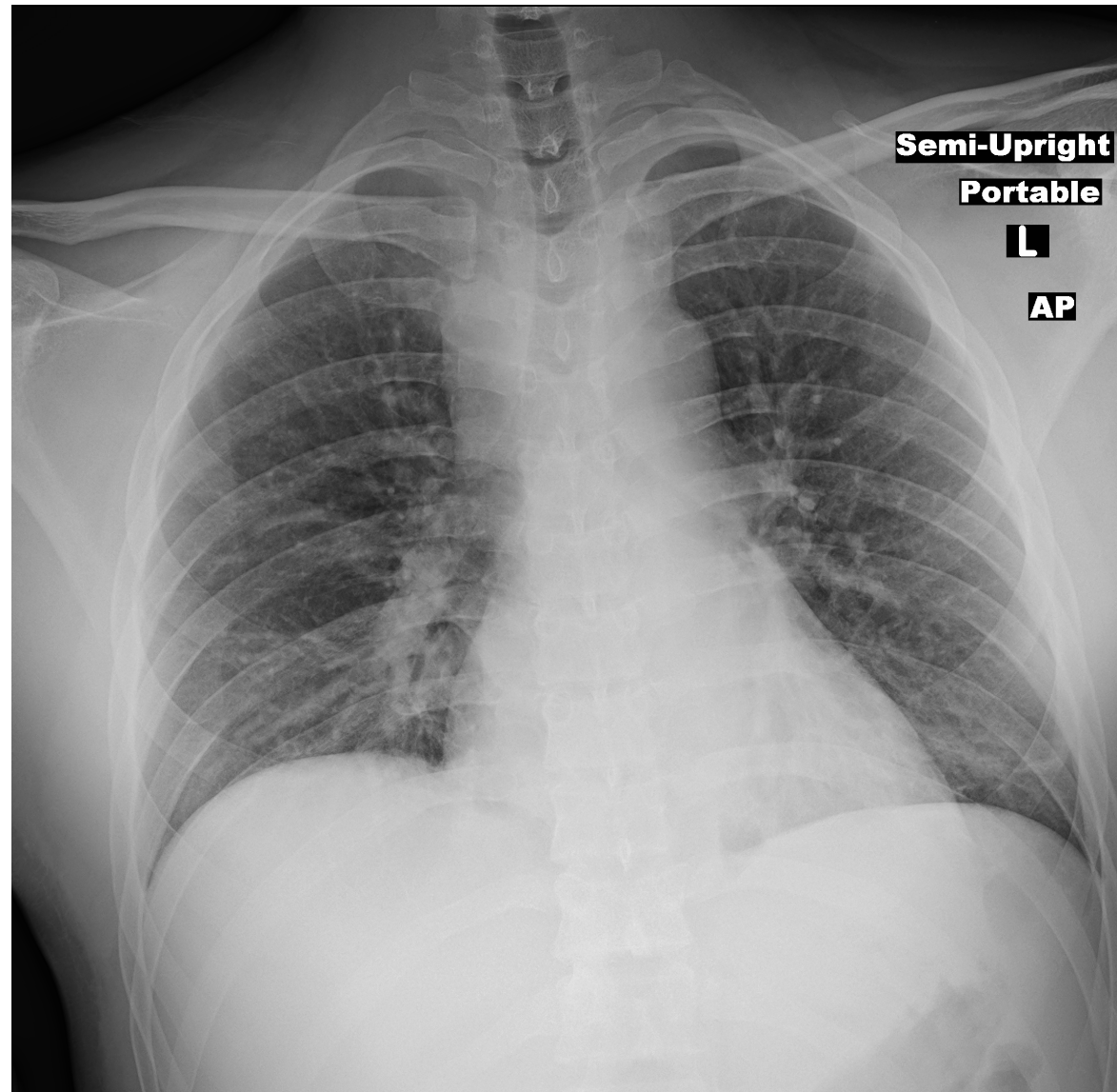
- **Insert video**

<https://otaonline.org/video-library/45036/procedures-and-techniques/multimedia/18101485/sc-joint-fixation-surgical-technique>



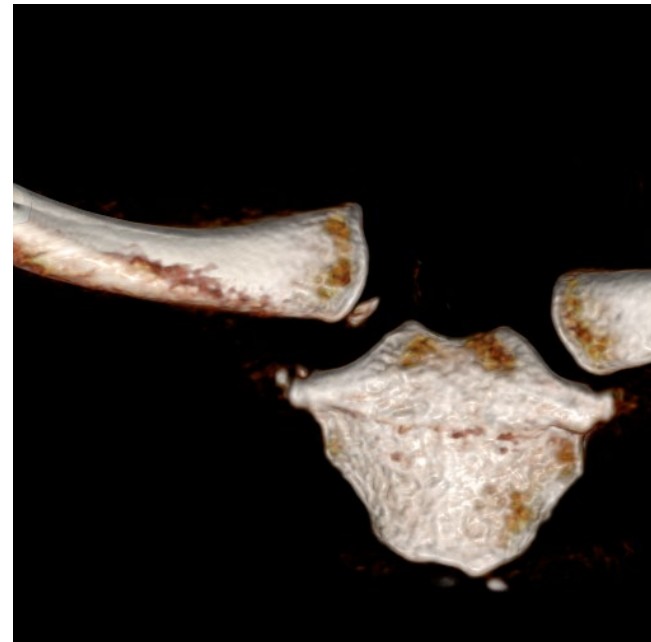
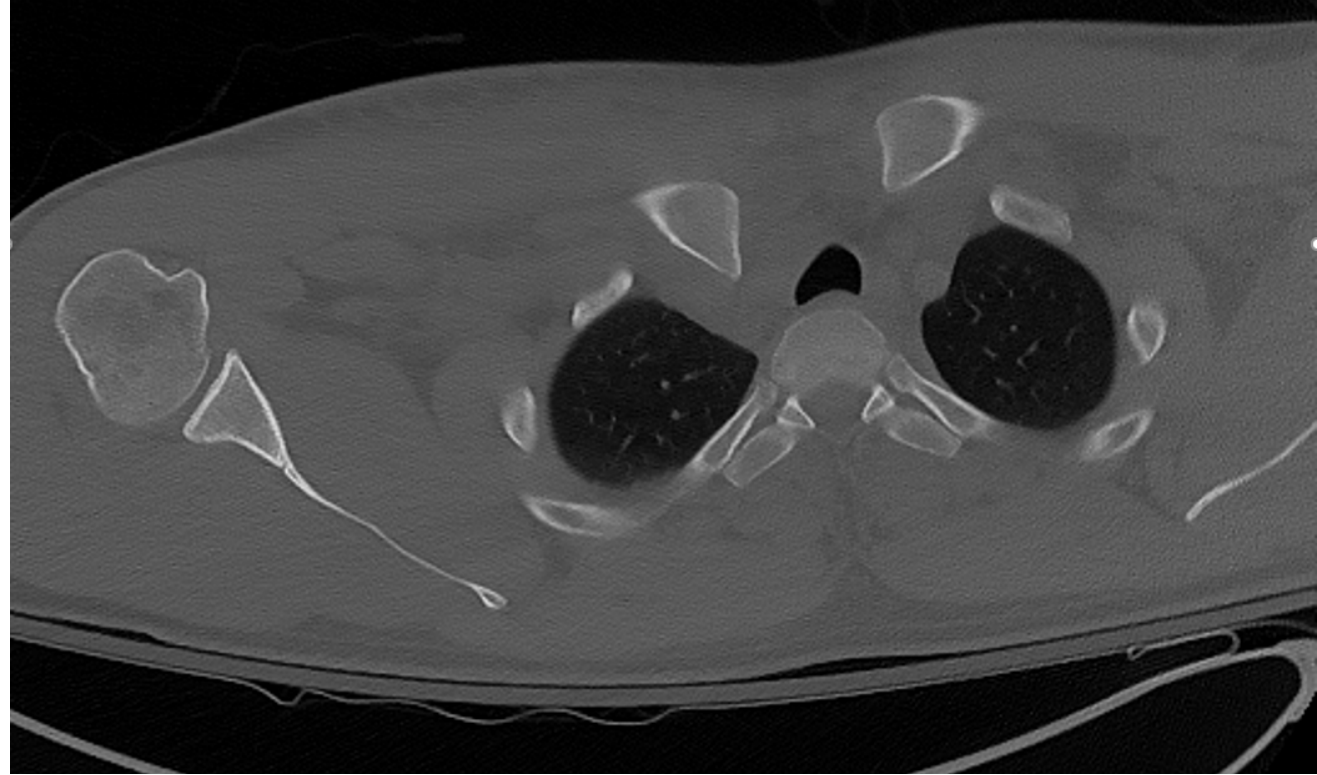
Case Example

- **29yo M**
 - 3 days from injury
 - Pain with swallowing
 - Shortness of breath with talking
 - Distally NVI
- **Posterior R SC dislocation**
- **Tracheal deviation**
- **Wide Mediastinum**



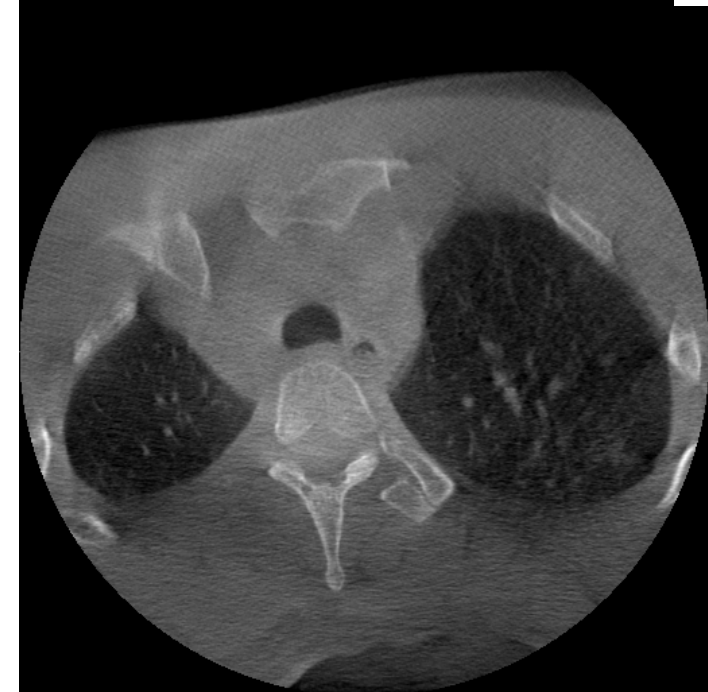
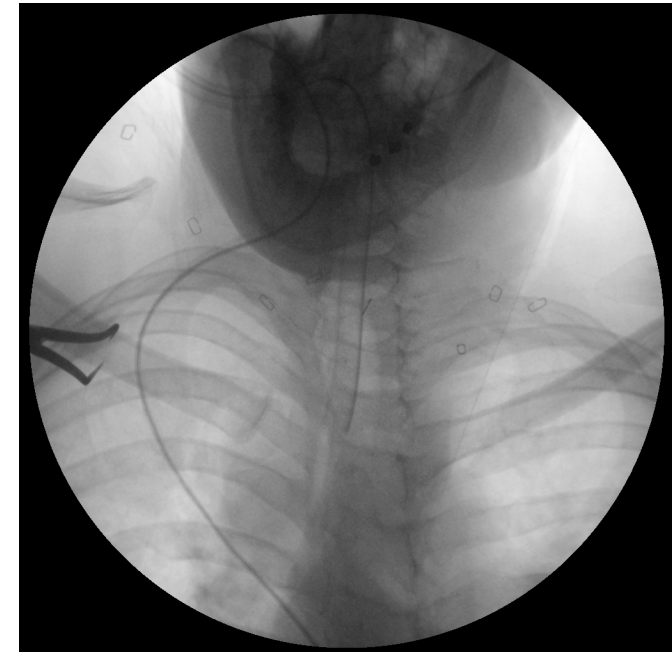
Case Example

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Case Example

- Attempted closed reduction in OR – unsuccessful
- Attempted percutaneous reduction → resubluxation
 - Confirmed with O-Arm



Case Example

- **Conversion to ORIF**
 - **Cardiothoracic surgeon available within 5 minutes**
 - **General Trauma surgeon immediately available**
- **2 cortical screws, 2 locking screws**
- **Planned removal at 6 months**

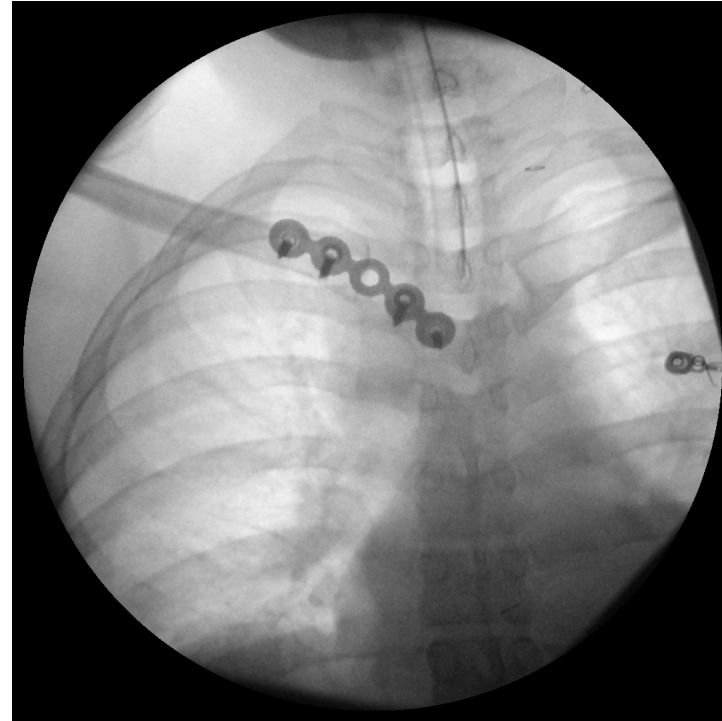
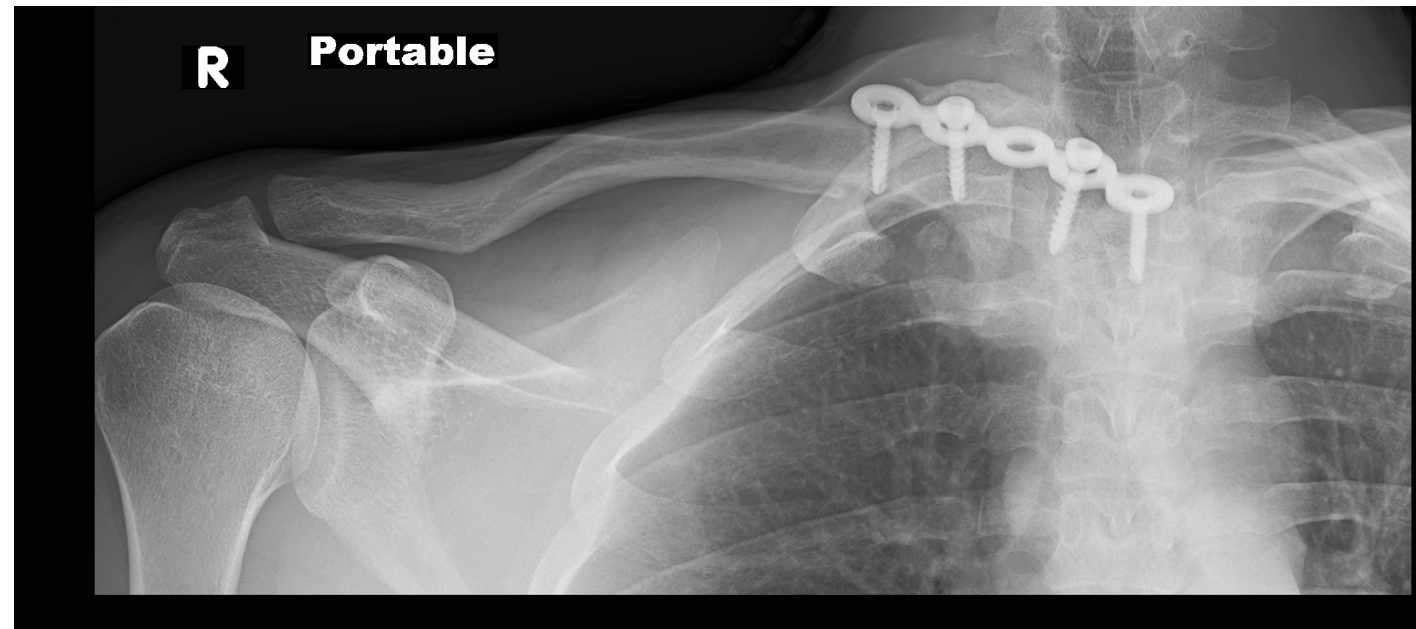
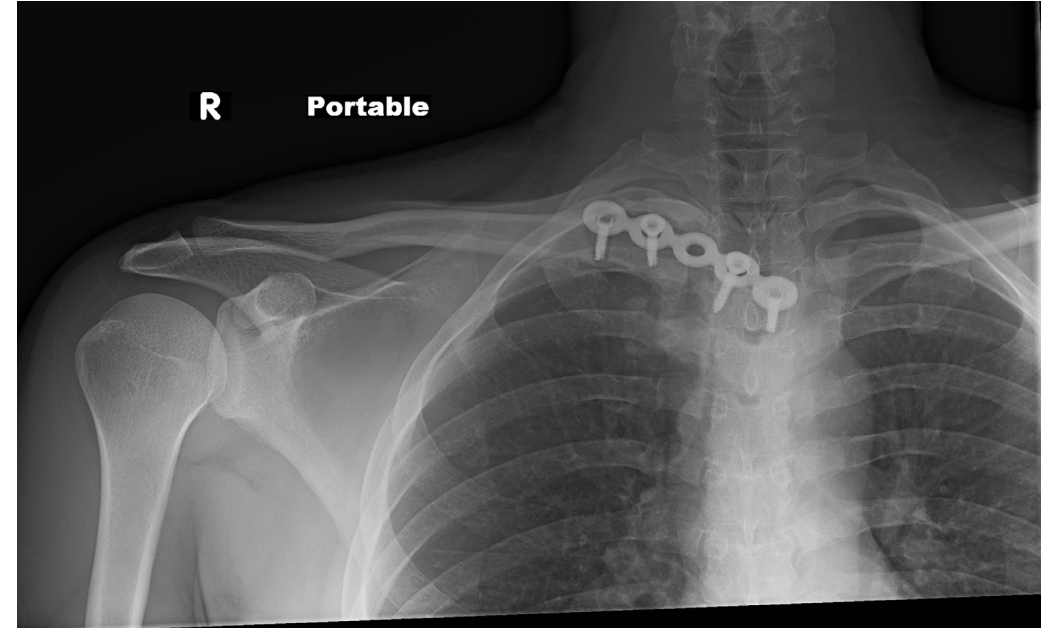


Image courtesy of Prof. David Seligson

Case Example

- Lost to follow up after 2.5 months



Literature Summary

- Bonyun, Marissa, MD, MEd, Nauth, Aaron, MD, MSc. Techniques for Reduction and Fixation of the Sternoclavicular Joint. *J Orthop Trauma*. 2020;34:S1-S2.
- Sernandez, Haley, Riehl, John. Sternoclavicular Joint Dislocation: A Systematic Review and Meta-analysis. *J Orthop Trauma*. 2019;33(7):e251-e255.
- McKee, Michael, MD, FRCS. Operative Fixation of Chronic Acromioclavicular Joint Dislocation With Hook Plate and Modified Ligament Transfer. *J Orthop Trauma*. 2016;30:S7-S8.
- Cole PA, Jacobson AR. Shoulder Girdle Injuries. In: James P. Stannard and Andrew H. Schmidt, eds. *Surgical Treatment of Orthopaedic Trauma*, 2nd ed. New York: Thieme 2016:285-331
- Wang C, Meng JH, Zhang YW, Shi MM. Suture Button Versus Hook Plate for Acute Unstable Acromioclavicular Joint Dislocation: A Meta-analysis. *Am J Sports Med*. 2020 Mar;48(4):1023-1030. Epub 2019 Jul 17. PMID: 31315003.
- McConnell, Alison, Yoo, Daniel, J BSc, MD, et al. Methods of Operative Fixation of the Acromio-Clavicular Joint: A Biomechanical Comparison. *J Orthop Trauma*. 2007;21(4):248-253.
- Canadian Orthopaedic Trauma Society. Multicenter Randomized Clinical Trial of Nonoperative Versus Operative Treatment of Acute Acromio-Clavicular Joint Dislocation. *J Orthop Trauma*. 2015 Nov;29(11):479-87.
- Chang, Nicholas, Furey, Andrew, MD, MSc, Kurdin, Anton. Operative Versus Nonoperative Management of Acute High-Grade Acromioclavicular Dislocations: A Systematic Review and Meta-Analysis. *J Orthop Trauma*. 2018;32(1):1-9.

AC Joint Additional Literature

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Summary

- AC Dislocations
 - Best, most recent literature seems to recommend non-surgical treatment for AC dislocations types I-III without other indications (skin, open injury, etc)
 - Possible exception for overhead workers and throwing athletes in type III
 - Treatment of types IV-VI likely surgical. Lack of good literature. Many authors are classifying type III-V as a single cohort.
 - Many options for fixation constructs and surgical techniques
- SC Dislocations
 - Possibly increasing indications for reduction and fixation of anterior SC dislocations in younger, active patients. More literature is needed.
 - All posterior dislocations should be reduced whether closed or open
 - No reports of cardiothoracic surgeon intervention in the literature that I could find. However, due to anecdotal reports of death with S-C manipulation, many authors recommend that having CT Surgeon available.