Fractures and dislocations of clavicle

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1.SUMMARY

Title: Fractures and dislocations of clavicle

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Clavicle fractures are relatively common injuries. They are usually seen in young, active people. The mechanism is commonly direct trauma to the shoulder or fall on outstreched hand. According to the Allman classification, they can be divided into three major subgroups- fractures of middle third (being the most common one), distal third and, the least commmon, proximal third fractures. The patients can present with pain, tenderness, limited range of motion of affected arm and sometimes even ecchymoses on the affected area. The most common complications of clavicle fractures are brachial plexus injury and subclavian vessel injury, but they can also include life threatening conditions , such as hemo/pneumothorax. The diagnostic imaging modality of choice is anteroposterior radiograph. Treatment options can be divided into conservative and operative.

The two basic types of clavicle dislocations are acromioclavicular and sternoclavicular. They share a similar mechanism of injury- they can be a result of direct trauma to the shoulder (contact sport, motor vehicle accident) or indirect force. Acromioclavicular dislocations are classified according to Rockwood classification. The patient presents with pain around the acromioclavicular joint which can sometimes be reffered to the trapezius muscle. Complication which most commonly occurs is accelarated arthritis. Imaging modality used is special radiograph (Zanca). Treatment strategy follows Rockwood classification. Sternoclavicular dislocations are usuallly divided into anterior and posterior, with anterior being more common. Posterior dislocations can compress mediastinal structures and cause dysphagia and dyspnea and are the main cause of complications, namely neurovascular compromise. Computerized tomography (CT) is the golden standard of imaging. Treatment options are divided into conservative and operative, of course, depending on the patient status.

Keywords: clavicle, fracture, dislocation

1.SAŽETAK

Naslov: Prijelomi i iščašenja ključne kosti

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Prijelomi ključne kosti su relativno česte ozlijede. Obično ih nalazimo u mladih, fizički aktivnih ljudi. Mehanizam ozlijede je najčešće direktni udarac u rame ili pad na ispruženu ruku. Prema Allmanovoj klasifikaciji, možemo ih podijeliti u 3 grupe: prijelomi srednje trećine (ujedno i najčešći), distalne i, najrjeđe, proksimalne trećine. Pacijenti mogu imati bol, osjetljivost na dodir te smanjen opseg kretnji zahvaćene ruke, ponekad i ehimoze na zahvaćenoj strani. Najčešće komplikacije prijeloma ključne kosti su ozljeda brahijalnog pleksusa, ozljede arterije i vene subklavije, no mogu i uključivati po život opasne komplikacije, kao što su hemo/pneumotoraks. Prikladna dijagnostička metoda je rentgenski anterioposteriorni film. Terapijski pristup može biti konzervativni i operativni.

Dva osnovna tipa iščašenja ključne kosti su akromioklavikularno i sternoklavikularno. Oni dijele slični mehanizam ozlijede- mogu biti rezultat direktne traume (kontaktni sport, prometna nesreća) ili indirektne sile. Akromioklavikularna iščašenja su klasificirana prema Rockwood-ovom sistemu. Pacijenti se žale na bol oko akromioklavikularnog zgloba te se ponekada ta bol referira u trapeziusu. Komplikacija koja se najčešće javlja je ubrzani artritis akromioklavikularnog zgloba. Dijagnostička metoda koja se koristi je specijalni rentgenski film(Zanca). Terapijski pristup se ravna po Rockwood-ovoj klasifikaciji. Sternoklavikularna iščašenja se obično dijele na anteriorna i posteriorna. Posteriorna iščašenja mogu komprimirati medijastinalne strukture i uzrokovati disfagiju i dispneju te su glavni uzrok komplikacija, poglavito neurovaskularnih. Računalna tomografija (CT) je zlatni standard u dijagnostickom postupku. Opcije liječenja su podijeljene u konzervativne i operativne, naravno ovisno o statusu pacijenta.

Ključne riječi: ključna kost, prijelom, iščašenje

2. INTRODUCTION

This review paper brings an insight into the fractures and dislocations of the clavicle. Fractures of the clavicle are quite common injuries, making up to 10% of all fractures and are the most common fractures of childhood (1). They can be isolated or co-joined with dislocations, namely acromioclavicular and sternoclavicular dislocations. Those three injuries will be the basis of this review paper.I will focus on the most important clinical parameters, such as etiology, clinical picture, complications, classifications diagnostic procedures and treatment modalities.

3. ANATOMY

The clavicle (collar bone) connects the upper limb to the trunk. Furthermore, it joins the appendicular and axial skeleton in conjuction with the scapula and together those structures form the pectoral girdle. Medially, it articulates with the manubrial portion of the sternum, forming the sternoclavicular joint (SCJ). This joint, encapsulated by a fibrous capsule, contains an intra-articular disc in between the clavicle and the sternum. Superiorly, the interclavicular (IC) ligament connects the ipsilateral and contraleteral clavicle, together providing further stability. Laterally, it articulates with the acromion of the scapula at the acromioclavicular joint (ACJ). This joint, like the sternoclavicular joint, is also lined by fibrocartilage and contains an intra-articular disc.There are three main ligaments which provide support to this joint: the coracoclavicular (CC), coracoacromial (CA) and acromioclavicular (AC) ligaments. The body (shaft) of the clavicle is divided in two parts: medial two-thirds and lateral third. It is clinically significant because this helps the physician to identify the attachment points of muscles. The medial two thirds have an attachment site for the sternocleidomastoid muscle (clavicular head) on the superior surface and subclavius on the inferior surface. The anterior surface is an attachment point for pectoralis major (clavicular head). Sternohyoid muscle attaches to the posterior surface. The lateral third of the clavicle provides attachment for deltoid and trapezius muscles, anteriorly and posteriorly, respectively. The clavicle recieves its blood supply from suprascapular, thoracoacromial and internal thoracic artery. Innervation comes from supraclavicular, subclavian and long thoracic/suprascapular nerve (2,3). Relevant anatomy is well summarized in figures 1,2 and 3.

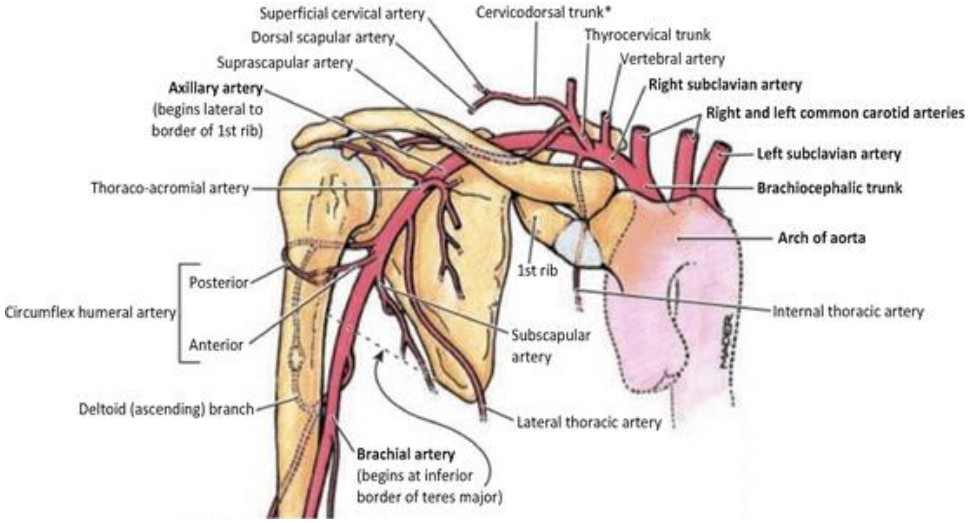


Figure 1. Representation of main vascular branches of the subclavian artery arising around the clavicle. The subclavian artery continues as the axillary artery distally to supply the entire upper extremity. Taken from: Netter FH. Atlas of Human Anatomy, 6th ed. , p. 430, Saunders, Philadelphia, PA. 2014

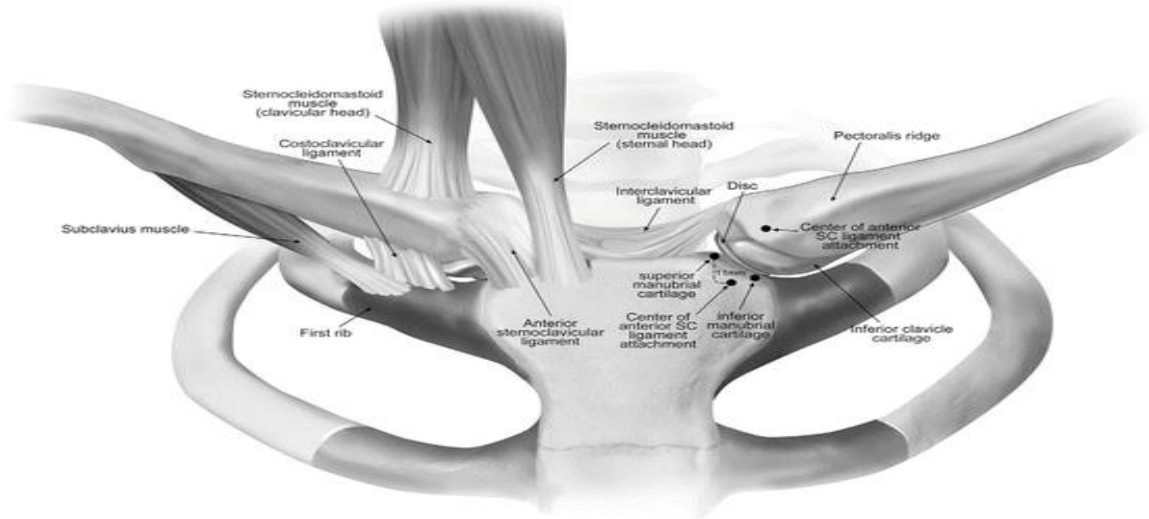


Figure 2. Illustration depicting the anatomy of the medial clavicle and the sternoclavicular joint and demonstrating the robust structures around the joint including the sternoclavicular, costoclavicular and interclavicular ligaments. The subclavius muscle is seen insterting on the inferior surface of the clavicle along its groove. Taken from: Lee JT, Campbell KJ, Michalski MP, Wilson KJ, Spiegl UJ, Wijdicks CA, Millett PJ. Surgical anatomy of the sternoclavicular joint: a qualitative and quantitative anatomical study. J Bone Joint Surg Am, 96(19): e166, 2014

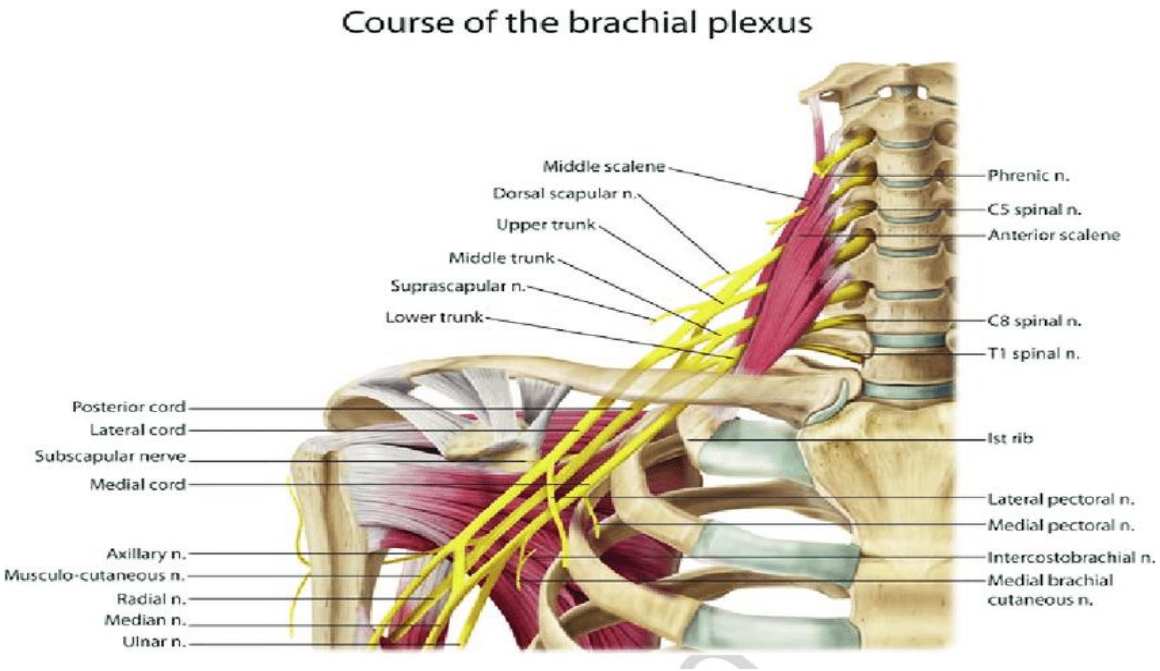


Figure 3. Brachial plexus anatomy. Taken from: Darriush NIkkhah. Brachial Plexus Palsy - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Brachial-plexus-anatomy-Image-Published-under-License-from-wwwshoulderdoccouk_fig1_317498028 [accessed 20 Feb, 2022]

4.CLAVICLE FRACTURES

Clavicular fracture is the most common trauma of pectoral girdle (4). It represents up to 10% of all fractures and it affects 1 in 1000 people per year. Clavicle fractures can occur across all age groups but are most commonly seen in young, active patient population (<25 years), followed by elderly population (>65 years of age). An interesting fact is that approximately 20 % of females and more than 1/3 of males that suffered a clavicular fracture are aged between 13 and 20 years of age. Clavicular fractures represent 95% of all the fractures seen in children and represent 95% of fractures seen during childbirth (5). Clavicular fractures mostly result (85% of cases) from a direct fall onto the lateral shoulder. Less commonly, they may result from direct trauma to the clavicle or from a fall onto an outstretched hand. In the

younger population, clavicular fractures are predominantly a consequence of sports injury or traffic accidents while in elderly, it is usually a result of a fall on the shoulder. Fractures of the clavicle are usually described using the Allman classification system, dividing them into three groups based on location. Fractures of middle third or midshaft fractures are Group I, fractures of distal or lateral third are Group II and fractures of the proximal or medial third are Group III (1).

4.1 Middle third fractures

Fractures of the midshaft are the most common clavicular fractures and they account for 80% of cases (1). Usually they are seen in young, active patients. The mechanism is most often fall on outstreched hand or direct trauma to the shoulder. The middle third is the most common site of fracture because it is the thinnest part of the bone and is the only area not protected by or reinforced with muscle and ligamentous attachments. Middle third fractures can be , according to Neer, further divided into displaced and non-displaced. There can be diplacement of medial fragment where the sternocleidomastoid pulls the medial fragment posterosuperiorly and there can be lateral displacement where the pectoralis and weight of arm pull the lateral fragment inferomedially (6). The acting of the forces is summarized very well in the Figure 4.

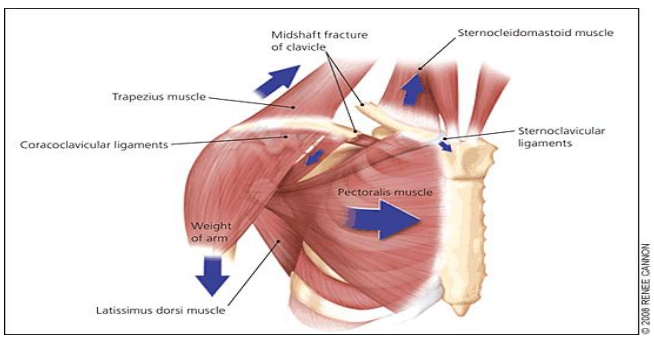


Figure 4. Deforming forces on displaced midshaft clavicle fracture. Taken from: Matthew Peci, Jeffrey Kreber, Am Fam Physician, 2008 Jan 1; 77(1): 65-70 Available at: Clavicle Fractures - American Family Physician (aafp.org) [last accessed 20.2.2022]

The classic presentation of a midclavicular fracture is pain that is well localized and exacerbated by movement of the arm. The patient may also report a snapping or cracking sensation at the time of the injury and localized swelling over the affected area (7). Because the clavicle lies close to the skin, examination very often shows a visible bulge due to haematoma, bone angulation or displaced bone edges. Tenting of skin (if present), suggests significant angulation or displacement (1,7). It is very important to perform a complete neurovascular examination due to proximity of brachial plexus and subclavian vessels (1). The most common complication is malunion and it can result in shortening, angulation or even poor cosmetic result. Serious complications are very uncommon but can include subclavian artery or vein compression, brachial plexus injury or thoracic outlet syndrome (7).

In the diagnostics, besides thorough anamnesis and physical examination, the main modality is an anteroposterior radiograph and it is usually sufficient to demonstrate middle third fracture and assess displacement. If a fracture is suspected, but the anteroposterior view is unrevealing, a 45° cephalic and 45° caudal radiographs can be obtained to better assess any displacements (7,8, Figure 5). Another useful modality reviewed in literature is the ultrasound (9).

Figure 5. This plain radiograph shows a middle third clavicle fracture with comminution (3rd bone fragment clearly seen between proximal and distal fragments). Nonoperative management was chosen in part because displacement was less than the full width of the clavicle. Taken from: Robert L Hatch, James R Clugston, Jonathan Taffe. Clavicle fractures in : UpToDate. [last accessed 20.2.2022]. Available from : Clavicle fractures - UpToDate

The treatment options of midshaft fractures can be divided in conservative and operative.The goal of conservative treatment is pain control (most commonly achieved with usage of moderate strength opioids such as oxycodone or hydrocodone) and reduction of motion at the fracture site until clinical union occurs. The fracture site is best stabilized by restricting shoulder motion to less than 30° of abduction,forward flexion or extension. In the past, both a sling and a figure- of- eight bandage were used and similar outcomes were reported. However, more recent studies do not advise the use of figure-of-eight bandage, due to the patients suffering from more pressure sores in axillae (7,10). The indications for surgery can be classified into absolute and relative. Absolute indications are open fractures, severe angulation, or displacement causing potential risk for skin perforation, neurovascular compromise, and symptomatic nonunion. Relative indications for surgery include fracture shortening >1.5 to 2 cm, or 14% to 15% of the contralateral side,

polytrauma, floating shoulder, significant seizure or neuromuscular disorder and unsightly cosmetic appearance due to displacement (11). Surgical techniques used are open reduction and internal fixation (ORIF) and intramedullary fixation. ORIF using plates and screws is considered the current gold standard for the operative management of displaced and/or shortened midshaft clavicular fractures. The other procedure, intramedullary fixation, was performed clasically with Rockwood pins and Haggie pins, but the current most used material is titanium elastic nail (TEN) (10).

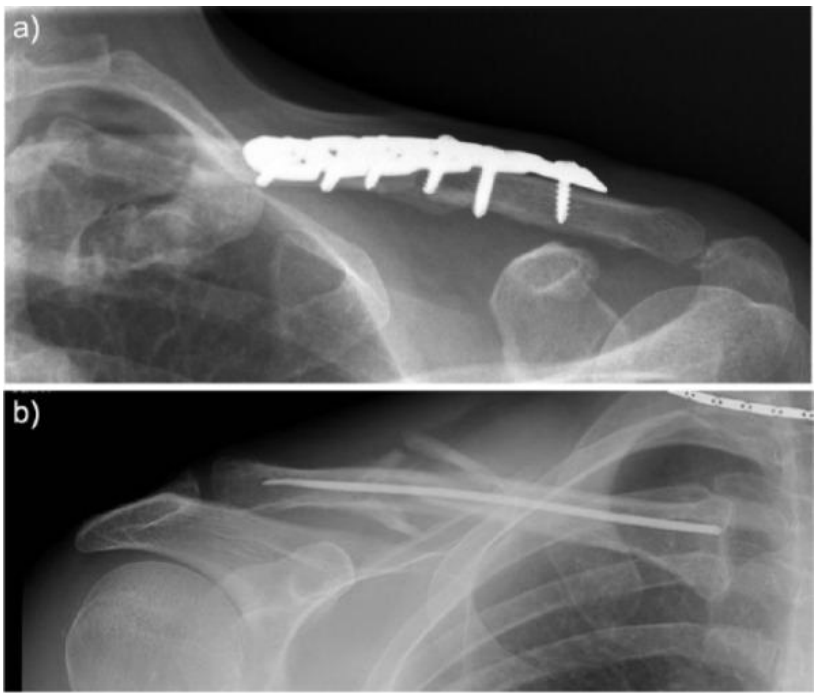


Figure 6. a) Example of plate fixation of a clavicle fracture ; b) Example of intramedullary fixation. Taken from: Hoogervorst P, van Schie P, van den Bekerom MP. Midshaft clavicle fractures: Current concepts. EFORT Open Rev. 2018 Jun 20;3(6):374-380. doi: 10.1302/2058-5241.3.170033.

“When comparing non operative and operative management, operative treatment with either ORIF or intramedullary fixation leads to improved short-term functional outcomes, increased patient satisfaction, an earlier return to sports and lower rates of non-union compared with conservative treatment. In terms of cost-effectiveness, operative treatment seems to be advantageous. However, operative treatment is

associated with an increased risk of complications and re-operations, while long-term shoulder functional outcomes are similar” (10).

4.2 Distal (lateral) third clavicle fractures

When compared to midshaft fractures, they are occur less commonly (around 10-15% of all clavicle fractures).The mechanism, however, is very similar to midshaft fractures-usually occurs after a direct compressive force is applied to the shoulder (fall, trauma) (6). The patient will usually present with tenderness and pain in the area of acromioclavicular joint and those features are commonly accompanied by ecchymosis and swelling. Most notable complications that can occur are nonunion and acromioclavicular joint arthritis. The diagnostic modality is the same as with midshaft fractures- thorough medical history and physical exam, followed by an anteroposterior radiograph. Distal third fractures can be classified according to the modified Neer classification. It is based on fracture location in relation to the coracoclavicular ligament on simple anteroposterior radiographs and its involvement. “Type 1 fractures occur lateral to the CC ligament with minimal displacement and no involvement of the acromioclavicular joint. Type 2 fractures occur medial to the CC ligament and are divided into two subtypes, subtype 2A (medial to the conoid ligament) and subtype 2B (between the conoid and trapezoid ligaments with a rupture of the conoid ligament). Type 3 fractures are similar to type 1 (i.e., also lie lateral to the coracoclavicular ligament), but they have intra-articular extension; type 4 fractures involve disruption of the periosteal sleeve and the medial fragment gets displaced upwards in children; and type 5 fractures are similar to type 2 (involve a small inferior fragment attached to the coracoclavicular ligament) and are comminuted ”(12).

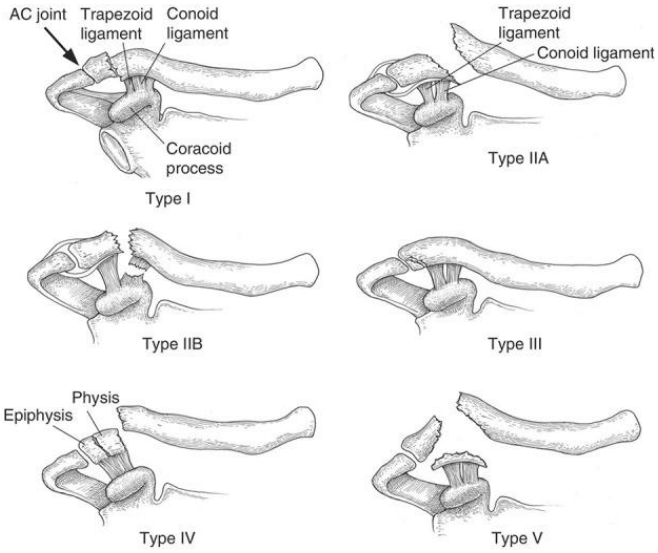
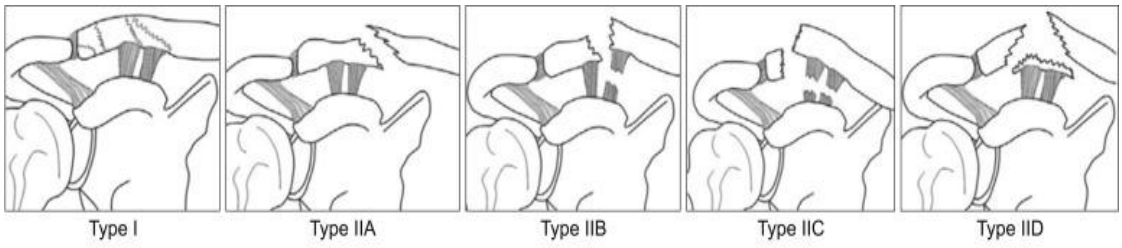


Figure 7. This illustration shows the modified Neer classification . Reprinted with permission from Banerjee R, Waterman B, Padalecki J, Robertson W. Management of distal clavicle fractures. *J Am Acad Orthop Surg.* 2011;19:392-401. Taken from: Stenson J, Baker W. Classifications in Brief: The Modified Neer Classification for Distal-third Clavicle Fractures. Clin Orthop Relat Res. 2021 Jan 1;479(1):205-209. doi: 10.1097/CORR.0000000000001456.

Besides the modified Neer classification system, a newer classification system has been reported in literature. In 2018, Cho et al proposed a new classification system which considers fracture displacement and stability, as well as as fracture location to provide more information for diagnosis and associated treatment options including fixation methods. It is based on simple anteroposterior and oblique views of the acromioclavicular joint and an axial view in shoulder radiography.It proposed that type I fractures are stable, involve no or minimal displacement (<5 mm), and can occur in any location, while type II fractures are unstable and have more significant displacement (≥5 mm) (12,13,14).Furthermore, type II fractures are divided into four subcategories : type IIA (occurs medial to the coracoclavicular ligament and both the conoid and trapezoid ligaments remain attached to the distal fragment); type IIB (occurs medial to the coracoclavicular ligament and the conoid ligament is detached

from the distal fragment); type IIC (occur lateral to the coracoclavicular ligament and both the conoid and trapezoid ligaments are detached from the medial fragment); and type IID (involve comminution with the inferior fragment that remains attached to the coracoclavicular ligament) (14). This system is well described in Figure 8.



Type I-stable	Nondisplaced or minimally displaced (<5 mm) regardless of location
Type II-unstable	Displaced (≥5 mm)
IIA	Fracture medial to the CC ligaments: conoid and trapezoid intact
IIB	Fracture medial to the CC ligaments: conoid torn, trapezoid intact
IIC	Fracture lateral to the CC ligaments: conoid and trapezoid torn
IID	Comminuted fracture: CC ligaments attached to inferior ligament

Figure 8. Cho's classification system of distal clavicle fractures. Taken from: Kim DW, Kim DH, Kim BS, Cho CH. Current Concepts for Classification and Treatment of Distal Clavicle Fractures. Clin Orthop Surg. 2020 Jun;12(2):135-144. doi: 10.4055/cios20010. Epub 2020 May 14

Distal third fractures can be treated non-operatively or surgically. According to Cho et al, treatment options of distal third fractures can be divided based on the magnitude of displacement and involvement of coracoclavicular ligament. If the displacement is < 5mm, conservative measures are applied. This minimal displacement corresponds to type I fractures. The conservative treatment modalities are immobilization with an arm sling or a figure- of- eight bandage. Arm sling is generally prefered over figure-of-eight bandage due to higher patient comfort and less problems reported (temporary neurovascular dysfunction, pseudoarthrosis). If the displacement is greater than 5 mm, the next important step is to determine if there is involvement of coracoclavicular ligaments. If not, type IIA and type IID are

suspected. For type IIA, precontoured locking plates are used. They provide firm fixation of the fracture site and allow for early motion of the affected arm. They are precontoured for anatomical fit with the distal clavicle and facilitate multi-planar fixation of the distal fragment and better stability of the small fragment. In addition, this type of plate is not associated with impingement of the subacromial space because it allows for fixation of the fracture site without crossing the AC joint. For type IID fractures, precontoured locking plates, as well as hook plates are used. Hook plates are extremelly useful if distal fragment is too small to insert screws. The hook is located under the acromion and provides distal leverage that helps maintain reduction of the superiorly displaced medial fragment (14).

If there is presence of displacement which is greater than 5 mm, as well as involvement of coracoclavicular ligaments, those fractures are classified into IIB and IIC types. Type IIB fractures can be managed with previously mentioned precontoured locking plates and hook plates, as well as tension band wiring and, finally, coracoclavicular fixation. Type IIC fractures can be managed with coracoclavicular fixation and transacromial intramedullary fixation (14).

4.3 Proximal (medial) third fractures

Proximal third fractures are the least common type of clavicle fractures, making up to 5% of them. Unlike the previous mentioned clavicle fractures, the mechanism of injury is different here. They are usually linked to high energy trauma (motor vehicle accidents), typically accompanied by significant multisystem trauma and have a high associated mortality rate (15). Medial third clavicle fractures can be classified by Edinburgh system (Figure 9), Throckmorton system (Figure 10) and, as proposed by

Van Tongel et al.,the new anatomically- based classification systems (Figure 10). The Edinburgh system defines type 1 medial fractures which are located within the one-fifth of clavicle bone lying medial to a vertical line drawn upward from the center of the first rib. Furthermore, subclassifications A and B describe the aspect of displacement. Edinburgh classification defines displacement as translation of the major fragments greater than 100%. Finally, type-1A and type-1B fractures can be divided into extraarticular or intraarticular (16). Throckmorton classification system described the fracture in two ways, one system based on fracture pattern and another based on fracture displacement. Fractures were classified as transverse, oblique intra-articular, oblique extra-articular, comminuted, or avulsion. Fractures were classified as minimally displaced if there was less than 2 mm between fracture fragments. Moderately displaced fractures were those with 2 to 10 mm of gapping between fragments. Those fractures with more than 10 mm between fragments were classified as severely displaced. The AB classification classified the fracture as medial (Type 1) or lateral (Type 2) to the costoclavicular ligament and no or minimal displaced (Type A) or displaced (Type B) (16).

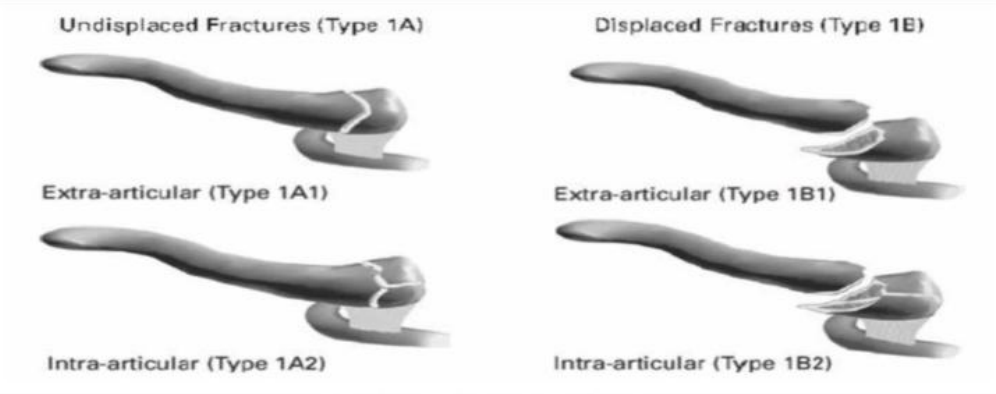


Figure 9. Edinburgh classification of proximal clavicle fractures

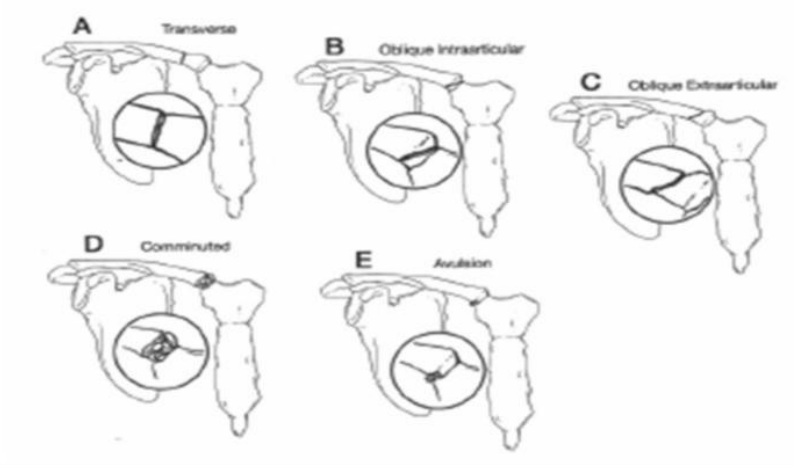


Figure 10. Throckmorton classification of proximal clavicle fractures

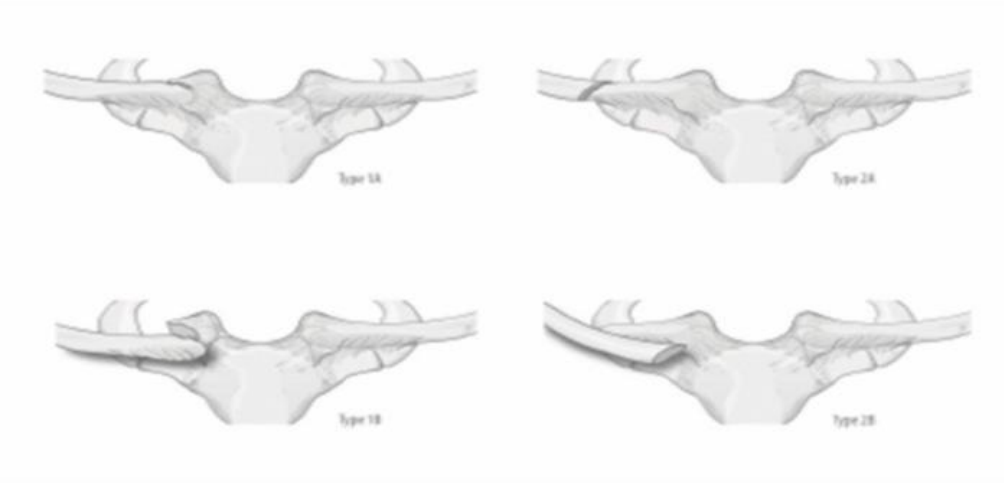


Figure 11. Anatomically based classification of proximal clavicle fractures

Figures 9,10,11 taken from: Van Tongel A, Toussaint A, Herregods S, Van Damme S, Marrannes J, De Wilde L. Anatomically based classification of medial clavicle fractures. Acta Orthop Belg. 2018 Mar;84(1):62-67.

The patients usually present with pain near the sternoclavicular area, worsened by movement of the shoulder. The supine position may increase pain, and patients are usually more comfortable if they sit up and support the arm.Occasinally, ecchymoses can be seen as well. Because medial third fractures are in most cases a part of multisystem trauma, it is also extremelly important to perform neurovascular and

lung examination to rule out additional complications (hemothorax, pneumothorax, rib fractures). The imaging modality used is anteroposterior radiograph and if the radiograph is inconclusive, additional modality is the CT-scan (7). Regarding the treatment options, there are, again, two options available. Nonoperative (conservative) method, as reported in the literature, is still the golden standard and surgical procedures are only indicated in cases of displacement, open injury and segmental fractures (17). Event though there is not a specific surgical method for open reduction and internal fixation of proximal third clavicle fractures, some studies described the techniques well (18,19).

5. ACROMIOCLAVICULAR DISLOCATION

An acromioclavicular dislocation, also known as shoulder separation, is a traumatic injury to the acromioclavicular joint with the disruption of acromioclavicular ligaments and/or coracoclavicular ligaments (20). It accounts for approximately 9% of all shoulder injuries. It typically occurs in young, athletic male adults (20-39 years of age), and is predominantly a result of contact sports, such as ice-hockey, handball and rugby (21,22). The mechanism of injury, in most cases, is direct, high-energy impact on shoulder. It can also be indirect, as a consequence of a fall on extended arm. Acromioclavicular dislocations can be classified according to Rockwood classification system (23). Rockwood divided the dislocation into six categories, with respect to involvement of acromioclavicular ligaments, acromioclavicular joint, coracoclavicular ligaments and deltoid and trapezius muscles. (Tables 1,2)

Table 1. Rockwood classification of acromioclavicular separations Types I–III

Structure	I	II	III
Acromioclavicular ligament	Sprained	Complete tear	Complete tear*
Acromioclavicular Joint	Intact	Disrupted; widened in the transverse plane	Dislocated; clavicle displaced superiorly relative to the acromion
Coracoclavicular ligaments	Intact	Sprained; slight widening of interval	Disrupted; interval widened up to 100%*
Deltoid and trapezius muscles	Intact	Possible partial detachment	High probability of detachment from distal clavicle

*In a Type III variant, the clavicle ruptures through the periosteal sleeve superiorly, leaving behind, inferiorly, a periosteal tube attached to the cartilaginous epiphysis that maintains the integrity of the AC joint. The CC ligaments are intact and remain attached to the periosteal sleeve.

Table 2. Rockwood classification of acromioclavicular separations Types IV–VI

Structure	IV	V	VI
Acromioclavicular ligaments	Complete disruption	Complete disruption	Complete disruption
Acromioclavicular joint	Dislocated; clavicle displaced posteriorly into or through the trapezius muscle	Dislocated; extreme vertical incongruity between lateral clavicle and acromion.	Dislocated; clavicle displaced inferior relative to the acromion*
Coracoclavicular ligaments	Partial or complete disruption with change in interval orientation	Complete disruption; interval widened 100% to 300%	Intact; interval is decreased or reversed*
Deltoid and trapezius muscles	High probability of detachment from distal clavicle	High probability of detachment from distal clavicle	Intact, partial, or complete detachment

*In a continuation of Type VI, the clavicle is displaced inferior to the coracoid process. In this case the coracoclavicular ligaments are completely torn, and the coracoclavicular interval no longer anatomically exists.

Tables 1 and 2 taken from: Gorbaty JD, Hsu JE, Gee AO. Classifications in Brief: Rockwood Classification of Acromioclavicular Joint Separations. Clin Orthop Relat Res. 2017 Jan;475(1):283-287. doi: 10.1007/s11999-016-5079-6. Epub 2016 Sep 16.

The patients usually present with pain localized around the acromioclavicular joint which can be sometimes reffered to the trapezius muscle. Complications which can occur are acromioclavicular arthritis, residual pain and osteolysis of distal clavicle. On physical exam, one can find lateral clavicle or acromioclavicular joint tenderness and abnormal contour of shoulder compared to the contralateral side. It is important to assess stability of the joint. Vertical (superior-inferior) stability evaluates

coracoclavicular ligaments while horizontal (antero-posterior) stability evaluates acromioclavicular ligaments (20). From the imaging modalities, it is necessary to perform a bilateral, weight-bearing Zanca view radiograph (10 kg, “water-bearer” radiograph), an axial radiograph and bilateral Alexander view radiographs (outlet view with cross-body maneuver) (22). The treatment strategy follows the Rockwood classification system. Type I and II dislocations are treated conservatively, with analgetics, local cooling and an immbilization sling (maximally worn for 2 weeks, after that physiotherapy is started). Types IV, V, and VI are best managed operatively. Surgical techniques used are open reduction and internal fixation (ORIF) with coracoclavicular fixation (Bosworth screw), ORIF with coracoclavicular suture fixation, ORIF with acromioclavicular pin fixation (Phemister technique), ORIF with acromioclavicular hook plate fixation, coracoclavicular ligament reconstruction with coracoacromial ligament (Modified Weaver- Dunn method) and coracoclavicular ligament reconstruction with free tendon graft. Treatment option for type III dislocations is still controversial, with some studies showing better prognosis with non operative management and some with operative (20,22,23).

6. STERNOCLAVICULAR DISLOCATION

Sternoclavicular dislocations are relatively uncommon injuries to the thoracic wall, making up to 3% of dislocations around the pectoral girdle. This joint is in its nature unstable, due to lack of articular contact and it requires stability from ligamentous structures such as interclavicular, costoclavicular and capsular ligaments. They can be a result of a trauma (result of motor vehicle accident, contact sport) or can be atraumatic (collagen deficiency conditions such as Ehler-Danlos syndrome and

generalized hypermobility syndrome, infection, arthritis or abnormal mucle patterning) (24). Traumatic dislocations can be divided into anterior and posterior, with anterior being much more common. Posterior dislocation of the sternoclavicular joint can be caused by a direct force over the anteromedial aspect of the clavicle or an indirect force to the posterolateral shoulder, forcing the medial clavicle posteriorly. Anterior dislocation is usually due to a lateral compressive force to the shoulder girdle, which results in sparing of the posterior capsule but rupture of the anterior capsule and often part of the costoclavicular ligament. Additionally, Stanmore triangle has been used for evaluation of sternoclavicular joint instability." The Stanmore triangle is based on three groupings of instability; type I is traumatic structural, type II is atraumatic structural, and type III is muscle patterning non-structural. In the case of type I instability there is clear trauma leading to structural change of the SCJ, such as dislocation or fracture. Type II instability is not related to any trauma but still shows clear structural changes in the SCJ causing instability possibly as a result from repetitive microtrauma. Type III instability occurs when the musculature, particularly the pectoralis major, contracts abnormally and causes instability of the sternoclavicular joint" (24,26).

Patients with anterior dislocation present with a deformity which manifests as a painful lump, just lateral to the sternum. Posterior dislocation may present with medial clavicular pain, but also with compressive symptoms, such as dysphagia or dyspnea and tachypnea and stridor (while in supine position). Posterior dislocation can sometimes even lead to vascular and neurological compromise. The findings of the physical exam vary but can consist of swelling, reduced range of motion of arm, paresthesias in affected extremity, even venous congestion or diminished pulse in comparison to the unaffected side (24, 25). Complications of sternoclavicular

dislocations are mostly linked to posterior dislocations and include brachial plexus injury, vascular injuries, esophageal rupture and tracheal compression. Dislocation of sternoclavicular joint can also be joined with acromioclavicular dislocation and ,in this case, it is called traumatic floating clavicle (24).

Anteroposterior X-ray as an imaging modality is not the first choice in the case of sternoclavicular dislocation because it does not yield sufficient delineation of this anatomical region. However, serendipity view (40° cephalic tilt) can present the anterior dislocation as superiorly displaced medial clavicle and posterior dislocation as inferiorly displaced medial clavicle. The golden standard is the CT scan due to its ability of 3D reconstruction of the joint and determination of its exact position. Additionally, it can also help to identify injuries to mediastinal structures. (24,25,26).

Sternoclavicular joint dislocation can be managed conservatively (closed reduction) or surgically. If the patient presents with acute anterior dislocation, the initial strategy would be closed reduction with sedation or under general anesthesia. The patient is placed supine with a bolster placed between their shoulders. Traction is then applied to the affected upper limb in 90 degrees of abduction with neutral flexion and direct pressure is applied over the medial clavicle. Following reduction the arm should be placed in a polysling, maintaining scapular protraction for up to 4 weeks. In the case of posterior dislocation, closed reduction should be initially attempted too, as shown in figure 12.

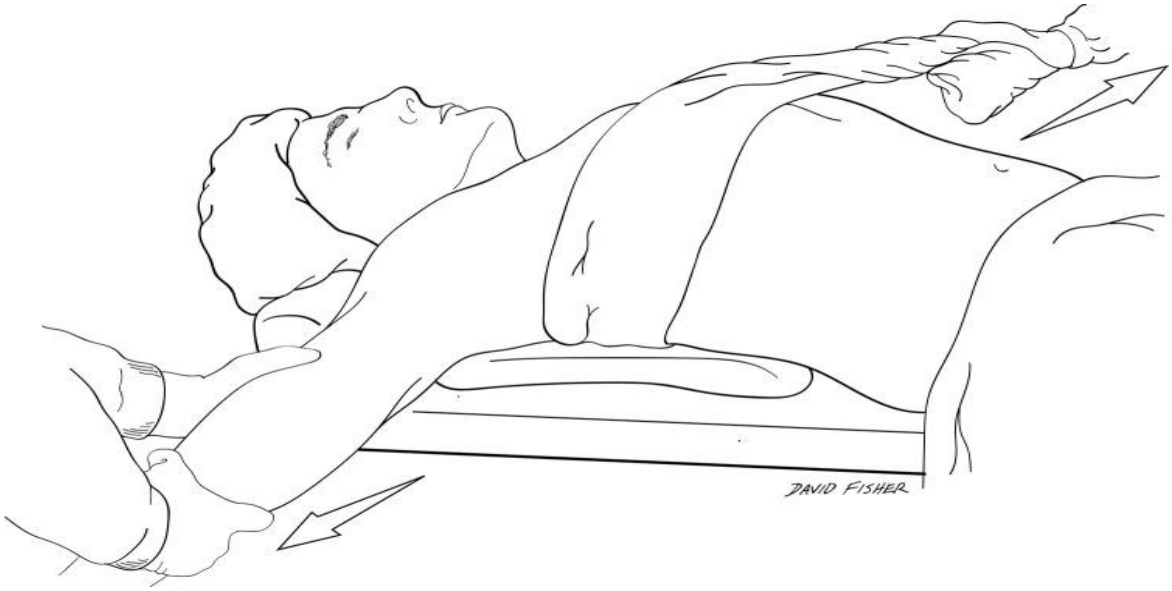


Figure 12. Illustration of closed reduction of a posterior SCJ dislocation. A foam pad or bolster is placed under the scapulae while lateral traction is applied as the arm is pulled into extension. Taken from: Garcia JA, Arguello AM, Momaya AM, Ponce BA. Sternoclavicular Joint Instability: Symptoms, Diagnosis And Management. Orthop Res Rev. 2020 Jul 28;12:75-87. doi: 10.2147/ORR.S170964.

However, if If closed reduction is not possible or there is ongoing symptomatic instability of the sternoclavicular joint, surgery should be performed. The main surgical procedures are sternoclavicular joint reconstruction using the Figure-8 surgical technique with grafted ligament or tendon, reconstruction using the suture anchor technique described by Bak et al, reconstruction using the Roman numeral X technique described by Guan et al and reconstruction using the Sternal Docking technique described by Sanchez-Sotelo et al (26).

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9. BIOGRAPHY

I was born on 23/08/1996 in Zagreb, Croatia. I attended elementary school “Ksaver Šandor Gjalski” and later Archbishop classical gymnasium, both in Zagreb. In third year of my higschool studies, I developed interest in medicial studies and, in 2016, I enrolled in the University of Zagreb, Medical Studies in English programme. During my medical studies, I am a member of student sections for surgery and dermatology, which, alongside family medicine, are my fields of interest. In my free time I like to learn new languages, explore new cultures and workout.