Reasons and treatments of shoulder dislocation

Shani Ashri, Costa Alon

UNIVERSITY OF ZAGREB
SCHOOL OF MEDICINE

Costa Alon Shani Ashri

Reasons and Treatments of Shoulder Dislocation

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ABBREVIATIONS

SJ – Shoulder joint

ISJ – Instability of the shoulder joint

H-S lesion – Hill-Sachs lesion

B lesion – Bankart lesion

SGHL – Superior glenohumeral ligament

IGHL – Inferior glenohumeral ligament

Contents

1. Abstract

Joints in the human body are capable of dislocating, and the shoulder joint is the most predisposed to such events. Shoulder dislocations are the most common dislocations in the human body. One of the main causes is a disproportion of size between the articulating surfaces. Furthermore, anterior shoulder instability originating in traumatic mechanisms account for 95% of glenohumeral dislocations and is the most frequent condition in younger population and athletes, making it a bothersome challenge for medical physicians. Due to pathological changes, following the primary dislocation, recurrences usually follow. Therefore, prompt and adequate treatment should be applied. Although subluxations do not cause pathological lesions, with every recurrent dislocation, the risk of additional lesions such as the Hill-Sachs and the Bankart lesions only rises while the overall joint stability only decreases. Following a dislocation, the shoulder joint must be immobilized until a skilled professional can treat it accordingly, and adequate rehabilitation program must be exercised subsequently. Furthermore, given the evidence and research collected so far, surgical treatment ought to be considered. On the topic of surgical techniques, there are different types of surgical interventions regarding open and arthroscopic surgery. While in the field's past, open Bankart operation was considered the gold standard for surgical treatment of this condition, nowadays alongside the development of arthroscopic methods, open surgeries are becoming less and less popular. There are pros and cons regarding each technic, but it must not be forgotten that in some occasions, open surgery is still the superior choice.

Keywords: Shoulder joint dislocation, Hill-Sachs lesion, Open Bankart repair, Arthroscopic shoulder instability procedures

2. Sažetak

Zglobovi u ljudskom tijelu se mogu dislocirati, a rameni zglob je najskloniji takvim događajima. Iščašenja ramena su najčešća iščašenja u ljudskom tijelu. Jedan od glavnih uzroka je nesrazmjer veličine između zglobnih površina. Nadalje, prednja nestabilnost ramena uzrokovana traumom čini 95% glenohumeralnih dislokacija i najčešće je stanje kod mlađe populacije i sportaša, što liječnicima predstavlja izazov. Zbog patoloških promjena, nakon primarnog iščašenja obično slijede recidivi. Stoga treba primijeniti brz i adekvatan tretman. Iako subluksacije ne uzrokuju patološke lezije, sa svakom ponovljenom dislokacijom, rizik od dodatnih lezija kao što su Hill-Sachsove i Bankart lezije samo raste, dok se ukupna stabilnost zgloba smanjuje. Nakon iščašenja, rameni zglob mora biti imobiliziran sve dok ga kvalificirani stručnjak ne može u skladu s tim liječiti, a naknadno se mora provesti adekvatan program rehabilitacije. Nadalje, s obzirom na do sada prikupljene dokaze i istraživanja, trebalo bi razmotriti kirurško liječenje. Postoje različite vrste otvorenih i artroskopskih kirurških intervencija. Iako se u prošlosti otvorena operacija po Bankartu smatrala zlatnim standardom za kirurško liječenje ovog stanja, u današnje vrijeme, uz razvoj artroskopskih metoda, otvorene operacije postaju sve manje popularne. Svaka tehnika ima prednosti i nedostatke, ali ne smije se zaboraviti da je u nekim prilikama otvorena operacija i dalje optimalan izbor.

Ključne riječi: dislokacija ramenog zgloba, Hill-Sachsova lezija, otvorena Bankartova operacija, artroskopske operacije nestabilnosti ramenog zgloba

3. Introduction

In this review paper, I will present aetiologies and mechanisms, along with various conservative and operative methods to manage unstable shoulder conditions. The shoulder joint is the most mobile joint in the human body, thanks to the loose joint capsule and the disproportion between the joint surfaces that make up the humerus and the glenoid cavity. Precisely because of this, the shoulder is a relatively unstable joint with frequent dislocations, and its dislocations make up 50% of all dislocations. Shoulder joint instabilities can be classified according to the direction of the dislocation. Could be anteriorly, posteriorly, inferiorly and in a multidirectional way. It could be even further divided into traumatic and atraumatic. The mechanisms of dislocation are a fall on an outstretched or elbow-bent arm, as well as a direct blow to the shoulder area. The causes differ depending on age, activity, number of previous events and more. Shoulder joint instability is often accompanied by concomitant pathologies such as Bankart's and Hill-Sachs lesions. Said lesions can definitely complicate and prolong a patient's management and recovery period. In the case of an unstable shoulder, treatment can be conservative, ie treatment with orthoses and physical therapy, as well as surgical treatment. There are two ways to operate on an unstable shoulder: open surgery and, recently popular, minimally invasive arthroscopic stabilization procedures.

4. Anatomy of the shoulder joint

The shoulder joint, in short, is a “ball (humeral head) and socket” (glenoid cavity) synovial type of a joint. This joint specifically, is unique in its hypermobility compared to all other joints in the human body. This extreme mobility advantage also entails an obvious disadvantage; with a wide range of motion comes the inevitable predisposition for joint instability. Its extraordinary range of motion is made possible thanks to the combination of 5 different joints in the shoulder region: glenohumeral joint, thoraco-scapular joint, sternoclavicular-joint, acromioclavicular joint, and subacromial joint. The most relevant one, regarding the topic of dislocations, is of course the glenohumeral joint. The glenohumeral joint allows movement of the arm in multiple planes: flexion, extension, adduction, abduction, internal and external rotation. The glenoid cavity (or fossa) is a shallow concave bony surface that is structurally deepened and surrounded by a fibro-cartilaginous rim, the glenoid labrum. The glenoid labrum increases the articulating surface area by an additional 50% to the glenoid cavity. It is further reinforced by the tendon of the long head of the biceps brachii at its superior aspect (figure 1)[13]. The fact that the shoulder joint capsule is relatively loose, alongside the objective existing measures of the articulating surfaces of said ball and socket (4:1 ratio between the humeral head and the shallow glenoid fossa respectively), make the shoulder joint – the most commonly dislocated joint in the entire body [14].

Glenohumeral stability is sustained by a combination of *static* and *dynamic* structures. The static stabilizers include the bony articular anatomy and joint congruity, the glenoid labrum, the joint capsule, the glenohumeral ligaments, and the negative intraarticular.

The glenohumeral joint is locked up inside the joint capsule that secures the structures of the joint under its fibrous sheath. The reason the joint capsule is such a tolerating enclosure (regardless of its relative looseness), is due to the shape, position, angle, origin and insertions of its constituent glenohumeral ligaments, that basically make up the entire structure. They are the superior, middle and inferior glenohumeral ligaments. Those ligaments are the primary structures that help prevent anterior shoulder dislocation. The joint capsule encloses the anatomical neck of the humerus head to the rim of the glenoid fossa. The inner most surface of the joint capsule is lined by a synovial membrane. To reduce the friction between the articulating structures, this membrane produces the necessary synovial fluid [15].

To further reduce the friction, there are additional structures called bursae within the shoulder complex. Bursae are small synovial fluid filled sacs that are lined by a synovial membrane.

The fluid consistency is like that of a raw egg white. Bursae function as a shock absorber and a gliding surface between joint structures. The most clinically important bursae are the subacromial and the subscapular bursae.

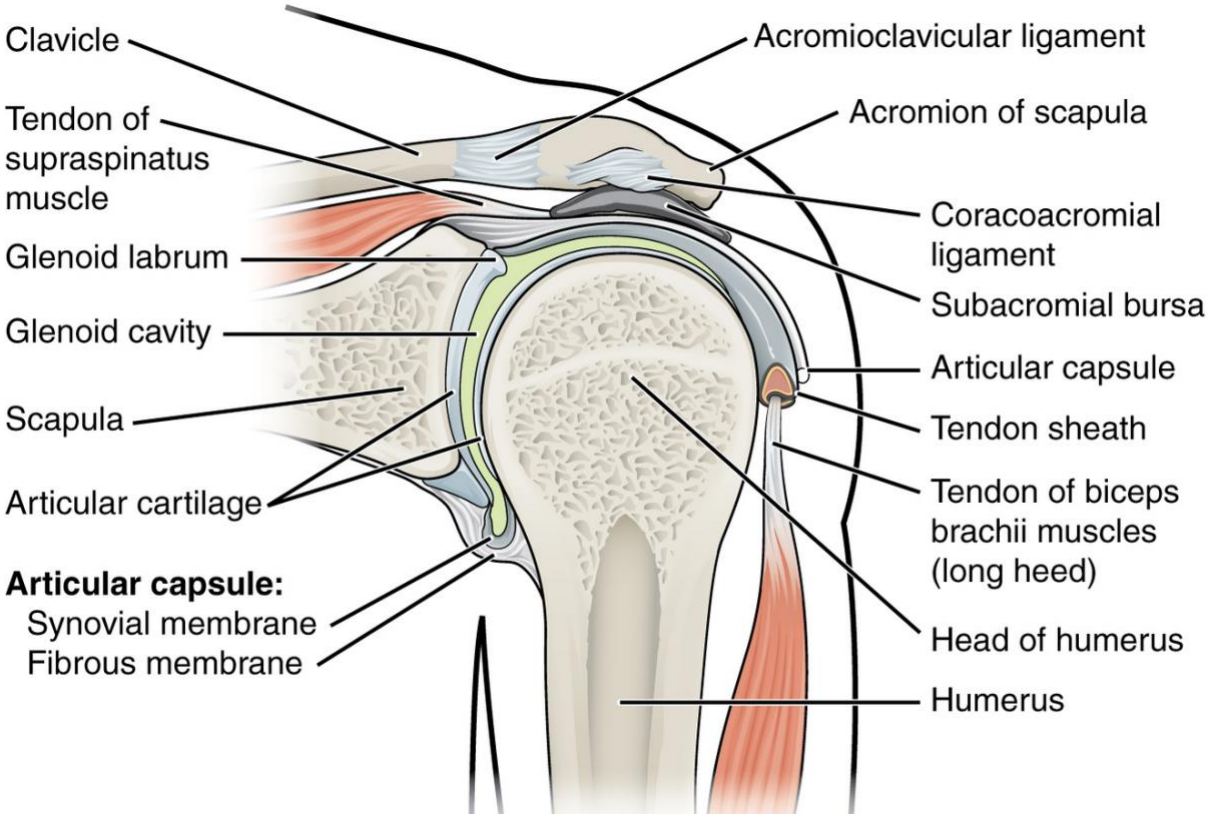

Figure 1: Anatomy of shoulder joint. According to https://commons.wikimedia.org/wiki/File:914_Shoulder_Joint.jpg [1].

The subacromial bursa reduces friction between the deltoid muscle and the joint capsule. During internal rotation of the arm, the friction between the joint capsule and the tendon of the subscapularis muscle is reduced thanks to the subscapular bursa.

The dynamic stabilizers include the periscapular muscles, the rotator cuff muscles, the long head of the biceps brachii and the rotator interval.

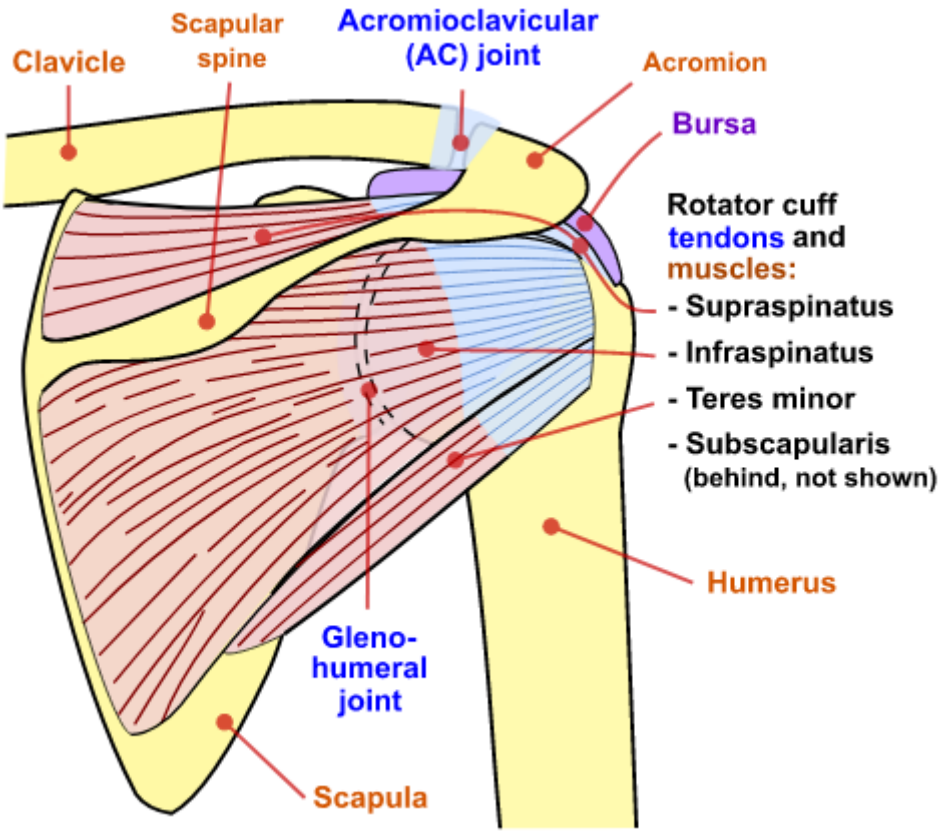

Figure 2: Rotator cuff muscles. According to https://commons.wikimedia.org/wiki/File:Shoulder_joint_back-en.svg [2].

As can be observed in figure 2, the four rotator cuff muscles are: the supraspinatus, the infraspinatus, teres minor and subscapularis. The main combined function of the four "SITS" muscles is to capture and pull the relatively large head of the humerus medially, holding it against the smaller, shallow glenoid cavity of the scapula [16]. The tendons of the muscles blend with the fibrous layer of the joint capsule to form a musculotendinous rotator cuff, which reinforces the capsule on three sides (anteriorly, superiorly, and posteriorly) as it provides active support for the joint. The supraspinatus occupies the supraspinous fossa of the scapula and initiates and assists the deltoid in the first 15° of abduction of the arm. The infraspinatus occupies the medial three quarters of the infraspinous fossa and is partly covered by the deltoid and trapezius muscles. In addition to helping stabilize the glenohumeral joint, the infraspinatus is a powerful lateral rotator of the humerus. The teres minor is a narrow, elongate muscle that is completely hidden by the deltoid, and is often not clearly delineated from the infraspinatus. The teres minor works with the infraspinatus to rotate the arm laterally and assist in its adduction. The teres minor is most clearly distinguished from the infraspinatus by its nerve supply.

The teres minor is supplied by the axillary nerve, whereas the infraspinatus is supplied by the suprascapular nerve. The subscapularis is a thick, triangular muscle that lies on the inner surface of the scapula, and forms part of the posterior wall of the axilla. The subscapularis is the primary medial rotator of the arm, and it also adducts it. The long head of the biceps brachii also helps to stabilize the glenohumeral joint, but its role is controversial. At the moment, most medical providers agree that the stabilizing role becomes more relevant in the setting of rotator cuff dysfunction, [17]. As can be seen in figure 3, the axillary artery, branching out to both the posterior and anterior circumflex arteries in its 3rd section, as well as the subscapular artery and many others, is the one to supply the glenohumeral joint. The current consensus in the literature is that the anterolateral branch of the anterior humeral circumflex artery is the one to supply the main blood supply to the humeral head [18].

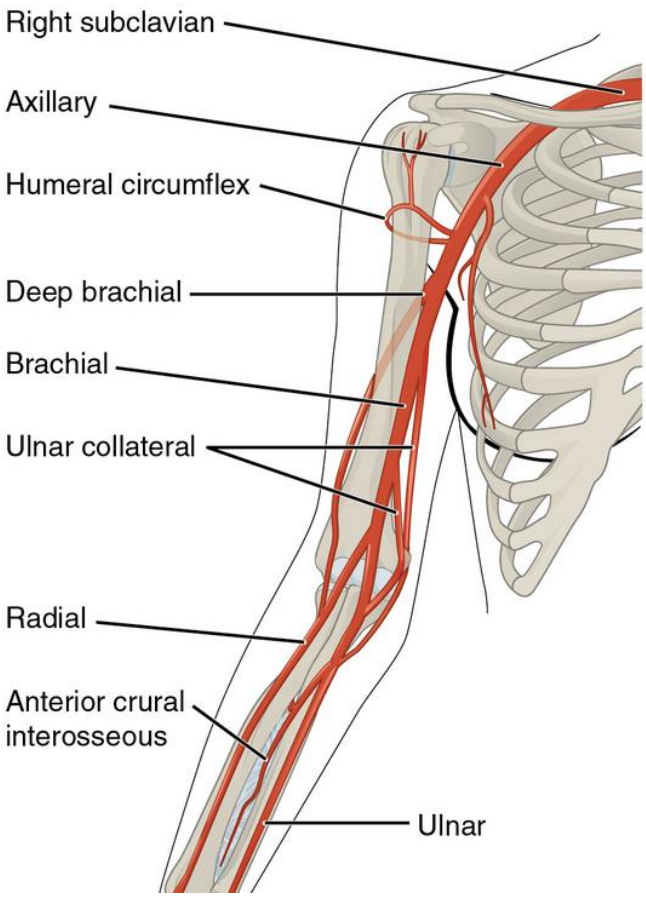

Figure 3: Axillary Artery. According to https://commons.wikimedia.org/wiki/File:2127_Thoracic_Upper_Limb_Arteries.jpg [3].

As can be seen in figure 4, most of the upper extremity lymph nodes reside within the axilla. Based on location, these can be divided into five main clusters: central, subscapular, pectoral,

humeral and apical. From the apical axillary nodes, efferent vessels travel through the cervico-axillary canal and then fuse to form the subclavian lymphatic trunk.

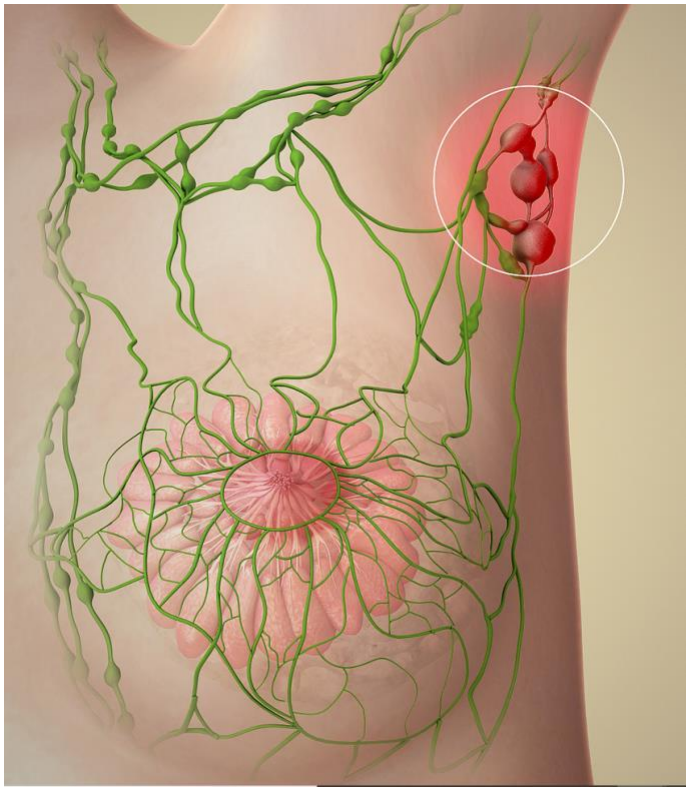

Figure 4: Axillary lymph nodes and lymphatic drainage of right upper limb and breast. According to https://commons.wikimedia.org/wiki/File:Swollen_Lymph_Nodes.jpg [4].

The trunk will continue to enter at the right venous angle or will drain directly into the thoracic duct to the right and left, respectively. Lymphatic drainage disturbance from the upper limb can, however, cause lymphedema, a condition in which lymph accumulates in the subcutaneous tissue leading to painful swelling in the upper limb.

Innervation of the glenohumeral joint is a function of the lateral pectoral, suprascapular, and axillary nerves. All the nerves that supply the glenohumeral joint originate in the brachial plexus, which is a neural network formed by the ventral rami of the four lower cervical nerves and the first thoracic nerve. (C5, C6, C7, C8, and T1). Due to the proximity of the glenohumeral joint, the anatomy of the axillary nerve is vital. From the posterior cord of the brachial plexus, the axillary nerve arises and courses along the subscapularis to its inferior edge. It is only then when it passes closely along the inferior glenohumeral joint capsule and further travels posteriorly to the humerus. It bundles up around the surgical neck of the humerus with the posterior circumflex artery, continuing in the deep deltoid fascia.

In this joint, much like in any other joint in the body, *Hilton's law* is valid and true. Hilton's law states the following — the nerves to the muscles acting on a joint give branches to that joint as well as to the skin over the area of action of these muscles.

Some of these nerves go to the fibrous capsule and ligaments while others innervate the capsule and reach the synovial membrane. Some of these nerves are sensory while others give both motor and sensory fibres to the arteries that accompany them.

The sensory fibres to the fibrous capsule are divided into 2 types: (A) algetic, which are dedicated for painful stimuli, particularly when the capsule or other ligaments are overstretched or torn, and (B) proprioceptive, which terminate in various forms of specialized structures and convey information to all parts of the central nervous system, including the cerebellum and the cerebrum. It has been established that this information includes the posture of a resting joint and both the rate and extent of motion at a moving joint. The latter is supplemented by impulses conveyed by the nerves from the specific acting muscles as well as the skin affected by the movement of said muscles.

The sensory fibres innervating the synovial membrane make their way to it by penetrating the fibrous capsule at various points and spread out to form a wide-meshed network in the sub-synovial layer. They are primarily algetic in function, and their stimulation gives rise to *diffused* rather than *localized* pain. The sensory fibres that innervate the fibrous capsule alone, are solely for *localised* type of pain. The synovial innervation fibres are found anywhere in the synovial membrane and are especially abundant in the fat pads. They are also present over the peripheral (non-articulating) parts of the articular cartilage, disks, and menisci. In general, this is shown to be evident in the extreme pain that accompanies injuries to these latter structures. Although, the articulating part of the articular cartilage has no innervation, it seems.

5. Epidemiology and the mechanism of origin of shoulder joint dislocation

After interpreting many studies done on this matter, one might seem to notice a few patterns. Such as the tendency of incidence rate to increase over the last three decades, the two "peak" population groups phenomenon [19], and many more. As reported previously in some studies [20,21,22], the male proportion of patients is significantly greater and consistently higher than the female proportion in the first "peak" group of young adults. One recent Scandinavian study [19] found that the male percentage of the first "peak" (72.4%) was even higher in comparison to two earlier Scandinavian studies, but had almost identical findings compared to a recently published American military study [22]. From this it can be inferred that the phenomenon observed in the first peak, does not discriminate between cultures or continents. It does so on the basis of young age, gender and the amount of physical activity an individual goes through regularly. The reasons why males more than females decide to participate and behave in a riskier manner in some contact physical activities – is not the topic of our discussion. Yet it seems that those very individuals who choose to act this way, are in fact the ones who suffer more frequently from this condition. The bimodal distribution of incidence throughout our average lifespan, depicts peaks for young adults and for the elderly. This is in agreement with previous studies that researched this condition patterns [20,22]. The reason for the inclination of incidents after the age of 50 is somewhat trivial. As we get older, our muscle mass is steadily decreasing, alongside the stability and support each and every joint requires. Especially, the relatively loose ones.

Although previous studies have claimed that primary dislocations were more common among females post the age of 50 years, a more recent study suggests that the incidences of these were almost identical for both genders [19].

Out of all major joint dislocations, 50% of them are dislocations of the shoulder. Out of all the dislocation direction types, anterior dislocation is the most common and accounts for 95-97% of cases. Inferior dislocation accounts for 0.5%, while posterior dislocation accounts for 2-4%. The mechanisms of anterior shoulder dislocation usually manifest by a hit to an abducted, externally rotated, and extended arm, like when a person is trying to block a basketball shot. Less common than that, is a blow to the posterior humerus or a fall on an outstretched hand.

On the other hand, a hit to the anterior portion of the shoulder, axial loading of an adducted and internally rotated arm, or violent muscle contraction following a seizure or electrocution – are the most common mechanisms of posterior shoulder dislocation [23]. Inferior dislocations are frequently a result of axial loading with the arm completely abducted or forcefully hyper abducting the arm [24]. When a patient falls and instinctively grasps an object above their head resulting in hyperabduction, it frequently tends to dislocate the shoulder in this manner.

All of that makes sense. Let us remind ourselves of the glenoid arc. An effective glenoid arc is defined as the surface area of the glenoid cavity that is available for communication and pressure by the humeral head. Sufficient force directed at the shoulder surface can simply push the articulating humeral head out of its comfortable platform. Potentially modifying the glenoid arc and reversibly or irreversibly reducing the overall stability of the naturally insufficient joint stability. Even with the labrum functioning to deepen the articular surface by 50%, which increases the overall surface area (and therefore increasing resistance to anterior translation of the humerus with respect to the glenoid by approximately 20%), it is still a very predisposed joint. The higher the occurrence rate, the more predisposed the joint will be for further events in the potential horizon. Such events are often seen in contact sports, as well as in occupations where external rotation is pronounced: tennis, volleyball, water polo, handball etc.

6. Classification of shoulder joint dislocations

The most used classification nowadays is the ‘Thomas and Matsen’ classification. This order divides shoulder instability events into the following: **t**raumatic, **u**nidirectional, **B** lesion, and **s**urgery (TUBS). It further splits it into: **a**traumatic, **m**ultidirectional, **b**ilateral, **r**ehabilitation, and **i**nferior capsular shift (AMBRI) categories [25]. According to the frequency of dislocations, they are divided into acute and chronic, and chronic is still divided into habitual and obsolete. In the case of habitual dislocation of the shoulder from the anamnesis, it is learned that the patient repeatedly dislocated the shoulder during bizarre movements. Finally, multidirectional dislocations are not usually associated with a traumatic episode. Instead, the primary etiology of multidirectional dislocations here includes congenital or acquired capsule-ligamentary looseness. As such, it may be an indication that underlying multidirectional dislocation is in fact a connective tissue disorder or that repeated minor stretches may lead to damage to the capsule-ligamentary complex. Often multidirectional instability may be associated with signs of general ligament laxity such as hyperextension of the thumb, elbow hyperextension, etc. Shoulder dislocations can be further classified according to the cause, into traumatic and atraumatic. Both mechanisms lead to loss of stability in the surrounding muscle and capsular structures. Traumatic injury to one of the soft or hard tissue components of the shoulder leads to joint instability. Atraumatic causes lead to multidirectional instability of the shoulder joint. These causes include recurrent atraumatic causes, Ehlers-Danlos syndrome, Marfan syndrome, congenital glenoid deficiency, proximal humerus deformities, as well as emotional and psychological instability.

As we stated before, shoulder dislocations can be further divided into partial (subluxation) and complete (luxation). In subluxation, the head of the humerus does not protrude completely from the glenoid. Partial dislocations most commonly occur in fractures of the humerus in its upper and middle thirds, damage to the rotator cuff, muscle weakness, damage to the joint capsule, and rarely due to nerve damage. Anterior instability most commonly manifests as unidirectional instability, this type of injury most often occurs as a result of a single traumatic event in a vulnerable position, which is a combination of abduction and external rotation of the arm. Injury may include avulsions of the antero-inferior portion of the labrum to the glenoid, commonly referred to as a B lesion. Sometimes a fragment of the bony part of the glenoid rim can be broken, and this lesion is called a bony Bankart's lesion.

Other lesions may also be present with symptoms of anterior instability, including subscapular muscle rupture, humeral avulsions of the glenohumeral ligaments (HAGL), superior labrum anterior to posterior (SLAP) injury, and rotator cuff lesions. The subclassification of anterior dislocation with respect to the position of the head of the humerus is luxation: subcoracoid, prescapular, subclavicular, axillary and supracoracoid. Posterior dislocations are often associated with axial load on the adducted arm and are typically associated with epileptic seizures. Posterior dislocations often remain neglected or clinically unnoticed, and sometimes the only way to prove it is by radiological examinations. But in which view would we miss them the least? Frontal views pose a bit of a problem when it comes to posterior dislocations. Some claim that in up to 50% of cases, posterior dislocations are missed at the outset. The reason for that is the humeral head, which appears to be quite normally aligned with its glenoid cavity. The preferred view of such diagnoses is the axillary view (figure 5). It came to my attention that a '*Velpeau'*, '*Wallace'* or '*modified trauma'* axial views can act as alternatives. Another view which is considered to be unreliable is the '*scapular Y'* view. Due to that, it should not be practiced for such diagnoses. The structural changes associated with posterior instability are avulsions on the posterior labrum (reverse B lesion), which may be associated with damage to the bony portion of the glenoid rim. Injuries to the superior glenohumeral ligament (SGHL), posterior inferior glenohumeral ligament (IGHL) band, subscapular muscle, and coracohumeral ligament can also be seen in posterior instability. The most common problems associated with posterior instability are recurrent posterior dislocations. They usually result in tearing off the posterior segment of the labrum and the stretching of the postero-inferior piece of the capsule.

Figure 5: Axillary lateral view of posterior dislocation. According to https://commons.wikimedia.org/wiki/File:Inverse_Hill-Sachs-Laesion_-_posterior_shoulder_dislocation_-_CT_axial_und_Roe_001.jpg [5].

7. Clinical Presentation and Diagnostics

During anterior dislocation of the shoulder, the patient holds his hand close to the body and does not allow any movement of the hand. A protrusion is seen laterally from the front of the shoulder. If the shoulder is repositioned before coming to the doctor or spontaneous reposition has occurred, it is clinically difficult to prove instability. In these cases, radiological methods and ultrasound can prove secondary signs of luxation, such as H-S lesion, and thus the direction of instability is determined. The biggest problem after the initial traumatic dislocation of the shoulder joint is damage to the soft tissue formations, and the consequent re-dislocation that occurs in 85% of patients [26].

The patient is usually a young man or woman who gives a history of a ‘slipping out’ shoulder, usually during a sporting event. The primary event of acute dislocation is a landmark and the person may be able to describe the mechanism accurately. As we stated before, a force exerted when the shoulder is in abduction, external rotation and extension. It is possible that the diagnosis was verified by X-ray and the injury was treated by a closed reduction and "immobilization" in a bandage or hanger for several weeks. This may be the first of many similar episodes: recurrent dislocation requiring treatment usually develops in about one-third of patients under 30 and about 20% of older patients, with a 48% re-dislocation rate [27]. Some studies have reported instability rates following acute discharge ranging from 88-95% in patients under the age of 20. A larger proportion have instability with no actual displacement. The symptoms and signs of recurrent subluxation are less clear, as we mentioned before. The patient may describe a “locking” sensation, followed by a 'numbness' or 'weakness' - the infamous *'dead arm syndrome'* - whenever a shoulder is used with the arm in an overhead position like when serving in tennis or swimming. Abduction arm pain may indicate *rotating sleeve syndrome*; Important to keep in mind that recurrent subluxation can cause tendonitis in the supraspinatus muscle. An unstable shoulder can be diagnosed with several clinical tests. Physical tests would help the physician determine the etiology of the condition. There are two basic types of shoulder instability tests. The first tests to determine the looseness of the joint help to figure out the overall looseness of the ligaments that stabilize the shoulder. These tests

are mostly painless. Other tests are the *provocative* tests that provoke the appearance of symptoms by creating stress on the shoulder.

Joint Looseness Tests: The "*load and shift*" test is performed in several ways. One way is to keep the patient in a sitting position while the examiner stabilizes the shoulder blade with one hand, while the other hand grabs the head of the upper arm and moves it forward and backward. Excessive mobility of the upper arm head indicates a loose capsule. The range of motion which is considered normal is up to 25% of the diameter of the humerus head. Anything above 25% indicates a loose capsule.

The "*apprehension"* test, is performed with the patient sitting and the examiner standing behind the patient. The arm is in 90o abduction and in external rotation. With one hand the examiner holds his hand by the wrist, and with the other hand he stabilizes the shoulder blade and pushes the head of the humerus forward with his thumb. The test is positive if the patient feels fear that the shoulder would pop out [28]. Adequate tests should not actually produce pain.

The same effect can be demonstrated by the "*fulcrum"* test. With the patient lying supine, arm abducted to 90 degrees, the examiner places one hand behind the patient's shoulder to act as a pivot over which the humeral head is levered forward by extending and laterally rotating the arm; the patient immediately becomes apprehensive.

If instability is marked, the "*drawer"* test may also be positive. With the patient supine, the scapula is stabilized with one hand while the upper arm is grasped firmly with the other so as to manipulate the head of the humerus forwards and backwards (like a drawer).

The "*jerk*" test is done in order to detect postero-inferior instability of the glenohumeral joint. It is performed by stabilizing the scapula with one hand and holding the arm in 90 degrees abduction and internal rotation while the examiner grasps the elbow and applies force to the humerus in the proximal direction. The test is positive if the humeral head is felt slipping off the glenoid cavity. As the pressure on the arm is released, a second skip is felt as a result of the humerus head returning to the glenoid.

The "*bear hug*" test is a provocative test for subscapular muscle pathologies. The patient places the diseased hand on a healthy shoulder with the elbow directed forward. The test is positive if the patient shows discomfort when trying to lift the hand from the shoulder with the resistance of the examiner. The Sulcus test is performed in patients with suspected lower instability of the shoulder joint. The patient sits and the examiner pulls his arm toward the distal. The test is positive if a sulcus appears below the acromion.

Additional diagnostics must be made using comprehensive imaging, starting with routine radiographs, as well as true anteroposterior (AP, figure 6), axillary, and scapular-Y (figure 7) views of the pathologic shoulder. Additional views might be beneficial if a bony defect is suspected, as well as apical oblique, 'Stryker Notch' view, and 'West Point'. The internal rotation AP view of the shoulder would give the best view of H–S lesions when suspected.

Figure 6: Anterior shoulder dislocation AP view. According to https://commons.wikimedia.org/wiki/File:Dislocated_shoulder_X-ray_08.png [6].

Figure 7: Posterior shoulder dislocation "scapular y" view. According to https://commons.wikimedia.org/wiki/File:Y_CR_shoulder.jpg [7].

Other better imaging methods like the CT (figure 8) or the MRI scans exist and prove to be beneficial in many cases. Especially if loss of bony integrity is suspected. An MRI arthrogram is classically recommended due to the hypersensitivity in identifying injuries of the labrum [29]. Not surprisingly, MRI is also useful in examining bony edema, rotator cuff tears, biceps pathology, chrondral injury, and lastly, HAGL lesions (figure 9).

Figure 8: CT image of a large bony Bankart. According to https://commons.wikimedia.org/wiki/File:CT._Bony_Bankart_lesion_at_the_antero-inferior_glenoid._Clearly_dislocated_at_the_cranial_part._Humeral_head_is_still_centered..jpg [8].

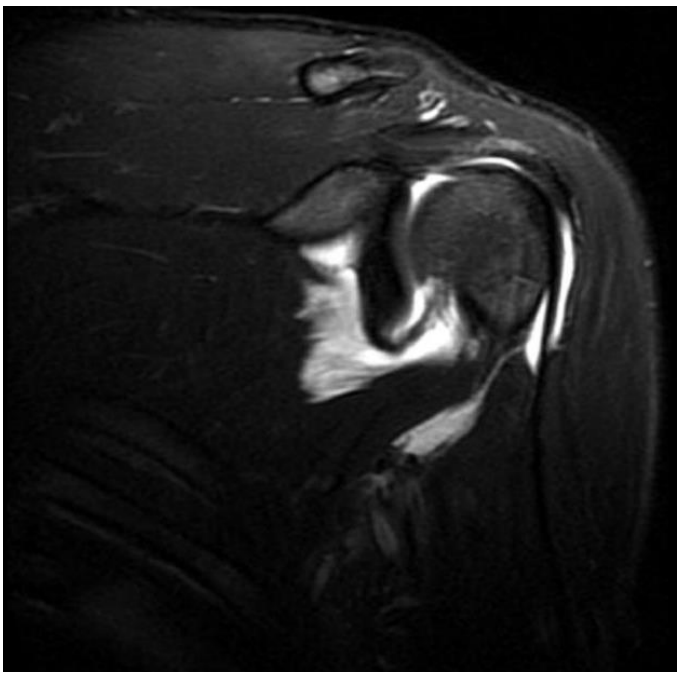

Figure 9: Humeral avulsion of glenohumeral ligament lesion. According to https://radiopaedia.org/articles/humeral-avulsion-of-the-glenohumeral-ligament [9].

8. Associated Pathological Changes:

As we stated before, certain pathological consequences could occur given appropriate unfortunate conditions. There are already some prior conditions that predispose for such changes to happen; for example, due to the anatomical fact that the arm is strapped and compressed (by the resistance that the static ligaments apply and by the origins and insertions of the rotator cuff muscles) to the torso via the humeral head articulating with the glenoid cavity – the humeral head would **necessarily** be strongly pulled towards its original physiologic location and position, when accidently displaced. It cannot simply 'dangle' outside its correct pressure point peacefully without exerting that same pressure on any other anatomical structure in its path towards the glenoid cavity. Due to this force (which is continuous), even the 'road' in which the humeral head took towards the place where it 'now' lies, is not safe. Let us discuss about the main pathological changes that might occur to a certain degree in these kinds of circumstances.

The first structure on the 'path of destruction' that might get damaged if a shoulder would dislocate in any direction would obviously be the edges of the glenoid cavity. Going from inwards – outwards, the labrum would be the first wall to break before the invasion outside the cavity. We shall discuss two types of labral tears, the SLAP tears and the Bankart lesions. A B lesion, typically, is considered to exist when one's labrum and capsule are detached (to a certain extant) from their glenoid rim and there is complete tearing of the anterior scapular periosteum. Even Mr. Arthur Sydney Blundell Bankart himself have said that the most common injury sustained in a first-time anterior 'dislocator' is the B lesion [30]. When spoken about, the B lesion is usually associated with the anteroinferior capsuloligamentous complex. Even though many other variants exist in reality (figure 10). B lesion occurs in 83.5% of anterior dislocations [32], and whenever the glenoid bone itself is involved, it is then considered, an 'osseus (or bony) Bankart lesion'. 'Reverse Bankart' is the same phenomenon, only it is the posterior (rather than anterior) glenoid rim that is damaged, in addition to the tearing of the posterior scapular periosteum, with or without an osseus fragment of the glenoid. 'Perthes' is almost the same phenomenon as the classic 'B lesion' (in the aspect of anteroinferior ligament being the main damaged structure), but the difference is with the detached medially stripped periosteum. It stays intact in this type. 'ALPSA' stands for Anterior Labral Periosteal Sleeve Avulsion. Medially displaced labro-ligamentous complex with absence of the labrum on the glenoid rim. 'GLAD' stands for Gleno-Labral Articular Disruption.
It represents a partial tear of anteroinferior labrum with associated cartilage damage.

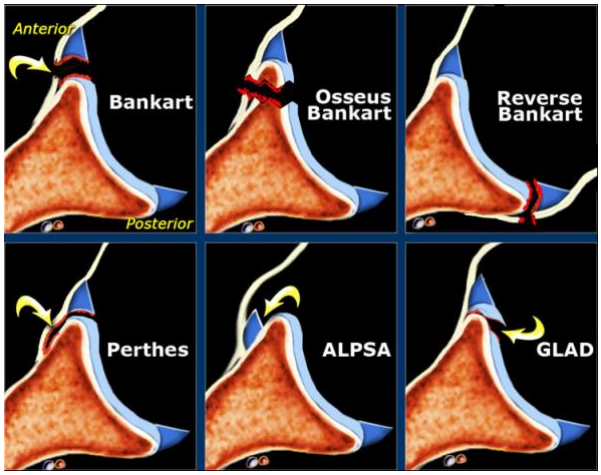

Figure 10: Axial images of Bankart lesion variants. According to https://radiologyassistant.nl/musculoskeletal/shoulder/instability [10].

Meanwhile SLAP tears (Superior Labral tear from Anterior to Posterior), are labral detachments that occur in the superior border of the cavity and are associated with the long head of the bicep's tendon (figure 11).

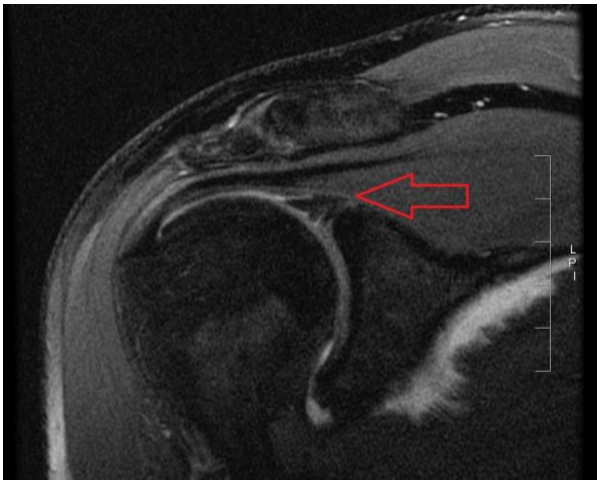

Figure 11: Superior Labral tear from Anterior to Posterior. According to https://commons.wikimedia.org/wiki/File:MRI._2_SLAP_II_lesion.jpg [11].

Tears are commonly caused by repetitive overhead motion or fall on an outstretched arm [32]. SLAP lesions might lead to shoulder pain and an unstable humero-glenoid joint. Clinical diagnosis is difficult and thus proper use of imaging is crucial for any physician.

Four types are described:

A. Non-traumatic superior labral degeneration, usually in elderly and often asymptomatic.
B. Avulsion of the superior part of the labrum – the commonest type.
C. A 'bucket handle' tear of the superior labrum.

D. Just like type C with an extension into the tendon of long head of biceps.

Regarding what was established prior, it seems also logical that when the humeral head translates anteriorly from the glenoid cavity, the posterior portion of said head, will anchor on the corner of said glenoid edge. The anchoring of the humeral head, with its consistent compression proximally – hinders the integrity of the head of the humerus (figure 12). Those lesions are called 'Hill-Sachs' (H-S) lesions [31]. Those impression fractures of the posterosuperior humeral head, are common following acute dislocations. In severe cases, the labrum can be injured at multiple locations. H-S lesions were first described by two American radiologists - Harold Hill and Maurice Sachs in 1940. It occurs when the humerus head is impacted by the antero-inferior part of the glenoid during anterior shoulder dislocation. It is often associated with other lesions such as the B lesion. A reverse H-S lesion (McLaughlin's lesion) occurs in posterior shoulder dislocation and is defined as an impactive fracture of the antero-medial part of the humerus head.

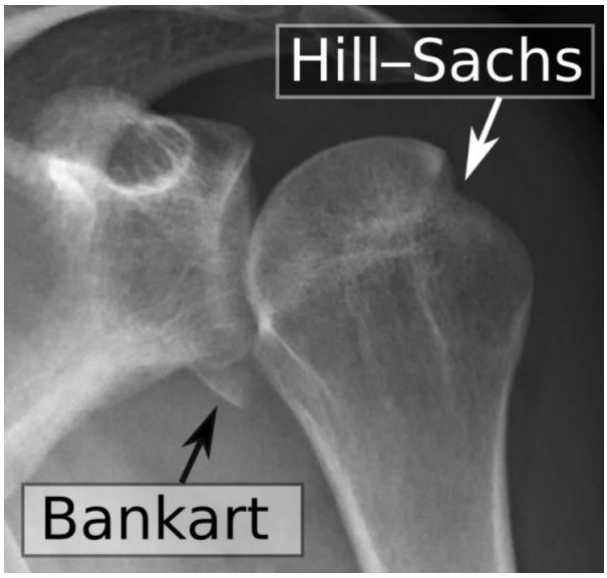

Figure 12: Hill Sachs lesion. According to https://commons.wikimedia.org/wiki/File:Shoulder_dislocation,_anteroposterior_after_reduction,_with_Bankart_and_Hill-Sachs_lesions,_with_labels.jpg [12].

Last but not least in the list, is the humeral avulsion of the glenohumeral ligaments (HAGL). It is defined as avulsion of the lower glenohumeral ligament from the anatomical neck of the humerus. HAGL injury occurs in 7.5–9.3% of anterior shoulder dislocation [33]. The most common cause of avulsion is anterior shoulder dislocation caused by hyperabduction and external rotation, and mostly younger men who are engaged in contact sports are affected, not surprisingly. Patients report joint pain, inability to move the arm, especially in abduction and external rotation.

9. Treatment of shoulder joint dislocation

9.1. Conservative treatment

Acute dislocation of the shoulder should be repaired as soon as possible and, if and when possible, without further injuries to the joint. Prior to repositioning, it is necessary to do an X-ray to detect possible bone fractures, as mentioned before. Repositioning with short-term anaesthesia should be attempted. As a last resort, general anaesthesia is required. There are many techniques for repositioning the shoulder joint, and it is important to use the one that does the least amount of damage to any structure along the way. After repositioning, the arm is placed in the shoulder bandage for some time until the pain stops. The older the dislocation, the more difficult the repositioning and the more frequent the complications. Despite advances in arthroscopic techniques and improved outcomes of patients treated surgically due to instability following the first displacement, the most common initial treatment remains nonoperative. conservative treatment consists of a short period of sling fixation followed by an early range of motion and physical therapy. It usually starts with a short fixation until the pain is well controlled and usually takes around two weeks of observation. This initial period of time is quickly accompanied by treatment aimed at restoring and optimizing the range of motion and strengthening the dynamic stabilizers of the gleno-humeral joint based on the specific pattern of the patient and the nature of his instability. The purpose of range of motion exercises is to restore functional movement and prevent stiffness. Strengthening the rotational cuff and periscapular muscles starts after the patient reaches a full and painless range of motion and is done to improve the dynamic stabilization of the gleno-humeral joint. Finally, activity progresses from low-risk actions to overhead activity and only then to sports that include contact. Typically, only after 16-20 weeks postoperatively, sports-specific exercises may initiate, followed by return to contact sports only after 20–24 weeks, given the adequate progress of the patient [34]. Patients may return to non-contact sports with the restraint of raising their arm above their head after three months. Athletes can return to active sports four months after injury, but the success of such a regimen depends largely on the age of the patient. Patients are advised to adjust daily activities such as avoiding working your hands over your head, avoiding hard physical work as well as engaging in high-risk sports. Such preventive measures may reduce the possibility of recurrence.

An article written by Hovelius et al. found that the exact type of nonoperative treatment does not seem to have significant bearing on recurrence rate considering all nonoperative treatment modalities [35].

9.2. Operative treatment

The purpose of surgical management is to bring back the once normal stability by repairing and securing the injured labrum, the humeral head or glenohumeral ligaments, and if needed, plication of any redundant capsule. The questions if, when and how a surgery is required following a first-time dislocation, remains an individual mystery. These days, technologic advances have increased the orthopaedic surgeon's ability to manage shoulder instability arthroscopically, not only via open surgery. Arthroscopic shoulder stabilization is considered by many surgeons to be the preferred method of management because it allows for a detailed diagnosis of coexistent shoulder pathology and is associated with less postoperative pain, lower morbidity, and improved cosmesis [36]. Furthermore, because it does not disrupt the subscapularis tendon, there is less risk of subscapularis insufficiency and scarring. High rates of patient satisfaction and improved outcome scores have been reported in the short term and midterm, with low rates of recurrent instability and disability [37]. One example would be a double-blinded, randomized clinical trial evaluating arthroscopic Bankart repair versus a 'sham' surgery (a placebo surgery, where the therapeutic step is skipped), patients with a first-time dislocation had decreased recurrence of instability and improved outcome scores after repair [38].

9.2.1. Arthroscopic Bankart lesion repair and capsular shift

Arthroscopic Bankart repair has become common because it allows excellent visualisation of the entire intracapsular joint and is minimally invasive; it is now the treatment of choice among new surgeons in the United States [39]. This type of arthroscopic surgery is done for anterior shoulder joint instability that is refractory to conservative treatment. The technique itself is composed of reconstruction of the labrum using bone anchors instruments, postero-inferior capsular plication, antero-inferior capsule displacement, and closure of the HAGL lesion when required. Before repairing the labrum arthroscopically, the humeral head, the capsule-labral complex and the glenoid cavity must be evaluated thoroughly using the arthroscope. Bony B lesions specifically could be repaired using 2 techniques. Either they will get incorporated into the labrum using bony anchors or by screw fixation if the size of the bone fragment is sufficiently big. additional soft-tissue damages could be repaired simultaneously. Following early arthroscopic treatment, results were favourable. A certain study showed a decrease by seven times in recurrent dislocations when was compared between early arthroscopic and nonoperative treatment [40].

Capsular shift is a procedure of joint capsule tightening. The reason why the capsule has to be tight is to preserve stability and congruency. A capsular shift is commonly performed using an arthroscope. In this procedure the physician tightens the capsule, in addition to the ligaments that stabilize the shoulder. It could be described as the process a tailor does when tucking a loose fabric by overlapping and sewing the two parts. By tightening the ligaments, they are then able to perform their stabilizing function. In one retrospective study, 302 patients have undergone arthroscopic Bankart repair and capsular shift. The recurrence rate after this technique was 13.2%, and the average time for the first recurrence post-surgery was 12 months. Recurrences occurred in 55% of patients within a year [41]. In accordance with that, it is necessary to carefully select the patients who would benefit from it the most (or suffer from it the least). Risk factors for a surgical failure are being younger than 20 years of age, the presence of glenoid bone loss, and the presence of H-S lesions.

9.2.2. Surgical filling of Hill Sachs lesions

The procedure known as 'Remplissage', is done whenever a H-S lesion is sufficiently troublesome and in fact predisposing the translation of the humeral head out of the cavity. Remembering that the constant compression on the humeral head exists, whenever there is a chance of the humeral head to slip and get anchored on the glenoid rim due to the existence of the H-S 'crater' – it will in fact happen. Many patients that have these lesions suffer to a certain extent from this phenomenon, and nowadays are able to solve them in a satisfactory way. Enter an arthroscopic technique named 'Remplissage'. The procedure consists of an arthroscopic capsule-tenodesis of the posterior part of the capsule and infraspinatus tendon to fill the H-S defect, converting the *intra*-articular location of the defect to an *extra*-articular one. To properly access the field of work, the patient must be set in the lateral decubitus position and a posterior portal should be established at the lateral aspect of the convexity of the humeral head that is cantered over the lesion. Two more portals are established, the anterior-inferior, the anterior-superior and the camera is placed in the anterior-superior one. The Hill-Sachs lesion is freshened with a 'bur' through the posterior portal. A cannula is inserted in the posterior portal through the deltoid but not through the infraspinatus or capsule, and an anchor is placed in the inferior aspect of the humeral defect. A penetrating grasper is passed through the tendon and posterior capsule, 1 cm inferior to the initial portal entry site to pull 1 suture limb. A second anchor is placed superiorly, and 1 suture limb is similarly passed. The inferior suture is tied first with the knots remaining extra-articular, pulling the infraspinatus and capsule into the lesion. After completion, a B lesion can then be attended.

9.2.3. Open Bankart repair

Open Bankart lesion repair has historically produced sufficient results over the years for shoulder instability. It is similar in some ways if not others to the arthroscopic procedure, so let's examine the main differences. The first disadvantage is obviously the larger incision made in the open method, but at least the patient setup and positioning are much easier. The second disadvantage I would mention is the disruption of the subscapularis muscle, although, if there are any bipolar bone defects on the humeral head or the glenoid rim – they can be easily accessed. If we are mentioning other concomitant issues that may arise and demand addressing, then we might as well mention the difficulty in attending any SLAP lesions. Although, identification and treatment of HAGL lesions are definitely possible and advantageous. The next disadvantages are regarding the post-operative period, like the risk of a certain restriction in the range of motion and the potential loss of external rotation. On the other hand, the capsular shift procedure is markedly more powerful in the open technic, and there exists a potential for less recurrence in high risk population (young males with H-S lesions). Another advantage of this procedure is the correction of the labral defect and the reconstruction of the capsule without the use of any metal internal fixators. A deltopectoral approach is used to expose the subscapularis tendon which is then reflected to expose the capsule. A capsulectomy is often started from the capsular attachment to the humeral head and may be extended posteriorly to completely free the dual attachment of the IGHL. This is done in an attempt to allow complete freedom of the capsuloligamentous complex for a thorough shift. Results after open Bankart repair have been excellent nonetheless, especially in active, high demand contact athletes in whom recurrent dislocation rates have been shown to be lower than those treated arthroscopically [42]. The procedure may be performed through a subscapular split, or in more muscular individuals the cleft may extend superiorly, approximately 1 cm and more medially to the bicep's tendon, leaving the L-shaped subscapular muscle in this way. A third of the subscapularis muscle may retract inferiorly for the purpose of displaying the lower part of the capsule, paying attention to the axillary nerve. The subscapular cleft preserves neuromuscular functions and minimizes the possibility of post-operative tendon separation. Two to three anchors are installed in the glenoid at 3, 4 and 5:30 hours relative to the glenoid. The thread passes through the labrum, the capsule and approaches each other [43].

9.2.4. Bone grafting procedure

Occasionally, glenoid augmentation is necessary in order to alleviate the rate of postoperative instability due to glenoid bone loss. The amount of glenoid bone loss necessary to consider glenoid augmentation is variable, but a significant amount of studies suggest that arthroscopic stabilization is not adequate if bone loss is equal or greater than 20–25% [44]. Significant glenoid deficiency due to a bony B lesion or erosion,c has been shown to cause high rates of recurrence when not addressed surgically with either repair or bone graft augmentation. We have learned that anatomic reduction and internal fixation is the preferred method of treatment on the condition that the remaining bone can either be reduced and stabilized with screw fixation or be incorporated within the soft-tissue Bankart repair.

In cases of patients that suffer from recurrent dislocations, the remaining bony fragment is often found to be insufficient in order to restore functional stability. Augmentation, either autograft or allograft must be performed to obtain at least satisfactory results. Perhaps the most common method of augmentation is the famous 'Latarjet Bristow' procedure, first described by French surgeon Dr. Michel Latarjet in 1954. In this method, the coracoid bone is incised and pulled down (still attached to the short head of the biceps and its vascular supply) through the subscapularis muscle in order to be reattached to the troublesome portion of the glenoid rim, where it is fixed with two screws [45].

The Latarjet has gained many supporters due to its "Triple-Blocking Effect," which is explained as follows: (1) lengthening or restoring the glenoid arc, (2) the sling or hammock effect of the conjoint tendon, and (3) Bankart repair [46]. Autograft examples such as from the iliac crest and distal tibia can also be utilized in glenoid augmentation, but they also acquire the additional morbidity of a second surgical intervention and potentially donor site complications [47]. Free autografts are lacking an inherent vascular supply and also do not have a soft-tissue sling to aid in stability. Iliac crest autografts are utilized in large bony defects, and some studies exhibited high patient satisfaction and low rates of recurrent instability. In addition, the surgery can be performed either open or arthroscopically [48]. Not to mention, allograft avoids donor-site morbidity and can also be used for glenoid augmentation. Results of the Latarjet procedure for glenoid augmentation have been very promising, with recurrence rates ranging from 0% to 15% in various studies [45].

9.3. Post-operative treatment

After surgery, the patient's hand can be placed in internal or external rotation regardless of the success of rehabilitation [49]. The shoulder is immobilized with a Desault bandage or a cotton stabilizing orthosis. Immobilization can be worn for 3 to 4 weeks without difference in the quality of rehabilitation [50]. In open surgeries, longer wound healing is expected when compared to arthroscopic surgery. Movements are allowed only under strict supervision of a physiotherapist. Strengthening the shoulder girdle muscles can begin after the shoulder is painless, with full passive and active range of motion. Some authors recommended a return to non-contact sports following 12 to 16 weeks, and a return to contact activities and throwing sports after 24 weeks after Bankart’s open surgery.

10. Conclusion

The management of acute shoulder dislocation is heavily dependent on the orthopaedic provider, having a firm understanding on the anatomy, pathology, and predisposing factors that weigh on the recurrence rate of instability. After fully understanding these features, providers are able to lend advice for both nonoperative and operative managements of a very complex pathological process. All aims of treatment are focused on retrieving functionality of the injured extremity to the optimum, while investing efforts to prevent future recurrencies and instabilities.

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13. Biography

Costa Alon Shani Ashri was born on May 6, 1991 in Eilat, Israel. After finishing elementary school in the city, his family cell decided to relocate themselves to a collective community settlement not far from their hometown in Israel. While attending the school system in the settlement, Costa was most intrigued in high school with sciences and biology in his extracurriculars. After graduating, Costa joined the paratrooper's division during his mandatory military services. Following an injury to his knee in addition to a shoulder dislocation, he was sent to a 'combat medic' course in order to not waste time while healing. It was then when he finally realised what was his greatest interest and perhaps life passion. At the end of that medic course, he had decided to apply for officers' school in pursuit of the position of the medical course commander, in order to teach soldiers how to become the optimal combat medics in the field. Realising this must be the only path for him, Costa decided to enrol at the Faculty of Medicine, University of Zagreb in 2016, after resigning his army service. In 2019, he was elected to lead the student society of orthopaedics and traumatology (SSOT) along with 6 others, and specifically to represent the society in any international event that may arise. He stayed in that position until he graduated in July 22, 2021. During his studies, he became active in many student societies and also volunteered in the emergency room at the Department of Traumatology clinic. During his 3-month clinical rotations, he has worked in the emergency room at the University hospital centre Rebro, as well as in the surgical ward of the Obstetrics and Gynecology department at Merkur clinical hospital. He is actively involved in sports. He speaks English Hebrew and a bit of Croatian. He has travelled the world and worked in order to pay his tuition for his academic years in Zagreb.