



TITLE

Age- and time-specific management of traumatic anterior shoulder instability: the ESSKA-
ESA Formal Consensus

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INTRODUCTION

Anterior shoulder dislocation or instability is a very common disorder in patients from all ages and conditions. While it is more frequent in young and active individuals, it can really affect both athletes and sedentary people, or individuals ranging from young adolescents to elderly people. In addition to the heterogeneity provided by patients' age and condition (i.e. athlete, worker, or retired), the topic of shoulder instability is also very broad because it can be classified according to the direction of dislocation or instability (anterior, posterior, or inferior), type of injuring mechanism (traumatic or atraumatic), intention (voluntary or involuntary), or number of episodes (first episode or recurrent dislocation). Because of all these variables, there is a lack of consensus on how to approach or manage (diagnosis and treatment) anterior shoulder instability, particularly as a function of age and time.



The purpose of this article was to provide a Consensus Statement to help the practitioner in their daily clinical decisions regarding the diagnosis and treatment options for traumatic anterior shoulder instability (TASI) according to age and timing of injury.

DEFINITIONS

Definition of traumatic anterior shoulder instability

The present study will cover the TASI. Anterior shoulder dislocation occurs when the humeral head displaces anteriorly or anterior-inferiorly past the rim of the glenoid (the humeral head is completely out of the glenoid), regardless of its ability to self-reduce or not. In some instances, the humeral head can move up to the rim of the glenoid and then come back in a centered position quickly, a phenomenon defined as subluxation. Shoulder instability is that condition in which the joint (the glenohumeral joint) is unable to function appropriately because of damaged static and/or dynamic stabilizers (labrum, capsule, ligaments, cartilage, bones, and tendon/muscles). The dislocation will occur whenever the anteriorly directed force is strong enough to either tear or stretch the shoulder stabilizers. The mechanism of injury is defined as traumatic when there is a specific moderate- or high-energy force applied directly (to the posterior shoulder and directed anteriorly) or indirectly (generally in an abducted and externally rotated shoulder position) into the shoulder (glenohumeral joint) causing the dislocation or subluxation. Traumatic dislocations generally occur during sports activity but can also occur in heavy labor conditions or after any accidental fall.

Definition of shoulder hypermobility



The term hypermobility can be referred to any joint. Shoulder hypermobility can be defined as the presence of shoulder motion exceeding beyond the normal values for the general population. Shoulder hypermobility can affect one, two, or the three planes of motion. When this condition has an inherited origin, the motion in all planes will be increased, but sometimes an injury or repetitive microtrauma can induce excessive motion in some planes and not others.

Definition of generalized joint hypermobility and related terms

Generalized joint hypermobility is a hereditary condition that results in an ability to move the joints beyond their normal range. According to Gebska, this is considered an inherited abnormality of the structure of connective tissue usually related to disturbances in the proportion and biomechanical properties of the collagen network [99]. When this condition was related to musculoskeletal symptoms, the term was further referred as hypermobility syndrome [272]. Hypermobility syndrome was later termed benign joint hypermobility syndrome to differentiate it from more serious and potentially life-threatening conditions such as Ehler-Danlos's syndrome, Marfan's syndrome or osteogenesis imperfecta [272].

Age groups

Shoulder instability is clearly affected by the age at presentation. It is widely accepted that the prognosis for recurrent dislocation and good clinical and functional outcomes are related to the age of the patients, which is also related to the mechanism of injury. Therefore, the present article has defined three age subgroups that may affect decision-making in TASI. The age subgroups are not defined by the number of years, but using a descriptive wording. However, for practical reasons, an estimated age range is provided. The three age subgroups



are: adolescents (less than 20 years old), young adults (from 20 to 40 years old), and older adults (>40 years old including elderly).

Timing of dislocation

Two different scenarios are considered: first-time and recurrent dislocation. First-time dislocation is defined by shoulder dislocation in a previously healthy joint. In contrast, recurrent dislocation implies more than one shoulder dislocation episode in the same joint.

METHODS

The methodology employed in this study has been so-called “Formal Consensus” and adopted by the European Society of Sports medicine, Knee surgery and Arthroscopy (ESSKA). This is a modified Delphi methodology that is robust, clear and rigorous based on a repetitive evaluation by three groups of experts. The method has been described by the French National Healthcare Institution (Haute Autorité de Sante, HAS) [302]. The ultimate goal of this methodology is to provide a reference frame, rather than a strict guideline, for the management of TASI based on both the available literature and a balanced expert opinion. This reference frame seeks to be clinically helpful; that is, to help the daily practitioner in their clinical decisions.

Three groups of 61 shoulder experts from 23 countries were involved: 15 experts from 9 countries formed the Steering group, 18 experts from 18 countries formed the Rating group, and 28 experts from 13 countries (from 15 European shoulder societies) formed the Peer-review group. The steering group was formed by a question group with three shoulder experts (from three different countries), and a literature group with four shoulder experts (from four different countries). Both subgroups were assisted and directed by three other experts (from



three different countries) designated as co-chairs (two) and a project advisor (one), completing the steering group. A series of 3 meetings were held by the entire steering group to discuss and define the principal goal of the project, which was to provide a Consensus Statement of TASI depending on age and timing. Therefore, the questions related to the topic were classified according to age subgroups. The literature group made an initial overview of the literature so that they were able to get a sense of the age subgroups that were most commonly considered in the literature. In one of the preliminary steering group meetings, they recommended to stay away from strict age subgroups defined by age in years, but to define the subgroups in a descriptive way. The entire steering group accorded to define the following three groups: adolescents, young adults, and older adults. After that, the two subgroups worked on parallel but independently to accomplish their tasks.

Each of the three members of the question group were assigned to a specific age subgroup and, each one assisted by one of the steering group chairs. These members made a specific brainstorming to elaborate a list of clinically relevant questions related to diagnosis and treatment of TASI. Then, a series of 4 meetings between the question group members and the three steering group members coordinating the project were conducted to come up with the final list of questions.

In parallel, the literature group worked independently and through the following organization: each member of the group was assigned to a specific age subgroup, and a fourth member served as literature group coordinator. The four members worked on conducting a systematic literature search to come up with an initial output. Three databases were employed: Google Scholar, PubMed and ScienceDirect using keywords. The search strategy was: (shoulder) AND ((instability) OR (dislocation) AND (anterior)) AND ((adolescent) OR (young) OR (adult) OR (aged) OR (elderly)). The search was limited to the last 10 years for studies with level of evidence III-IV, and 20 years of studies with level of evidence I-II or epidemiology



studies. Articles were included if they were written in English, and were specifically conducted to investigate aspects related to the diagnosis and treatment of TASI. Review articles, case reports, short anecdotal case series, expert opinions or basic science articles were excluded. Duplicates were excluded and the title and abstracts were then checked for suitability. Those articles that were found related to TASI were full-text scrutinized and a final list of articles generated. The literature group then classified the articles to the age subgroups (each article could belong to more than one group), and each member began to extract the information from the articles through an excel template data extraction sheet. This sheet included the most relevant aspects of each article including the purpose, year, design, type of intervention, aspects of the diagnosis and treatment of TASI, and outcomes. The entire steering group then met on three occasions so that the literature group could provide feedback on the question list according to their literature search, and a final list of 35 questions was generated. The questions were classified according to several categories: history taking, physical examination, imaging studies (timing and associated injuries), and treatment (conservative, surgical, and outcomes). Once the final list of questions was finalized, the literature group elaborated a Excel spreadsheet to summarize what questions each of the articles could provide answer to, so that data extraction and literature summary was made easier for the members of the steering group. Then, five members of the steering group were assigned to each of the three age subgroups, and a literature summary was made for all the questions. The entire steering group worked then on elaborating specific statements that represented specific answers to the 35 questions. Each statement was discussed among all members of the steering group through a series of several consecutive meetings.

Once a final product (i.e. statements and literature summaries) was obtained, two entire steering group meetings were held to determine the grade of recommendation according to the following classification:



- Grade A was defined as a high level of scientific support
- Grade B as a scientific presumption
- Grade C as a low level of scientific support
- Grade D as an expert opinion.

A final preliminary version was obtained and circulated among all members of the steering group for final approval. Then, the document was sent to the rating group, who rated the level of agreement on each statement according to a numeric scale (from 1 to 9), which represented the appropriateness of the statement and the agreement among the rating group. A value of 1 meant that the reviewer considered the proposal totally inappropriate, not indicated or unacceptable. A value of 9 meant that the reviewer considered the proposal totally appropriate, indicated or acceptable. Values of 2 to 8 represented possible intermediate situations. A proposal was deemed: appropriate when the value of the median was $>$ or equal to 7 AND the scores were all $>$ or equal to 5; inappropriate when the value of the median was $<$ or equal to 3.5 AND the scores were all $<$ or equal to 5; of uncertain appropriateness when the median was between 4 and 6.5 or when there was no consensus (Table 1). The members of the rating group were encouraged to make comments to the text if required. Proposed statements with strong agreement were definitively accepted (if appropriate) or deleted (if inappropriate) at the end of the first rating round. Proposals with relative agreement or uncertain were reformulated by the steering group during an interim phase and proposed again to the rating group (second round), allowing to select the proposals on which there was a consensus with the rating group.

| Proposal | Agreement among experts | | Median |
|----------|-------------------------|------------------------|--------|
| | Degree | Distribution of scores | |
| | | | |



| | | | |
|---------------|--------------------|------------------|------------|
| Appropriate | Strong agreement | [7-9] | ≥ 7 |
| | Relative agreement | [5-9] | ≥ 7 |
| Inappropriate | Strong agreement | [1-3] | ≤ 3 |
| | Relative agreement | [1-5] | ≤ 3.5 |
| Uncertain | Undecided | [1-9] | [4-6.5] |
| | No consensus | Other situations | |

Table 1. Classification of the proposal according to the value of the median and the distribution of the scores.

The final accepted document was then sent to the 26 members of the peer-review group, who sent back their feedback with comments and suggested corrections. Comments from the peer-review group members were important to assure adaptability of the Consensus to each specific country. All these comments were considered and incorporated whenever found pertinent. A final meeting of the entire steering group was made to approve the final document.

QUESTIONS AND ANSWERS

A) History taking:

1. What are the most important factors related to history taking for decision about conservative and surgical treatment in patients with first-time anterior dislocation?



1.1 Statement

The most important factors related to history taking for decision about conservative and surgical treatment in patients with an isolated episode of anterior shoulder dislocation are: age, residual apprehension, level of sport participation specially the involvement in contact sports, gender, degree of trauma especially mechanism of injury, occupation, and nerve injury (Grade B). Age at the time of first dislocation is the most important variable that increases the risk of recurrence (Grade B).

Adolescents

Younger patients, particularly those aged 14 to 18, are more susceptible to higher recurrence rates and type of sports (contact, collision and overhead) needs to be considered (Grade C).

Older adults

In the elderly group pre-existing complaints from the shoulder might be related to pre-injury rotator cuff disorders. In addition, the greater the age, the greater the possibility for the patient to suffer from an associated rotator cuff tear (Grade D).

Median (Range): 9 (8-9).

1.2 Literature summary



1.2.1 Adolescents (Best evidence: 1 prospective comparative, 3 retrospective case control, 1 diagnostic study, 3 systematic review, 9 retrospective case series, 3 retrospective epidemiologic, 1 descriptive (level V) study):

Management of first-time anterior dislocations remains extremely controversial, even in patients with less than 20 years old. Age seems to be a constant factor influencing this decision [94,190,204]. Hovelius and Rahme[132] reported a 28% of non-recurrence rate at 25 years of follow-up, in a cohort of 94 patients with less than 22 yo, and an additional 20% of the patients became stable over time, even though recurring 2 or more times after the first episode. In the same paper the authors reported a non-recurrence rate at 25 years of follow up of 44 and 73 percent for the older cohorts, 23-29 yo and 30-40 yo respectively, and concluded that prognosis with respect to recurrent dislocation in three different age groups is better with increasing age at the time of the first dislocation [132]. Gigis et al. [103] conducted a prospective comparison of operative versus nonoperative management for first-time anterior shoulder dislocations in patients aged 15 to 18, and found a 70% recurrence rate in the nonoperative group. Longo et al. [206] found a combined recurrence rate of 71.3% in patients younger than 18 treated without surgery in a systematic review of operative versus nonoperative treatment including 15 studies comprising 693 patients and 705 shoulders. Even though younger patients have higher recurrence rates after a first episode of anterior shoulder dislocation, it has also been reported that this age group has a higher redislocation rate after surgical stabilization, when comparing to other age groups [47,189].

Type of sport, namely contact, collision and overhead sports, seems to be related with a higher redislocation rate after a first episode [22,81,126,129,160,180,205,234,246,250,285,318,333,364].



In few studies male gender is theoretically associated with a higher recurrence rate, but the authors discuss the fact that young boys are usually more involved in high risk sports and that this may be an important bias regarding the gender influence in the natural history of the first time dislocator [278]. In a retrospective study of prospectively collected data from 133 first-time adolescent dislocators, Roberts and colleagues concluded that gender did not significantly predict recurrent dislocation during a period of 95.5 months of follow-up. Similarly, in the majority of studies the authors did not find a significant difference between genders when it comes to redislocation rate after a first episode [103,132,233,250].

Other factors as type of episode (dislocation vs subluxation), mechanism of injury, level of sport, desire to return to sports, instability of other joints, skeletal maturity or bilateral dislocation are extensively mentioned in the literature but we found no statistical comparative data relating these factors with recurrence rate after a first time anterior dislocation episode.

1.2.2 Young adults (Best evidence: 1 systematic review, 4 prospective case series, 1 retrospective case series):

When deciding whether conservative or surgical treatment is the best alternative for the management of an adult between 20 and 40 years old with an isolated episode of anterior shoulder dislocation, many epidemiological and anatomopathological factors have been shown to have an effect on the prognosis of the conservatively managed patient. The most important are: age, mechanism of injury, residual apprehension, sex, sport participation, occupation, hyperlaxity, nerve injury and greater tuberosity fractures.

Age seems to be the most important factor affecting the recurrence rate after a first-time dislocation. The seminal studies by Hovelius et al [131] are well-known and establish a very clear inverse relationship between age and recurrence or need of reoperation. Sachs et al.



[297] analyzed prospectively a cohort of 131 subjects with a first-time anterior shoulder dislocation. After 4 years, 33% had suffered recurrent dislocations and 22% had required surgery. The main predictor of need for surgery were younger age (90% of recurrences were in under-40-years-old subjects). Robinson et al. [278] followed a prospective cohort of 252 subjects under 35 years old with an anterior dislocation for at least 2 years. They found that age and male sex were the main and only predictors of recurrence.

Residual apprehension has also been identified as a risk factor for failure of conservative treatment. Safran et al. [298] found in a prospective study of a single cohort of 52 young males (ages 17-27 years) with a first episode of anterior shoulder dislocation that the apprehension test performed at 6 weeks after dislocation predicted the chances of recurrence at three years follow-up. A positive test was associated with a recurrence rate of 71%, those with a negative test had 37% recurrence rate. This same group reviewed the same cohort at minimum 6 years follow-up and found the figures were still different (79% vs. 53%) [220].

The level of sport participation and the involvement in contact sports or overhead activities also has been associated with poorer outcomes of conservative treatment. In the previously mentioned cohort of Sachs et al. [297] participation in contact sports or overhead activities increased the risk of recurrence with an incidence of 86% of recurrence (OR 7.8) at four years follow-up. For those who used their arm at chest level or above in their occupation the odds ratio for redislocation was 5.7.

Male sex seems also to be strongly associated with recurrence as ascertained by the prospective study from Robinson et al. [278].

Mechanism of injury should be highlighted in the history taking to clarify that the event is related to trauma. The hyperlax patients and voluntary dislocators are groups that entails different approach to treatment.



To finish, Olds et al. [245] performed a SR and MA of Ten studies comprising 1324 participants with first time anterior dislocations. Both age and male sex were identified as strong predictors of recurrence. Hyperlaxity (OR=2.68) was identified as a risk factor and nerve palsy (0.4) and a greater tuberosity fracture (OR=0.13) as a protective factor.

It should be noted that all these factors related to history taking that seem to be involved in failure of conservative treatment have also been identified a poor prognostic factors for surgical treatment too.

1.2.3 Older adults (Best evidence: 2 Case series):

Factors affecting the decision-making between conservative and surgical treatment in older adults are:

Patients' age:

Among patients > 40 years treated for anterior shoulder instability, patients suffering from concomitant rotator cuff tears (RCT) were significantly older than patients with intact cuffs (62 years vs 52), and the frequency of rotator cuff tears increased with advancing age. However, regression analysis showed that the better outcome of surgical treatment of rotator cuff tears over patients with RCT treated conservatively in this cohort was not explained by age or gender but was an actual treatment benefit. This finding was not investigated separately for acute and recurrent dislocations [319].

Patients' initial symptoms:

Among patients >60 years treated conservatively for primary anterior dislocation, patients who denied having any shoulder symptoms before their primary dislocation showed recurrences in 22% [114]. On the other hand, patients who reported having had occasional or



constant pain, weakness and/or a decreased range of movement of the involved shoulder before the initial dislocation showed a slightly lower recurrence rate of 18% [114].

2. What are the most important factors related to history taking for decision about conservative and surgical treatment in patients with recurrent anterior dislocation?

2.1 Statement

Recurrent anterior dislocation is often best treated surgically. The most important factors related to history taking for decision about surgical treatment in patients with recurrent anterior dislocation are: age (particularly those aged 14 to 18 years, gender, number of dislocation episodes, previous treatments, level of sport participation, type of sport (contact, collision and overhead), mechanism of injury, occupation (heavy manual labourer), nerve injury, general health and medical conditions (epilepsy/Parkinson) (Grade C).

Median (range): 8.5 (7-9)

2.2 Literature summary

2.2.1 Adolescents (Best evidence: 3 systematic reviews, 1 comparative study, 1 retrospective cross-sectional, 3 case series, 1 descriptive epidemiologic study):

Risk factors related to history taking for recurrent anterior dislocation, identified in most of the articles were: age, sex, mechanism of initial injury, shoulder dominance, side of the affected shoulder, multiple instability episodes (>5) and the type of sport. Among those, the



most important factors with a statistically significance were age, multiple instability episodes and the type of sport [82,206,244,250,285,318,364].

Age was the most correlated factor throughout the literature and it was observed that patients < 14 years old were less likely to have a recurrence compared with patients 14 years old and older [244,364].

One study took into consideration the number of instability episodes and revealed that under the age of 25, patients that had > 5 instability episodes between the first injury and time of the surgery, were more likely to have recurrence postoperatively than those who had < 5 episodes [250].

Several studies reported that the type of sport was correlated with a high rate of recurrence, especially in high energy contact sports (e.g. Rugby, American football) and high energy contact sports with the overhead position of the arm (e.g. Water polo) [82,285,318].

One meta-analysis with evidence level III studies included, was the only one reporting a statistically significant association between sex and recurrence, male patients < 18 years old being 3.44 times more likely to experience another instability episode [244].

2.2.2 Young adults (Best evidence: 3 reviews):

The literature available focus on the assessment of the best treatment after the first dislocation episode to understand those that benefit of early surgical intervention, and in other hand studies pointing history-taking factors to determine the appropriate surgical option in recurrent dislocations – bony vs soft tissue reconstruction. Despite this, it is important to collect relevant history to identify cases with recurrent dislocations that don't benefit of surgical treatment.



Assessment of patients with recurrent instability should be focused and systematic to facilitate decision-making. The direction of instability must be established to identify and exclude patients with posterior instability, multidirectional instability, and voluntary instability. Overhead athletes may report a decrease in velocity, accuracy, or distance without episodes of frank dislocation, suggesting more subtle forms of instability. Pain in the cocking phase of throwing may indicate anterior instability, whereas pain in the follow-through phase may indicate posterior instability. Internal impingement may occur as a result of anterior microinstability. Having confirmed the presence of traumatic recurrent anterior instability, assessment should seek to establish the degree of instability and define the extent of soft-tissue and bony pathology [227].

Most of the times, patients are significantly impeded for not only sports, but activities of daily living. In addition, most patients come to clinic after an adequate conservative treatment has been implemented. Therefore, many surgeons would recommend surgical treatment in recurrent anterior shoulder dislocation [104].

During the history taking, the number of recurrences should be assessed as well. The level of activity required to cause an instability event is important to note. For example, does the instability only occur in extreme positions of abduction/ external rotation, or does it occur in “everyday” positions during sleep or activities of daily living? This may provide clues to the surgeon regarding the severity of the soft tissue or bony restraint damage in the shoulder. Clinicians should also determine if the shoulder instability has a voluntary component, as these patients often have demonstrated poor response to surgical stabilization [196].

There is no evidence to answer what factors from history taking are more relevant to decide between conservative or surgical treatment in recurrent anterior shoulder instability in young adults.



2.2.3 Older adults (Best evidence: 1 comparative study, 7 case series):

Factors affecting the decision-making between conservative and surgical treatment in older adults are:

Patients' profession:

Heavy manual labourer with repetitive lifting was the only profession that continued to have moderate pain and rated strength as poor among patients treated with arthroscopic Bankart repair. Patients' employment as labourers may be a possible reason for suboptimal clinical outcomes [326].

Patients' age (correlation to several treatment options' outcome):

Among patients > 40 years treated for anterior shoulder instability, patients suffering from concomitant rotator cuff tears (RCT) were significantly older than patients with intact cuffs (62 years vs 52) [326]. The frequency of rotator cuff tears increased with advancing age: in the 40–55 age group, the frequency was 41%. In the 56–70 age group, 71%, and in those over 70 years, the frequency was 100%. However, regression analysis showed that the better outcome of surgical treatment of rotator cuff tears compared to patients with RCT treated conservatively was not explained by age or gender but was a genuine benefit of treatment. This finding was not investigated separately for acute and recurrent dislocations [319].

Similarly, age was not a risk factor for failure for patients > 30 years treated with arthroscopic Bankart repair for recurrent anterior shoulder instability. On the contrary, ISIS score ≥ 3 was a prognostic factor for failure in the same cohort of patients [66].

Age correlated with outcomes for patients over 40 years treated with open Latarjet procedure for recurrent anterior shoulder instability. Specifically, patients over 46 years had more pain; higher stages of OA; decreased ROM with less elevation and IR and lower Walch-Duplay, Constant Murley and Rowe scores compared to patients 40–46 years. Lower but not



statistically significant differences in the adjusted CMS, Subjective Shoulder Value, and satisfaction were shown for patients > 46 years compared to patients 40-46 years. The prevalence of recurrent instability, reoperation rates, and overall complication rates after open Latarjet were not significantly different between these two age groups. Nerve injuries were presented in the group 40-46 years, whereas postoperative hematomas and most radiographic complications (graft fracture, non-union, and static subluxation) were found in the group > 46 years [71]. Besides, older age at surgery significantly correlated with the progression and severity of dislocation arthropathy [86,184].

Finally, for patients >40years with primary anterior dislocation, patients with associated glenoid fractures were generally older than the others in this cohort [324].

Patients older than 55 years of age (range 55-80 years, mean 72 years) with recurrent anterior shoulder dislocations and massive or large rotator cuff tears and low functional demands of daily living have been successfully treated with a capsular shift technique consisting of capsule transfer superiorly and posteriorly to close the defect in the cuff. This operation was developed as a salvage procedure and displayed satisfying long-term outcomes for patients with these characteristics [191].

B) Physical examination:

3. What are the most important clinical tests findings that help to decide about conservative and surgical treatment in patients with first-time anterior dislocation?

3.1 Statement



A thorough clinical exam must be performed in each case, including anterior apprehension test, passive and active range of motion. If pain is present in clinical exams, suspicion should be raised for other pathologies (i.e. SLAP and rotator cuff tear). Both shoulders should be evaluated and compared. In each age subgroup the most important clinical findings to look for in a first-time anterior dislocation are:

Adolescents

The presence of the anterior apprehension sign, which is more frequently seen in adolescents with glenoid bone loss, suggesting a potential need for surgical intervention (Grade B).

Shoulder laxity and generalized ligamentous laxity (assessed by Beighton score) are also important for further decision-making (Grade C).

Young adults

The Apprehension and relocation signs, the anterior drawer test, and rotator cuff assessment that help in the decision-making between conservative and surgical treatment (Grade B).

Older adults

The most important factor in this age group is the integrity of the rotator cuff (Grade B). Also, the presence of a traumatic nerve injury should be an important finding to consider when deciding between conservative and surgical treatment (Grade C).

Median (range): 9 (7-9)



3.2 Literature summary

3.2.1 Adolescents (Best evidence: 2 comparative studies, 1 case-control, 2 retrospective, 2 cases series, 1 expert opinion):

Patients with acute anterior shoulder dislocation will often hold the arm at the side and be unable to tolerate range of motion and thus proper examination. After initial reduction, detailed neurovascular exam should be performed with particular attention to the axillary nerve [194]. Clinical test can be performed reliably when initial pain subsides. Several exam maneuvers are suggested in the literature (level II to IV studies) to provoke reproduction of symptoms and to assess shoulder laxity. Anterior provocative testing includes the load and shift test, anterior apprehension sign (placing the shoulder in an abducted and externally rotated position), relocation sign (placing a posteriorly directed force during apprehension testing and noting any sensation of relief), release test (releasing the posterior force and noting for recurrence of apprehension), hyperabduction test (Gagey test) and the sulcus sign [103,194,250,318]. Generalized ligamentous laxity should be documented as well and considered for further decision making [103,194,250,318]. For this purpose, the Beighton score is recommended. The presence of the anterior apprehension sign was the most common indicator for persistent instability and seen more frequently in adolescents with glenoid bone loss suggesting a surgical approach [82,103,180]. There was a tendency that the anterior apprehension sign was more likely to remain positive after conservative treatment when compared to surgical treatment [103,162].



3.2.2 Young adults (Best evidence: 1 randomized controlled trial, 1 diagnostic study, 2 cohort study, 1 case series, 1 narrative review, 1 expert opinion):

The most important clinical test for anterior shoulder instability are related to the apprehension and relocation signs, and its different variants. Despite there are not dedicated studies evaluating the predictability of clinical examination tests to decide upon conservative or surgical treatments in first-time anterior shoulder dislocation, there are several considerations that can be mentioned.

In patients aged 17 to 27 years with first-time anterior shoulder dislocation, Safran et al. observed a redislocation rate of 36.8% in patients with negative apprehension test compared to a 71.4% in patients with a positive test [299]. The specificity was 85.7% with an odds ratio of 4.285. The same group observed similar results at a longer follow-up of the cohort, confirming that patients with a positive apprehension test redislocated more and earlier after first-time anterior shoulder dislocation [221]. If redislocation is high in patients with positive apprehension test, surgical treatment might be favored over conservative treatment. This is specially true considering that up to 67% of patients aged 15 to 35 years old with first-time anterior dislocation may experience another dislocation episode within 5 years when treated non-operatively [278]. This is likely the reason why some authors (Level V evidence) recommend surgical treatment of first-time anterior shoulder dislocation when patients present with a positive anterior apprehension sign, particularly if meaningful bone loss is present [331]. The specificity of the apprehension test can increase up to 100 when an anterior force is applied (augmentation test) when conducting the apprehension sign [334]. On some occasions, the abduction and external rotation position causes pain rather than apprehension. Speer et al. observed that the diagnostic accuracy to detect anterior shoulder instability was <50% if the response to the apprehension position was pain rather than apprehension itself



(>80%) [325]. The authors concluded that pain with apprehension was not a good predictor of anterior shoulder instability. In this scenario, it is important to assure that an associated pathology is not present (i.e., adhesive capsulitis, rotator cuff disease, or SLAP lesions).

Other physical examination tests include the relocation test after provoking apprehension, and the anterior drawer test. The relocation test has demonstrated specificity up to 100% [325,334]. However, Speer et al. provided no information on the age of the included patients or whether they had first-time or recurrent anterior shoulder dislocation [325]. Despite the anterior drawer test has demonstrated a very good specificity of 92.7% [339], many clinicians consider it less predictable because it is difficult to be adequately performed in the outpatient clinic without complete muscle relaxation [216]. In most expert hands, this test is not the most adequate one to decide between conservative or surgical treatment of anterior shoulder dislocation. On another study, Van Kampen et al. evaluated the diagnostic value of the apprehension, relocation, release (surprise), anterior drawer, load and shift, and hyperabduction tests for anterior shoulder instability [339]. They found that while most test provided good diagnostic value, the release test was the best predictor for anterior shoulder instability. Again, the authors provided no information on the age of the included patients or whether they had first-time or recurrent anterior shoulder dislocation.

3.2.3 Older adults (Best evidence: 9 case series studies, 2 reviews):

First-time anterior shoulder dislocation in patients over 40 years of age is often accompanied by nerve and rotator cuff lesions, and these patients should be followed closely during the first weeks after the injury. It was shown that the incidence of the initial nerve (brachial plexus or axillary nerve) and/or cuff lesions was higher in patients with persisting symptoms at follow-up after treatment of the first-time dislocation [332]. Inability or weakness to abduct the arm



should result in further examinations to detect and, perhaps, treat such complications as early as possible [264].

Instability testing:

Physical examination for anterior instability should include the apprehension test, relocation test, and pathologic anterior translation with the load-shift manoeuvre [229,280]. Patients with negative physical examination findings consistent with anterior instability but only pain as their clinical presentation 2 to 4 weeks after initial conservative treatment for a single anterior dislocation episode should be further examined for rotator cuff pathology [280]. Sonnabend et al. [324], in their series of primary dislocation >40 years, suggests a difference between functional instability (i.e., the occurrence of dislocation or symptomatic subluxation with activity) and instability demonstrated by examination under anaesthesia. While three patients exhibited instability when examined under anaesthesia preoperatively and had significant subscapularis and capsular tears, they might never have developed functional instability. Such patients generally do not dislocate or complain of instability.

Rotator cuff testing:

In older patients who cannot abduct the involved arm after reduction or if abduction of the arm fails to improve in ten to fourteen days after the dislocation, rupture of the rotator cuff should be the primary suspicion [237]. Also, significant pain or weakness in the shoulder after glenohumeral dislocation is an essential indication for rotator cuff imaging [316,327]. For rotator cuff examination, resisted thumb-down shoulder abduction in the scapular plane suggests supraspinatus pathology. Similarly, weakness on resisted external rotation in adduction and at 90° of abduction suggests infraspinatus and teres minor pathology, respectively. Several physical examination tests have been described to assess for subscapularis tears, but the most used tests are the belly press and modified lift-off [229]. Quantitative muscle strength measurements of the rotator cuff are assessed with a portable,



handheld dynamometer. Elevation strength was tested with the patient seated with the arm flexed to 90 in the scapular plane. External and internal rotation were tested with the shoulder in a neutral position and the elbow in 90 flexion. Abduction was tested with the arm abducted to 90 in the coronal plane [229,276].

For the patients >60 years old, the extension of the tear anteriorly (subscapularis) caused considerable deterioration of the functional outcome in terms of constant score, whereas this detriment was not apparent when the tear extended posteriorly (infraspinatus) [269].

Nerve injury testing:

In a patient 3 to 4 weeks post-dislocation who experiences significant weakness in abduction and has negative rotator cuff imaging, nerve injury should be tested. Weakness of shoulder abduction with hypoesthesia in the deltoid region may suggest axillary nerve injury [114]. However, sensory testing for the axillary nerve may be unreliable sometimes; in such cases testing for nerve damage must rely on weakness, delayed functional return, and electromyography results [327]. Most authors suggest exploring the brachial plexus if no signs of improved muscle function are documented by electromyography or clinical examination at 3 to 4 months. If the motor function has not returned by 3 to 4 months, a poor prognosis is associated with the injury.

Prognosis:

Neviaser et al. showed that the group who had had a single dislocation, a ruptured rotator cuff, and no injury to the axillary nerve had dramatic relief of pain after the rotator cuff had been repaired, recovery of abduction strength, and none had pain at night [237]. The group who had had a single dislocation, a ruptured rotator cuff, and an injury to the axillary nerve had relief of pain and no pain at night after the rotator cuff had been repaired. However, there was incomplete recovery of the function of the axillary nerve and the deltoid muscle, as shown by decreased ROM and strength for abduction.



Finally, the group with recurrent instability but no axillary-nerve palsy had relief of pain, including nocturnal pain, and all regained full abduction of the arm and RC strength [237].

4. What are the most important clinical tests findings that help to decide about conservative and surgical treatment in patients with recurrent anterior dislocation?

4.1 Statement

A thorough clinical exam must be performed in each case, including passive and active range of motion, according to what is tolerated by the patient (usually after 6 weeks). Both shoulders should be evaluated and compared. In each age subgroup the most important clinical findings to look for recurrent anterior shoulder dislocation are:

Adolescents

The Anterior apprehension sign which is the most important indicator of persistent instability. Also, signs of shoulder hypermobility and general ligamentous laxity are important for decision-making. Additionally, clinical tests including load and shift test, relocation sign and release test can be performed if tolerated (Grade B). Scapular dyskinesis examination should be performed so that it can be addressed before any surgical treatment of shoulder instability is considered (Grade D).

Young adults

The combined use of the apprehension test and relocation test. Both need to be performed in this group of patients as they have excellent sensibility and good reproducibility. The surprise test might be of value if these two previous tests provide dubious results. Hypermobility of



the shoulder joint and generalized hypermobility should be examined specifically in all patients in whom surgery is considered (Grade B).

The anterior drawer test and the different labral and SLAP stress tests might be of use in some cases (Grade D).

Scapular dyskinesis examination should be performed so that it can be addressed before any surgical treatment of shoulder instability is considered (Grade D).

Older adults

The most important factor in this age group is rotator cuff's integrity. Recurrence is a less frequent problem in patients of this age group. However, when a patient of this age group suffers from recurrent episodes of dislocation, a massive full-thickness rotator cuff tears should be suspected, and the rotator cuff integrity should be evaluated (Grade C).

Median (range): 9 (7-9)

4.2 Literature summary

4.2.1 Adolescents (Best evidence: 2 prospective cohort, 2 prognostic retrospective cohort):

Several studies (Level of evidence II to IV) support the use of special maneuvers to provoke symptoms of instability and access for laxity, including the load and shift test, anterior apprehension sign, relocation sign, release test, hyperabduction test (Gagey test) and the sulcus sign [103,194,250]. The Beighton score is recommended to assess for general ligamentous laxity, which should be considered for further decision-making [35,179,194]. The presence of the anterior apprehension sign was the most common indicator for persistent



instability and seen more frequently in adolescents with glenoid bone loss suggesting a surgical approach [82,103,180]. There was a tendency that the anterior apprehension sign was more likely to remain positive after conservative treatment when compared to surgical treatment [103,162].

4.2.2 Young adults (Best evidence: 7 prospective diagnostic studies, 1 survey, 1 review):

Most active young individuals with recurrent anterior shoulder dislocation are good candidates for surgical treatment. Despite of this, a thorough clinical examination is necessary, mainly to confirm the diagnosis of recurrent instability and exclude other issues that might cause the patient symptoms. To reach this objective many clinical tests have been developed. The most commonly used are the anterior apprehension test, the relocation test, the surprise test, the anterior drawer test, various hyperlaxity tests (addressed elsewhere) and different labral-biceps stress tests.

Anterior apprehension and relocation tests:

These tests are described together as they are easy to performed in conjunction and are used by most if not all shoulder surgeons as reported by Sciascia et al. in 2012 [305]. The sensibility of the apprehension and relocation test to identify anterior instability was evaluated in a prospective cohort study by van Kampen et al. [339] and found the apprehension test to be the most sensitive (ranging from 91.7 to 98.3). These tests were found to have improved sensitivity and specificity when apprehension rather than pain was used as the definition for a positive test in another prospective study by Tzanness at al. [335].

Surprise test:



The surprise test was proposed by Gross et al. in 1997 [113] as a good alternative in patients in which anterior instability was suspected but traditional apprehension tests were dubious or inconclusive. Lo et al. [198] tested 46 subjects with different shoulder conditions and found that subjects who had a feeling of apprehension on all three tests (apprehension, relocation and surprise), the positive and negative predictive values were 93.6% and 71.9%, respectively. In fact, the surprise test was the single most accurate test (sensitivity = 63.89%; specificity = 98.91%). This study found that an improvement in the feeling of apprehension or pain with the relocation test added little to the value of the tests.

Modified apprehension test:

Bushnell et al. [40] examined 29 consecutive cases of symptomatic shoulder instability and assessed them with the bony apprehension test (an apprehension test performed at 45°, or below 45°, of abduction, and 45°, or less, of external rotation). The bony apprehension test was positive in all 8 patients with relevant bony lesions (>25% glenoid bone loss or engaging Hill-Sachs lesions) and in 3 of 21 patients without relevant glenoid injuries, representing a sensitivity of 100%, specificity of 86%, positive predictive value of 73%, and negative predictive value of 100% for glenoid bony lesions.

Anterior drawer test:

Gerber and Ganz [100] advocated the use of the anterior drawer test, assessing the degree of anterior displacement of the humeral head compared to the fixed scapula in the supine position to grade the subluxation of the humeral head. This test is not really a test to address instability but laxity of the shoulder. It has been shown to have a very limited sensibility (0.58) for the diagnosis of anterior instability [89].

Table 2 Performance of common maneuvers in evaluation of anterior shoulder instability (adapted from [196]).



| | Sensitivity | Specificity | Inter-rater reliability |
|----------------------|-------------|-------------|-------------------------|
| Apprehension test | 0.68–0.88 | 0.5–1.00 | 0.47 |
| Relocation test | 0.57–0.85 | 0.87–1.00 | 0.71 |
| Release test | 0.85–0.92 | 0.87–0.89 | 0.63 |
| Anterior drawer test | 0.53 | 0.85 | Unknown |

Labral-biceps stress tests:

A myriad of different tests have been proposed in an attempt to identify injuries of the biceps-labrum insertion (SLAP tears), or specific labral injuries. These maneuvers are often used in the context of the patient with anterior shoulder instability. They add very little, if anything, to the diagnosis of anterior instability and rarely, if ever, condition the decision on whether to operate or not one of these patients. Lizzio et al have recently provided an excellent review of these [196].

4.2.3 Older adults (Best evidence: 4 case series):

Recurrent anterior shoulder dislocation is seen commonly in younger patients. Although less frequent, we may also see some older patients with recurrent anterior shoulder dislocation. There is a significant incidence of full-thickness rotator cuff tears when anterior dislocation occurs in older patients, and this “posterior mechanism” can cause recurrent instability. Therefore, in such cases, rotator cuff integrity should be tested. However, when recurrent instability does occur without a significant rotator cuff tear, the “anterior mechanism” must be considered a significant contributing factor. Araghi et al. showed that recurrent anterior instability is usually the result of compromised anterior capsulolabral stabilizing structures.



[5]. In patients over 40 years old, in whom recurrent instability develops after initial dislocation of the shoulder, a rupture of the subscapularis tendon and the underlying capsule should be suspected. Testing for subscapularis integrity should be performed. If this injury is found, repair of the lesion alone will correct the problem [237].

The literature provides no further information regarding clinical testing of the “anterior mechanism” that results in recurrent instability. Mizuni et al. [222] showed that older patients with instability started after 40 years of age and developed recurrent shoulder dislocation without rotator cuff tears; they had a capsular tear in the acute stage. Ro et al. showed that intra-articular pathologies were varied; however, no single intra-articular lesion significantly impacted the recurrence rate [276].

5. What clinical tests should be performed to assess shoulder hypermobility in each specific age subgroup?

5.1 Statement

There is no specific test relative to each age group for assessing shoulder hypermobility. To assess shoulder hypermobility, the following clinical tests can be performed:

- (1) finding more than 85 degrees of external rotation in 0 degrees of abduction,
- (2) the sulcus sign,
- (3) hyperabduction assessed by the Gagey test,
- (4) translation of the humeral head (this test is better addressed under general anaesthesia).



The examination should be compared to the contralateral healthy side. Also, scapular control should be evaluated when assessing shoulder hypermobility (Grade C).

Older adults

Hypermobility in older adults patients is rarely found (Grade C).

Median (range): 8 (7-9)

5.2 Literature summary

5.2.1 Adolescents (1 randomized controlled trial, 2 case series, 1 expert opinion):

Shoulder hypermobility is frequently assessed using the Beighton score [36,194,266]. The range of external rotation with the elbow at the side and the Gagey test can also be used for this purpose [33].

5.2.1 Young adults (Best evidence: 2 prospective cohort, 2 retrospective cohort, 1 prospective comparative, 3 prospective cohort, 1 cadaveric study, 1 meta-analysis, 4 systematic review, 6 narrative review):

Some studies focused on the clinical evaluation and physical exam findings in patients with anterior shoulder instability but most of them only evaluated specific maneuvers of the anterior shoulder instability instead of specific clinical test to assess shoulder hypermobility [192,198]. Specific evaluations of hypermobility have been described in some studies



[119,196]. We will describe here the clinical test that should be performed to assess specifically the hypermobility/hyperlaxity of patient's shoulder.

Inferior hyperlaxity is not necessarily associated with Inferior instability and it seems above all that hyperlaxity is not the cause of instability but of failure of surgery [11,155].

Anterior and posterior drawer tests:

If the examination of the patient under general anesthesia is the "gold standard" for the evaluation of laxity by canceling the action of the dynamic stabilizers [155], the normal degrees of laxity of the shoulder seem poorly defined. Indeed, to be reproducible and objectively quantify the translation of the humeral head, it should always be performed with the arm in the same position and the same amount of force applied to avoid inter-observer variations. In addition, the examination must be painless, which makes interpretation difficult in some patients consulting for an instability problem. An anatomical study was able to find an average displacement of the humeral head in relation to the coracoid of 11.8 mm anteriorly, 20.2 mm inferiorly and 8.6 mm posteriorly [291]. Finally, the superior laxity cannot be objectified on clinical examination due to the existence of early contact between the humeral head covered by the cuff and the underside of the acromion.

The association of inferior laxity with anterior and/or posterior laxity is frequent and constitutes one of the main causes of failure of surgical treatment of instabilities initially described as unidirectional, in the same way as the presence of associated neurological lesions (such as the subscapular nerve) [48].

External rotation in 0° of abduction:

Walch and Coudane were the first to introduce the criterion of external hyper rotation greater than 85 degrees for the diagnosis of hyperlaxity of the shoulder [58]. According to the Instability Severity Index Score ("ISIS") method, bilateral examination of the patient in a



sitting or standing position with the examiner behind the patient and the assessment is always visual.

Ropars et al evaluated the inter- and intratester reproductibility of the assessment of ER1 using ISIS method With the “Elbow on the table method” (EOT) [283]. For this method, assessment is performed with the patient on the examining table in the decubitus dorsal position. Assessment is unilateral and visual, and the shoulder was considered hyperlax if ER1 is greater than 90° with the diagnosis made without measurement devices. The shoulder is hyperlax if the forearm is below the table. Kappa values for inter- and intratester agreement with the ISIS method were average, between 0.4–0.6. Results of the ICC were satisfactory (0.6–0.8) for intra- and intertester agreements ER1 with the EOT method was at least 5° more than that with the ISIS method in all patients ($P < 0.0001$). The hyperlax population identified by the ISIS method was statistically the same as that identified by the EOT method ($P < 0.001$). This simple, reproducible method can be used as an initial diagnostic tool of hyperlaxity. Its intratester agreement makes it a good method to monitor lateral rotation mobility in cases of instability, or for any other shoulder pathologies.

The load and shift test:

This test makes it possible to evaluate the anterior and posterior glenohumeral translation in a seated patient by trying to reproduce the patient's symptoms. The humeral head is applied and centered on the glenoid using axial loading. A translation is then performed on the humeral head to check for the presence of laxity. This test can secondarily be performed in different degrees of abduction to explore different components of the capsule. It must be performed on a relaxed patient so that the presence of a muscular contraction does not disturb him. If laxity is found, note the difference in glenohumeral translation with the contralateral shoulder. The



result is stated in terms of degree of variation (grade 1: translation at the level of the glenoid neck, grade 2: dislocation with spontaneous reduction and grade 3: dislocation without spontaneous reduction). Its specificity to diagnostic instability ranges from 89.9% to 100% while its sensitivity varies more significantly between 8.0% and 71.7% but its value to evaluate hyperlaxity was not assessed [339].

Sulcus sign:

This clinical sign was initially described by Neer and Foster as a inferior shoulder stress test to diagnose multidirectional shoulder instability [236]. Biomechanical studies have since been able to demonstrate that this maneuver allows testing of the superior glenohumeral ligament and the coracohumeral ligament [29,59]. It is performed on a patient seated and relaxed by directly applying a lower force on the arm in neutral rotation, by gripping the elbow maintained in contact with the trunk [100].

Thus, a lower displacement of the humeral head results in the appearance of a subacromial groove, which is not improved by the external rotation of the arm. Some authors have suggested that it is necessary for the sulcus to be of a minimum size in order to be able to speak of a multidirectional instability of the shoulder [25,217]. It was therefore proposed to take a size of 2 cm to define this sign [334]. However, this examination presents a large interobserver variability in the evaluation of the size of the groove observed with an interclass correlation of 0,60 ($p < 0,0001$) [334].

If the specificity of this test in the diagnosis of IMD of the shoulder was 97% with a cut-off of 2 cm, its sensitivity was unfortunately only 28% with a large inter-observer variability [334]. This test could also be described as a sign reflecting generalized ligament hyperlaxity [16].

Ropars et al. also performed a study on the diagnosis and treatment of anteroinferior capsular redundancy associated with anterior shoulder instability using an open Latarjet procedure and capsulorrhaphy [283]. Their objective was to assess the clinical features of patients presenting



with an anteroinferior capsular redundancy (ACR) and unilateral instability to determine the position of this particular population in the spectrum of instability in terms of history and clinical examination. They concluded that patients with ACR tended to express a MDI profile with more subluxation than dislocations and also presented a discrete history of injury with a significantly lower initial traumatic energy during a usually non-sports-related activity. A sulcus sign occurred significantly more frequently in patients with ACR using a cut-off of 1 cm. They also found that patients with ACR had increased Beighton score in comparison with the other patients. Therefore, sulcus sign > 1cm, Beighton score and the instability history seems to be correlated with ACR.

Hyperabduction test:

Described in the early 2000s by Gagey, it is performed on a seated and relaxed patient by stabilizing the scapula while passive abduction is gradually applied to the tested shoulder [96]. Inferior laxity at the expense of the inferior glenohumeral ligament is suspected when a passive abduction of more than 105° can be obtained with the scapula held fixed by the observer. The specificity and sensitivity of this test have been evaluated at 89% and 66.7% respectively [339].

5.2.3 Older adults (Best evidence: none):

No study is available for this age group that includes information about the assessment of hyper-mobility specific to this age group.

6. How does shoulder hypermobility affect the management and decision-making according to each specific age subgroup?



6.1 Statement

Hyperlaxity is considered a risk factor for a new anterior shoulder instability incident. Hyperlax patients have an increased odds ratio of developing recurrent instability, and additional procedures should be considered when these patients are managed operatively to achieve better stability (Grade B).

Adolescents

The presence of shoulder hypermobility is common in patients less than 20 years old. It should alert surgeons as it may compromise the postoperative outcome regarding return to baseline range of motion and strength (Grade B).

Older adults

Hypermobility is less common in this age group's patients (Grade C).

Median (range): 9 (7-9)

6.2 Literature summary

6.2.1 Adolescents (1 randomized controlled trial, 1 prospective comparative, 1 case series, 1 expert opinion):

Shoulder hypermobility is usually associated with generalized joint hyperlaxity [20,36,266]. These patients classically present a higher redislocation rate after surgical stabilization



[20,194,266]. Buckwalter and colleagues found that generalized joint laxity is a risk factor for failure to return or delayed return to baseline ROM and strength, and concluded that knowing this can help surgeons counsel patients concerning the likely short-term outcome of operations intended to treat shoulder instability and encourage further study of the group of patients that is at risk of failure to return to baseline shoulder ROM and strength [36].

6.2.2 Young adults (Best evidence: 1 randomized controlled trial, 2 systematic reviews, 3 cases series):

Hypermobility can be assessed either as a general ligamentous laxity or in a specific joint. Decision-making in anterior shoulder instability treatment is a meticulous consideration of the different risk factors for new instability incidents in a specific patient and hypermobility is one of the patient related factors to consider. Generalized ligamentous laxity is thought to be of importance in patients with anterior shoulder instability, however multi directional instability is a different topic and is not within the scope of this consensus.

The results of surgery and the type of procedure will be different in hyperlax patients. Patients with anterior capsular redundancy (ACR) in anterior shoulder instability might benefit from additional surgical procedures aiming to tighten the capsule. ACR can be evaluated during surgery and Ropars et al define it as present if the inferior capsular flap of a Neer T-shaft capsulorrhaphy was able to cover the superior capsular flap with the arm in the neutral position [282]. They found that ACR correlated with a positive sulcus sign, Beighton score and instability history and concluded that in anterior shoulder instability associated with ACR, the Latarjet procedure with a Neer capsulorrhaphy appeared to be a satisfactory treatment alternative to arthroscopic or open capsular shift. It decreased apprehension in comparison with Latarjet procedures without capsular repair.



Deficiency of the rotator interval and laxity of the anteroinferior capsuloligamentous complex is thought to be associated with instability in patients with hyperlaxity [211]. Surgical treatment to address the capsule stretching and capsular deficiency might be argued. There are two studies that compare surgical anterior stabilization with or without rotator interval closure (RIC). Maman et al performed a prospective randomized controlled study where adding RIC showed no superiority compared to arthroscopic Bankart alone [215]. Chechik et al. concluded that patient with hyperlaxity experienced delayed recurrence if RIC were performed [51].

The literature does not provide us with high level recommendations for soft tissue procedures like Anterior Subscapularis Augmentation (ASA) and/or Remplissage. Maiotti et al. published a case series of patients suffering from anterior instability and hyperlaxity, practising contact and collision sports, glenoid bone loss less than 15%. In this case series (level of evidence: 4) they concluded that ASA was safe and effective and resulted in a reduction of 15 degrees of external rotation (ER1) [211]. Hurley et al. have published a systematic review (SR) and meta-analysis (MA) on the results of the remplissage procedure that concludes that adding remplissage lower the risk of recurrence in general, however there are no publications on hyperlax patients in particular [142].

Olds et al. published a SR and MA on the risk factors of recurrent instability after the first shoulder dislocation. They found that there was an increased risk of recurrent instability with odds ratio of 2.6 in hyperlax patients [245]. This result indicate that the surgeon should lower the threshold for additional procedures in hyperlax patients.

6.2.3 Older adults (Best evidence: none):



No study is available for this age group that includes information about how hyper-mobility affects the decision-making of this age group.

7. What clinical tests should be performed to assess generalized joint hypermobility in each specific age subgroup?

7.1 Statement

The Beighton score is recommended to recognize generalized joint hypermobility as a screening method and not as a diagnostic tool. It is suitable for all age groups. However, the cut-off value is influenced by age, sex and ethnicity. Greater score is expected in younger patients, females and non-Caucasian ethnicities (Grade B) .

The Beighton score has only a moderate correlation with hypermobility of the shoulder joint (Grade C).

Adolescents

Children have greater values of Beighton score compared to adolescents and especially adults (Grade B).

Older adults

Generalized joint hypermobility is rarely found in older adult patients (Grade C).

Median (range): 9 (7-9)



7.2 Literature summary

7.2.1 Adolescents (Best evidence: 1 prospective comparative study, 2 prospective observational study, 1 case series, 2 review articles):

Even though hyperlaxity/general joint hypermobility (GJH) is often mentioned as an important factor influencing natural history of a first time dislocator and recurrence rate, only three out of 65 papers included in the literature search for this specific age group mention the clinical test used to access it. The Beighton score is specifically mentioned in two papers [194,333]. Gigis et al. [103] assessed hyperlaxity of the shoulder after first anterior dislocation measuring the external rotation of the contralateral shoulder, the sulcus sign, the hyperabduction test and the presence or absence of hyperextension of both elbows.

It is worth to know that elasticity of the ligaments and joint capsule is specific in pediatric and adolescent patients. This is because in this period of life development progress of collagen occurs and its composition changes from predominantly elastic type III collagen to inelastic type I collagen [103]. Patients with a higher proportion of elastic type III collagen may be more prone to shoulder instability [103]. Furthermore elastic type II collagen is less susceptible to permanent plastic deformation compared to type I collagen [103].

Following to this, Beighton score as a screening method for GJH is significantly influenced by age, sex and ethnicity [214,320]. Beighton score analysed on Australian population decreased across the lifespan at a similar rate for both females and males [320]. Furthermore, from the age of 14 years, in this study females had significantly higher values compared with males [320]. In addition, non-Caucasians compared with Caucasians had significantly higher values too [320]. Utilization of the arbitrary cut-off ≥ 4 lead to a greater likelihood of females



and of younger ages being classified with GJH and a high false-positive rate of 60% may occurred [214,320]. Therefore, utilizing a single cut-off for the entire population does not appear suitable. Suggested cut-off value for children 3-7 is 6/9, for children 8-13 is 5/9, for adolescent 14-19 is 4/9 for males and 5/9 for females [320,322]. Suggested cut-off value for males 20-39 is 4/9 and for females 5/9 [320]. Suggested cut-off value for males above 40 is 2/9 and for females 4/9 [320].

Some authors advised that due to the low sensitivity of the Beighton scoring system it should not be utilized as the sole assessment tool for the diagnosis of GJH [214,320]. Another important limitation is that Beighton score does not correlate with hypermobility of the shoulders and shows low sensitivity and low positive predicted values for shoulder laxity [214].

7.2.2 Young adults (Best evidence: 2 prospective cohort, 1 retrospective case series, 4 cross-sectional observational, 3 reproducibility, 2 narrative reviews):

There are three main tools used for assessing generalized joint hypermobility (GJH): the Beighton score [17], the Contompasis score [219], or the Hospital del Mar score [38]. The most commonly used and studied is the Beighton score [30,157,303].

The Beighton score [17], a nine-point scoring system based on clinical examination of the spine, knees, hands and elbows, is considered the standard method of assessment for generalized joint hypermobility (GJH). Although it was developed more as an epidemiological tool for population screening of GJH, it has been widely adopted as a clinical tool. It is reproducible in adult population with benign hypermobility syndrome [30]. It has sustained recent criticism as an apt tool for clinical diagnosis [214], as it fails to address major joints (including the shoulder) and focuses mainly on elbow and hand hyperlaxity.



The Beighton score is widely used in shoulder instability studies and cited in many different reviews on the exam of the unstable shoulder. Its results have been shown to have a clear correlation with the prognosis of different surgical procedures for the unstable shoulder [169,177,358]. This is despite the absence of a formal validation of its use for the assessment of hyperlaxity in young adults with shoulder instability. Its main limitation for the shoulder surgeon is that it does not assess specifically shoulder hyperlaxity or hypermobility [97,350]. Schlager et al. evaluated the inter- and intra-rater reliability of the Beighton, the Contompasis, and the Hospital del Mar scores [303]. The authors found that both reliability parameters were good-to-excellent to measure the range of motion in joints included in these methods. Despite the inter- and intra-rater reliability was poor-to-moderate for certain specific joints, values from the shoulder were still good-to-excellent, with prevalence-adjusted, bias-adjusted kappa value between 0.88 and 0.96 for inter-rater reliability, and 0.79 and 1 for intra-rater reliability.

7.2.3 Older adults (Best evidence: none):

No study is available for this age group that includes information about the assessment of generalized joint hyper-mobility specific to this age group.

C) Imaging studies:

Timing:

8. What are the most important imaging studies to decide between conservative or surgical treatment for first-time anterior dislocation?



8.1 Statement

In case of first-time anterior dislocation pre- and post-reduction X-ray imaging is paramount for basic bone damage identification and joint reduction confirmation. X-ray trauma series with 3 orthogonal views (anteroposterior, axillary and scapular/Y) is recommended and if any bony lesion is suspected a CT scan should be performed, particularly measurements on 3D CT scans. It enables to quantify glenoid bone and Hill-Sachs lesion. Additional views (Bernageau / West Point / Stryker Notch) can now be completely replaced by CT, which is the main diagnostic tool allowing decision-making in case of glenoid and/or proximal humeral lesions (Grade B).

Soft tissue evaluation with CT arthrogram, MRI or MRI arthrogram (especially in hyperlax patients) is recommended if the patient has no bony injuries and persistent symptoms or if surgery is being considered because of high risk of recurrence (Grade B).

Adolescents

One should be cautious to minimize the risk of radiation exposure in children and adolescent population. MRI can replace CT scan when assessing bony injuries in this group of patients (Grade D).

Older adults

Bone fragility in older adults is high; therefore pre-reduction X-ray is mandatory to identify fractures. Based on the higher risk of associated cuff tears in older adults, there is a low threshold for an ultrasound or MRI imaging based on persistent clinical symptoms (Grade B).

Median (range): 9 (7-9)



8.2 Literature summary

8.2.1 Adolescents (Best evidence: 1 prospective comparative study, 1 retrospective cross-sectional cohort study, 1 review article, 3 retrospective prognostic/diagnostic studies, 1 case series):

X-rays have to be acquired pre- and post-reduction in order to assess any bone damage and thus the need for surgery. The minimum recommended views include: anteroposterior, axillary and scapular-Y views. For a more detailed examination of the glenoid and humeral lesions, West Point view and Stryker Notch view should be taken [81,82,194]. Occasionally, glenoid bone loss can be overlooked on a plain X-ray and demands a more accurate set of advanced imaging [82].

MRI (Magnetic Resonance Imaging) is needed after the shoulder dislocation is confirmed through X-rays. This helps to assess any damage done to the soft tissue (e.g. joint capsule, glenohumeral ligaments, labrum, cartilage) and decide between conservative or surgical treatment [82,194]. MRI represents a reasonable alternative to the accepted golden-standard of CT (Computer Tomography) for both quantifying glenoid bone loss and characterizing Hill-Sachs lesions and bipolar “on-track” and “off-track” lesions without the risk of radiation exposure in a population where the risk of malignancy is already high [82,103,133,170,180]. In case of bony edema, accurate assessment of the Hill-Sachs lesions can be made using a MR Arthrogram [170]. MR Arthrogram was also suited for detecting anterior labral tears, but with limited accuracy regarding the anterior tears that extend beyond the anterior labrum and tears in other parts of the labrum [81].



8.2.2 Young adults (Best evidence: 2 randomized controlled trials, 3 reviews, 4 prospective comparative studies and 3 retrospective studies):

After a successful management to the first episode of dislocation it is important to identify those patients that can benefit of early surgical intervention. An appropriate imaging work-up can help surgeons to identify factors for conservative treatment failure.

Hasebrook et al. [124] performed a narrative review about the management of primary shoulder dislocations. According to authors, standard radiographs that help to assist with initial diagnoses and in post-reduction assessment, are the following: anteroposterior views in neutral, external, and internal rotation, a lateral, or “Y,” view in the scapular plane, and an axillary view [79]. Computerized tomography scans allow to better assess for bone loss in first-time dislocators or a CT angiogram if possible vascular injury. MRI is best for soft tissue pathology, such as damage to the labrum, axillary nerve, or shoulder capsule.

In another review paper, Kane et al. [158] authors gave important insights about the radiographic assessment in primary anterior shoulder dislocation. As for radiographic testing, a true anteroposterior, scapular Y, and axillary views should be obtained to determine the direction of the dislocation as well as other pathology that may be apparent. A scapular Y view confirms an anterior dislocation. An internal rotation view typically shows the Hill-Sachs lesion. A Garth view may be obtained for optimizing the detection of bony Bankart fractures as well as Hill-Sachs lesion. CT scan and MRI can be considered to rule out specific pathologies depending on the pathology that is expected. The CT scans are obtained in patients who are suspected of having complex bony injuries based on radiographic examination. An MRI is generally viewed as the gold standard for soft tissue pathology associated with shoulder instability. With MRI, capsular and ligament detachments, labral lesions, rotator cuff tears, and articular cartilage lesions can be identified more accurately than



on CT scan or radiography. The addition of intraarticular contrast in an MRA identifies labral tears with a sensitivity of 88% to 96% and a specificity of 91% to 98% [49,252,253,343,281]. Some authors have found MRI to be the most sensitive when diagnosing anteroinferior capsulolabral tears. The use of abducted, externally rotated shoulder (ABER) positioning during imaging has been found to improve the sensitivity of anterior labral pathology because of the tension/traction on the anterior capsulolabral structures in this shoulder position during MRA ($p=0.005$).

Antonio et al. [4] reported that MRA can assist in assessing treatment because of the high prevalence and wide variety of labral avulsions after primary traumatic anterior shoulder dislocation that can be picked up on MRA and that may affect the treatment regimen, especially if a significant amount of time has elapsed since the time of initial injury.

In a paper of Khiami et al. [163] about the management of recent first-time anterior shoulder dislocations, both an antero-posterior and a lateral radiographic view should be obtained according with authors. The lateral view is helpful in minimally displaced dislocations. It shows the direction of the dislocation and can help to detect concomitant lesions (fracture or impaction lesion). The axillary view and Y view require mobilization of the shoulder and are therefore not appropriate. Lamy's or Neer's view can be obtained without mobilization and show the direction of the dislocation while clearly delineating the base of the coracoid process and acromial vault. Garth's view shows any posterosuperior Hill–Sachs lesions and allows an evaluation of the anterior part of the glenoid. Computed tomography offers the best accuracy and sensitivity for detecting and evaluating a fracture and for assessing the extent of impaction damage.

In 2003 Kirkley et al. [172] evaluated the agreement between MRI and diagnostic arthroscopy. They found that MRI is of limited value in identifying certain posttraumatic lesions. It is a valuable tool, however, for the detection of Hill-Sachs and Bankart lesions in



these patients. MRI was not reliable in detecting clinically significant labral detachments in patients with traumatic anterior dislocations of the shoulder couldn't detect some of the subtle rotator cuff lesions associated with these injuries, but these lesions likely had no clinical significance. In addition, MRI was not able to detect capsular redundancy or in substance capsular injury with any degree of certainty. MRI accurately identified the presence of a Hill-Sachs lesion, but the discrepancy in measurement of size as determined by MRI versus by arthroscopy is unlikely to be clinically significant following a single dislocation. The most appropriate use of this imaging tool, therefore, would be to determine the presence or absence of a Bankart lesion in a patient considering immediate repair.

In a paper of Acid et al. [2] it was assessed the diagnostic effectiveness of MDCT arthrography in the preoperative planning of anterior shoulder instability compared with MR arthrography and arthroscopy. MDCT arthrography showed better accuracy than did MR arthrography in the detection of osseous, cartilage, and labroligamentous injuries related to anterior shoulder instability. Because MDCT arthrography was particularly reliable for the detection of glenoid rim fractures and humeral avulsion of the inferior glenohumeral ligament lesions, which represent crucial findings in the preoperative planning, this technique may beneficially affect treatment by means of selecting the proper surgical treatment.

8.2.3 Older adults (Best evidence: 15 case series, 2 comparative studies, 1 case report, 1 review, 1 systematic review, 1 diagnostic case control, 1 diagnostic case series, 1 descriptive epidemiology study):

A rotator cuff tear is the most common injury after an acute glenohumeral dislocation in patients older than 40 years old [1,229,267]. Two recent studies [1,321] also reported in this age group: greater tuberosity fractures up to 15.4%, coracoid fractures up to 4.8%, and acute



axillary nerve injuries up to 9.6%. Every patient usually undergoes an X-ray examination before and after the reduction manoeuvre in the emergency department to rule out concomitant fractures. Still, the most essential imaging focuses on evaluating the rotator cuff. Hence, an early ultrasound [366] or an early magnetic resonance imaging (MRI) [229,264,269] is usually recommended, as clearly stated by the British Elbow and Shoulder Society (BESS) and the British Orthopaedic Association (BOA) in 2015 [34]. The use of computed tomography arthrogram has also been suggested with the same purpose [191,238,326].

9. What are the most important imaging studies to decide between conservative or surgical treatment for recurrent anterior dislocation?

9.1 Statement

Surgical treatment is recommended for most of the patients with recurrent instability, as conservative treatment has failed. Imaging studies in this situation play a pivotal role in evaluating bone injury and soft tissue pathology, allowing decision-making on the appropriate type of surgical treatment rather than to decide between conservative and surgical treatment.

MRI or MRI arthrography allows proper detection and evaluation of soft tissue injuries and bony injuries in the majority of cases (Grade A). There is no clear superiority of MRI arthrography over conventional MRI (Grade B). Imaging study modality should be adjusted to the local availability and preference. CT arthrography could be used as well.

If precise evaluation of bony injuries and bone loss, whether on glenoid or humeral side, is necessary, then CT is indicated. CT is especially necessary in cases of suboptimal bone injury



detection with MRI and high number of dislocation episodes. In these patients CT scan with 3D reconstruction is recommended as it enables detailed analysis and quantification of glenoid and humeral bone loss. (Grade B).

Adolescents

In pediatric and adolescent patients with recurrent anterior shoulder dislocation MRI and/or MRI arthrography have major role in evaluating bone injury and soft tissue pathology. While CT scans can offer additional information, their judicious use is essential, particularly in young patients due to the potential risks of ionizing radiation (Grade D).

Older adults

Providing that recurrence rate in older adults is lower than in the other age groups, the following factors for recurrence or indications for operative treatment must be evaluated. Rotator cuff tears must be ruled out by ultrasound or preferably MRI. Bone fragility in older adults can result in fractures and bone loss. When significant bone loss or fractures and fracture sequelae are suspected (considering the number of dislocations, the medical record, and the results of the radiological evaluation), a CT scan is recommended for further evaluation.

Grade B.

Median (range): 9 (7-9)

9.2 Literature summary



9.2.1 Adolescents (Best evidence: 2 case series, 1 diagnostic, 1 expert opinion):

Imaging studies performed in patients with recurrent anterior shoulder dislocation can provide information about bone injury and soft tissue pathology. MRI studies reveal injury to joint capsule, glenohumeral ligaments, labrum, and cartilage [194]. Fat-suppressed fluid sensitive sequences can be helpful to identify marrow edema patterns on the glenoid and humeral head. Proton density imaging may help define the extent of structural bony injury [194]. A CT scan can be helpful to further characterize extent of bony injury. Some studies demonstrated that CT has superior sensitivity to MRI in the detection of glenoid bone defects and Hill-Sachs lesions [179,170]. However, CT should be used judiciously in young patients due to exposition to ionizing radiation [179]. Current studies even support the validity of MRI to characterize bone loss in pediatric and adolescent population [134]. Additionally, MRI arthrography can successfully replace CT scan, too. It can successfully depict bone deformity. MRI volume measurement techniques even allow to calculate the volume of bony bars [170].

9.2.2 Young adults (Best evidence: 5 diagnostic (level I) study, 1 cohort study, 2 systematic review, 2 narrative review, 2 case-control study, 1 cross-sectional study, 1 retrospective case series, 2 expert opinion):

Imaging studies are very important to decide between conservative or surgical treatment in recurrent anterior shoulder dislocation. This is particularly important in young adults, as the presence of concomitant injuries affecting the bone or the rotator cuff is not uncommon. In that regard, the presence of bone loss is an indicative of a recommendation for surgical treatment [140,141,227,258,313], and, therefore, the best imaging studies to evaluate bone



loss should be recommended as diagnostic studies for anterior shoulder instability. As a result, 3D-CT scan has proven to be the most accurate imaging study to evaluate bone loss [24,274], and should be order as a diagnostic tool in these injuries. Bishop et al. compared the reliability of plain radiographs, MRI and CT scans at detecting glenoid bone loss in fresh-frozen cadavers [24]. They found that 3D-CT scans were the most reliable imaging study to detect glenoid bone loss. In his classical article regarding glenoid bone morphology in recurrent shoulder instability, Sugaya et al. employed 3D-CT scans to define bony Bankart and glenoid erosion [329]. Other authors have found that the measurement accuracy of MRI to detect glenoid bone loss is not significantly lower than the CT scan, thus recommending MRI because of lower radiation and better ability to detect and define soft tissue injuries [306]. However, in terms of bone evaluation, CT should be considered the gold standard [110,140,141]. Because glenoid bone loss may be a common finding in recurrent shoulder instability, CT scans should be recommended as a diagnostic tool. In the presence of significant bone loss (see questions 11, 12, 14, and 15), a recommendation towards surgical treatment will be given. Humeral bone loss or bipolar bone loss are other bone lesions that need attention. Both off-track Hill-Sachs lesions and significant bipolar injuries should be treated surgically in recurrent anterior dislocation [110,140,141,143,227,258]. Gyftopoulos et al. demonstrated that the off-track on-track method applied in MRI studies were accurate and adequate at predicting off-track lesions in patients with mean age of 30 years with bipolar injuries [116]. In this regard, MRI is an important imaging study to decide between conservative and surgical treatment. If this study demonstrates significant Hill-Sachs lesion (off-track lesion), a recommendation towards surgical treatment will be done.

There are two soft tissue injuries that would make most surgeons recommend surgical treatment in recurrent shoulder dislocation: concomitant full-thickness rotator cuff tears and humeral avulsion of inferior glenohumeral ligament. Regarding rotator cuff tears, the most



important imaging study is the MRI [175], but CT arthrogram and ultrasound evaluation are also of value. However, MRI or MRI Arthrogram may help define other injuries like concomitant cartilage injuries. Regarding capsuloligamentous injuries, Acid et al. compared the diagnostic accuracy of multidetector CT arthrography to MRI Arthrogram (matched with arthroscopy findings) in a group of young adults with mean age of 26 years old [2]. The authors found that multidetector CT arthrogram was more accurate to detect osseous, cartilage, and labroligamentous injuries, but, importantly, was particularly reliable at detecting glenoid rim fractures and humeral avulsion of inferior glenohumeral ligament injuries. Because both of the latter injuries should be treated surgically, multidetector CT arthrogram should be taken into consideration as a helpful imaging study for recurrent shoulder dislocation. There are other studies comparing conventional MRI with MRI arthrogram. Haroun et al. found that MRI arthrogram had better sensitivity and accuracy values at detecting osseous, labral-ligamentous and capsular injuries in a group of patients with a mean age of 27 years [121]. While specificity was very high for both imaging modalities, conventional MRI missed some injuries like humeral avulsion of the inferior glenohumeral ligament. MRI arthrogram was also very sensitive (85%) and specific (96%) at detecting capsular laxity in cases of recurrent shoulder instability in a study with patients of mean 39 years [239]. However, it must be pointed out that the experience of the radiology may significantly affect the ability to detect shoulder instability-related injuries [338]. The presence of obvious capsular laxity in recurrent instability may be an indication for surgical treatment, particularly if recurrent non-traumatic instability has been developed after the first traumatic episode.

Therefore, either CT or MRI arthrograms seem to be the recommended imaging modalities for recurrent shoulder instability to decrease the risk of missing important soft tissue injuries that would require surgical treatment. Moreover, since CT is a better imaging study to detect



and quantify bone injuries, CT arthrogram might be considered one of the most important imaging studies in anterior shoulder instability. Despite CT is probably more commonly used to evaluate bone injuries across the literature, there is no clear consensus on whether CT (or CT arthrogram) is the gold standard imaging modality in recurrent anterior shoulder instability.

9.2.3 Older adults (Best evidence: 6 cases series, 1 descriptive epidemiology study):

Recurrence rates of dislocation in this age group are low. It ranges between 4% [264] and 22% [1]. No studies questioned the best imaging modality to choose between conservative or surgical treatment. The controversy is related to what we should treat. There is full consensus that a rotator cuff tear should be repaired, but questions remain about labral repair and capsular shift [66,191,265,321,326].

Associated injuries

10. What method should be used to measure glenoid bone defects?

10.1 Statement

CT-scan, especially 3D CT, is the most reliable and accurate method to measure glenoid bone loss across all age groups (Grade B). The consensus group recommends calculating the glenoid bone defect using the best-fit circle method or Pico method if contralateral glenoid is available for measurements (Grade C). MRI is also a reliable option (especially in children and adolescents to avoid radiation exposure) (Grade D).



Median (range): 9 (6-9)

10.2 Literature summary

10.2.1 Adolescents (Best evidence: 1 retrospective comparative study, 2 retrospective cohort study, 1 case-control study, 1 prospective non-comparative therapeutic case series, 2 therapeutic case series, 1 retrospective cohort study):

Evaluating for glenoid bone loss in adolescent patients was routinely performed using magnetic resonance imaging to avoid radiation [133]. The “on-track/ off-track” or “non-engaging/engaging” method was considered to estimate glenoid as well as humeral bone defects by using axial T1 view for length measurements of Hill-Sachs length starting at the infraspinatus insertion and measuring the glenoid bone loss by using the glenoid index in parasagittal T1 view. This concept of estimating bipolar bone defects in adolescent was used in modified manners [77,186,234].

In case computer tomography is available, 3D reconstruction is preferred to quantify glenoid bone loss by the “circle”-method. The glenoid defect is defined by the ratio of the defect width against the diameter of the assumed inferior circle of the glenoid [134,187,300].

A minimal-invasive method of measuring the glenoid bone loss is using an arthroscopic approach. The bare spot was found to be a consistent landmark in the center of the circle that was defined by the inferior articular margin of the glenoid below the level of the midglenoid notch that can be used as a central reference point to measure the percentage of bone loss of the inferior glenoid [47,277].



10.2.2 Young adults (Best evidence: 2 review articles, 4 research articles, 5 diagnostic studies, 1 systematic review, 1 cohort study, 1 cross-sectional observational study, 1 comparative study, 1 cadaveric study):

Glenoid bone lesions may occur in 22%-41% of patients with first-time dislocations and up to 86% of patients with recurrent dislocations [112]. Bone loss affecting the glenoid, the humeral head, or both significantly impairs the shoulder biomechanics and the surgical stabilization outcomes [258,308]. Therefore, the measurement of bone loss is critical to optimize the outcomes of patients treated for anterior shoulder instability. There are two main aspects to consider when evaluating bone loss: 1) the measurement method; and 2) the way the defect size is expressed.

Various methods have been reported to measure the glenoid bone loss: plain radiographs, computed tomography (CT-scan) or magnetic resonance imaging (MRI). Plain radiographs can be used to detect bony lesions and even quantify them. However, the measurement accuracy cannot be compared to CT. In fact, the most accurate imaging study to measure bone loss is 3D-CT [24,274].

Bishop et al. compared the reliability of plain radiographs, CT, and MRI at quantifying glenoid bone loss in recurrent shoulder instability in a cadaveric model [24]. The authors found that the *kappa values* between predicted bone loss and true bone loss, interobserver agreement, and intraobserver agreement was highest in 3D-CT, followed by regular CT, followed by MRI, and followed by plain radiographs. Interestingly, regular CT had superior interobserver agreement for defect sizes above 25%. In his classical article regarding glenoid bone morphology, Sugaya et al. employed 3D-CT scans to define bony Bankart and glenoid erosion [329]. Other authors have found that the measurement accuracy of MRI to detect



glenoid bone loss is very close to 3D-CT and CT scans, thus recommending MRI because of lower radiation and better ability to detect and define soft tissue injuries [118,306]. However, in terms of bone evaluation, CT should be considered the gold standard [110,268].

There are several ways to quantify and report the glenoid defect size. Shi et al. demonstrated that the use of the contralateral glenoid was an appropriate method, with <1% of side-to-side asymmetry in length and width [311]. Therefore, the contralateral glenoid may be a very good option to know how much of glenoid bone loss is present. The downside is that it requires more radiation (CT of both shoulders) and may not be adequate in the presence of bilateral shoulder instability problems. When using the ipsilateral affected shoulder, the first consideration is in which view the measurement has to be made. Griffith et al. claimed that en face images seen on the sagittal view are the most useful at quantifying anterior bone loss [111]. Once this view is obtained, the best-fit circle method can be used. This technique involves the overlapping of a circle into the inferior glenoid on the CT scan [329]. Then, the bone loss is calculated as an area or linear measurement. The linear technique is simple and only requires a ruler. A linear measurement of the actual injured glenoid is compared to the linear measurement of the circle. Area measurement may be automatically calculated by radiology software using the following formula: $(B/A) \times 100$, where A is the area of the best-fit circle and B is the area of the bony fragment (the PICO method) [14,329].

Kuberakani et al. compared the diagnostic accuracy of the best-fit circle with the contralateral shoulder measurement [181]. The authors found that the contralateral comparison was more reliable than the best-fit circle, but differences were small. Recently, new studies have investigated the use of 3D-MRI reconstructions to evaluate glenoid bone loss. This imaging modality has been found equivalent to 3D-CT for the measurement of glenoid bone loss [185,360]. Still, nowadays, the CT or 3D-CT is considered the gold standard measurement method to quantify glenoid bone loss [110].



10.2.3 Older adults (Best evidence: 2 case series, 1 diagnostic study):

Bone loss is not the main issue in patients who develop glenohumeral instability after 40 years old. Two studies reported the results after the Latarjet procedure in patients in this age group [72,86]. However, it must be highlighted that the instability developed when the patients were younger than 40. Anyhow, a CT was used in both studies to evaluate bone loss. One study used the PICO method [86], whereas a recent study estimated bone loss on MRI using the best-fit circle [1].

CT Scans are considered the gold standard for assessing bone defects. However, in this age group, the associated lesions are more frequent and severe (rotator cuff lesions), and the MRI Scan after first-time shoulder dislocations has a much higher importance.

11. What is the glenoid bone defect cut-off to indicate a bony procedure (bone block or Latarjet) in first-time anterior dislocation according to each specific age subgroup?

11.1 Statement

Displaced acute glenoid fractures should be fixed, particularly in adolescents and young adults (Grade C).

In cases of glenoid bone resorption from a previous fracture seen a long time after the first-time dislocation, the percentage of bone defect should be quantified. A bony procedure is recommended in cases of a glenoid bone defect cut-off of 20% in adolescents and young adults (Grade B).



Patients with subcritical bone loss (10-15%) may require a bony procedure, especially in cases of significant bipolar bony injuries or other risk factors (Grade C).

Some surgeons would recommend bony procedure even in case of no glenoid bone loss (Grade D).

Older adults

There is no clear cut-off value for older adult patients, as glenoid bone defects are better tolerated and related to a lower recurrence rate (Grade D).

Median (range): 8 (5-9)

11.2 Literature summary

11.2.1 Adolescents (1 retrospective cross-sectional study, 1 prospective cohort study, 1 retrospective cohort study):

Knowledge that glenoid bone loss directly affects success rate of arthroscopic capsulolabral reconstruction is mostly studied on general population of patients with anterior shoulder instability. Furthermore, patients with any sized bony Bankart lesion after first-time dislocation are more likely to develop recurrent instability [246]. However, the scientific evidence regarding analysis of glenoid bone loss in first-time dislocation in adolescent population is very limited. The literature search revealed no information on the glenoid defect cut-off value in this situation. According to analogy with recurrent anterior dislocation critical bone loss (defined as bone loss of >20% of the glenoid) is typically considered as indication



for an open bony procedure (e.g. bone block) [82]. Special consideration is needed in patients with subcritical bone loss and bipolar bone defects in whom arthroscopic stabilization may be associated with recurrence and poorer outcomes [308]. Generally, it is postulated that opposed to recurrent instability the major cause of glenoid bone defects in acute cases is glenoid fracture [82]. Still the scientific evidence for this statement is limited.

11.2.2 Young adults (Best evidence: 3 prospective randomized controlled trials, 1 prospective case control, 3 retrospective comparative cohort, 11 retrospective cohort studies, 5 retrospective case control studies, 2 meta-analyse with systematic review, 2 systematic reviews and 1 narrative review):

First-time anterior dislocation is a common injury of the shoulder and even though most of patients are managed non operatively, recurrent instability may lead to persistent functional disability and in the long term to glenohumeral arthropathy. It has been demonstrated that the glenoid bone loss increases with the recurrence of the anterior shoulder instability. Bone block procedure as the Latarjet procedure, are especially indicated in the setting of significant glenoid bone loss, Hill-Sachs lesions and collisions sports [136].

The decision to perform a bony procedure is usually based on a combination of factors, including the size and location of the glenoid bone defect, the patient's age, activity level, and other individual factors. In general, a glenoid bone defect greater than 20-25% of the glenoid width or 15-20% of the glenoid surface area is considered an indication for a bony procedure [159,256,329,356,367].

The cut-offs are not intended to be used as absolute criteria for treatment decision-making, but rather as general guidelines to help guide the decision-making process. Some studies focused especially about the management of first-time dislocation of the shoulder patients



[120,139,163,178,361]. Surgical stabilization after a first-time shoulder dislocations are more and more present in the literature to improve the quality of life of the patients, to prevent the augmentation of bone loss and of course to diminish the recurrence rate [153,173].

Numerous studies have tried to elaborate cut-off to indicate a bony procedure for shoulder instability [240,329] but only few of them studied more in detail first-time dislocation patients; This explain why most of the available data on the cut-off to indicate a bone block procedure are coming from studies about patients with recurrent dislocations that we have eventually cited in this review.

Cut-off described in the literature review:

Burkhart and de Beer introduced the concept of “inverted pear” glenoid with a defect size ranged from 25-45% of the glenoid width and reported not satisfactory outcomes after arthroscopic Bankart repair [39]. They concluded to a critical size of > 25% of glenoid width bone defect to indicate a bony procedure.

Zhu et al compared arthroscopic versus open Latarjet in the treatment of recurrent anterior shoulder dislocation with marked glenoid bone loss [367] and found that the both techniques were effective. They found a better position of the bone block in the superior-inferior direction in the open group and notably less graft resorption at 1 year after the surgery in the arthroscopic group. The cut off that they used were of 20% of glenoid bone loss.

Park et al studied the clinical outcomes and recurrence rates after arthroscopic stabilization procedures in young patients with a glenoid bone erosion in a comparative study between glenoid erosion more or less than 20 % and showed satisfactory clinical outcomes and recurrence rate [259]. These results were inferior with glenoid bone erosion more than 20% compared to the glenoid bone loss < 20%.

Shaha et al investigated clinical outcomes in active duty military personal a concluded that a preoperative glenoid defect of 13,5% was an appropriate threshold for “subcritical” glenoid



bone loss associated with a significant worsening of functional WOSI score [308]. This cut-off has then been accepted by other authors [122,359].

Shin et al evaluated critical value of anterior glenoid bone loss that leads to recurrent glenohumeral instability after arthroscopic Bankart repair and found that the optimal critical value of glenoid bone loss was 17,3% or more with respect to the longest anteroposterior glenoid width [314].

Hill-Sachs lesions (HSL) is a critical issue about bone cut-off to indicate a bone block procedure in first-time shoulder dislocators. Jeon et al. reported that in patients with glenoid bone loss between 15 and 20% with none or on-track HSL, an arthroscopic Bankart procedure was associated with significantly higher failure rates than the Latarjet procedure (22.9% vs. 6.5%, $p = 0.04$) [154].

Yian et al studied predicting failure after primary arthroscopic Bankart repair analysis of a statistical model using anatomic risk factors at mid-term follow-up and found that a glenoid bone loss $> 10\%$ what at risk of postoperative instability [362].

Yamamoto et al evaluated the effect of subcritical glenoid bone loss on activities of daily living in patients with anterior shoulder instability and concluded that 25% of glenoid bone loss was a critical bone loss and 17%-25% was a subcritical bone loss [356].

The absence of bone loss is also an important information for the surgical strategy. Hardy et al reported the clinical outcomes of patients undergoing a Latarjet procedure after 1 dislocation versus patients with multiple dislocations (2 or more) in cohort study [120]. They found that the number of preoperative episodes of dislocation does not influence recurrence rate after a Latarjet procedure. Interestingly, they also found that patients with first time dislocation had more postoperative pain compared with patients with recurrent dislocations before surgery. The authors made the hypothesis that this result was because patients with first-time dislocation had less glenoid bone loss and may have undergone greater remodeling



of the bone block with a greater osteolysis which may be a cause for the greater observed pain. The authors suggested that Latarjet procedure should be proposed with caution in patients after a first episode of shoulder dislocation with an intact glenoid due to the greater postoperative pain and an excessive remodeling of the bone block.

Here are the most commonly used bony cut-off found in the literature review:

- Critical bone loss: indicate a bone block or Latarjet procedure
 - o > 25% of glenoid bone loss [39,159]
 - o > 20% of glenoid width bone loss [256,259,329,367]
- “Subcritical” glenoid bone loss: depending on patient’s risk of recurrence
 - o < 20% of glenoid bone loss [259,286]
 - o 17-20% of glenoid bone loss [356]
 - o 15% of glenoid width [154,224]
 - o 13,5% of glenoid bone loss [122,270,308,367]
 - o 10% of glenoid bone loss [362]

11.2.3 Older adults (Best evidence: 2 cohort study, 3 case series):

There is a lack of evidence regarding the question. No specific recommendation for the age group can be found in the literature. Therefore, the general assumption and biomechanical evidence of 12,5-20% of glenoid bone are one aspect to consider when deciding the need for bony procedures. Further, no single technique nor graft choice can be recommended by evidence. CT Scans are regarded as the gold standard for assessing bone defects [110,268].

The importance of MRI Scans after first-time shoulder dislocations in this age group is much higher and is recommended for the detection of associated lesions.



12. What is the glenoid bone defect cut-off to indicate a bony procedure (bone block or Latarjet) in recurrent anterior dislocation?

12.1 Statement

A glenoid bone defect of 15-20% is generally accepted as a cut-off to indicate bony procedures across all age groups in recurrent dislocations. However, the cut-off might be decreased in the youngest (adolescent) patients with other risk factors or increased in older adult patients without other risk factors (high-level contact or collision sports, high number of instability episodes and/or associated Hill-Sachs lesion (Grade B).

Some surgeons would recommend bony procedure even in case of no glenoid bone loss (Grade D).

Median (range): 9 (6-9)

12.2 Literature summary

12.2.1 Adolescents (1 retrospective cross-sectional cohort study, 2 cohort studies, 1 case-control study, 1 retrospective comparative study, 1 therapeutic study, 1 retrospective study, 3 case series):

The incidence of glenoid bone loss with recurrent traumatic anterior shoulder instability in adolescents is reported to be 48,2% [82] as opposed to general population where variable incidence between 72% and 90% was detected. As opposed to acute glenoid fractures, the



postulated cause of the majority of instability-associated defects is gradual glenoid erosion from chronic recurrent instability [82]. Age related ligamentous laxity, lesser degree of chronic glenohumeral instability and relatively early surgical intervention present in younger patients may account for the observed lower incidence of glenoid erosion as compared with other populations and age groups [82].

Glenoid bone loss directly affects success rates of capsulolabral reconstruction. When critical bone loss (defined as bone loss of >20% of the glenoid) is identified, typically bone block procedure is considered [82]. In young adults, stabilization in the setting of subcritical bone loss has had variable outcomes [250]. Recent evidence from the general population demonstrated that bone loss previously identified as subcritical may also be associated with recurrence and poorer outcomes [308]. Glenoid bone loss of 13,5% or greater has significantly worse outcomes and rates of recurrent instability [308]. There were several attempts to identify glenoid bone defect cut-off value that predisposes to arthroscopic stabilization failure, but this value remains controversial, especially in the adolescent population [133,134].

Since bipolar bone defects have a significant impact on the stability of the shoulder joint, glenoid bone defect should be set into relationship to Hill-Sachs lesion [77,234]. Moreover, adolescent patients has a 9,4 x increased risk of having an off-track lesion than adult patients with anterior shoulder instability [186]. Nevertheless, additional risk factors such as hyperlaxity and high level sport practise are important when considering the cut-off value of glenoid bone defect [19,21].

12.2.2 Young adults (Best evidence: 4 cohort studies):



The decision to perform a bony procedure in recurrent shoulder dislocation is based on several factors and cannot be decided solely by a cut off value of glenoid bone defect size. A shoulder specialist would consider several factors such as age, gender, type and activity level, bipolar bone loss, comorbidities, and surgeon's experience.

Glenoid bone defect might be a result of a Bankart fracture or an erosion of the anterior glenoid. The prevalence of glenoid bone loss, for either reason, is higher in recurrent instability compared to first-time dislocations [313].

Glenoid bone loss in recurrent anterior shoulder instability, including bony Bankart and bone erosion, ranges from 26% to 86% in the literature [28,199]. In a paper from Lo et al., where the expression of the inverted pear was introduced, the authors observed that 11 of 42 patients were classified by arthroscopy to have an inverted pear shape of the glenoid, with a mean value of 29% of bone loss [199]. Glenoid bone loss is associated with higher recurrence rate after either conservative or surgical treatment [245,256,308,314]. Itoi et al. suggest that bone defects measuring up to 25% of the glenoid surface can be treated with a Bankart repair[152]. Burkhart found that in patients with glenoid bone loss of more than 25% the recurrence rate after arthroscopic Bankart repair was 67%, and 89% in contact athletes, compared to 4.9% recurrence after an open Latarjet [39]. However, it must be acknowledged that the sample age range was 15 to 64 years. It is likely though that most contact athletes were in the lowest part of this range. Yamamoto performed a retrospective study where they assessed the effect of critical glenoid bone loss on daily living in patients operated with arthroscopic Bankart procedure [356]. Patients with 17-25% glenoid bone loss had lower WOSI scores compared to patients with less than 17% bone loss. In a study by Wong et al., where they compared outcomes after distal tibial allograft to outcome after Latarjet, the cut off value for bony a procedure was 20% CT confirmed glenoid bone loss [351]. The safe bone loss for male collision/contact athletes are probably lower compared to other patient groups. Nakagawa et



al. propose this patient group need a bony procedure if glenoid bone loss exceeds 10% to avoid recurrence [235]. However, the age range of this study was 14 to 27 years, so it is very likely that age was a confounding factor affecting the recurrence rate.

12.2.3 Older adults (Best evidence: 2 cohort studies, 1 case series study):

There seems to be no specific cut-off value regarding patient age. However, several studies suggest a cut of around 15% measured on a two-dimensional CT-Scan en face view [86,308]. The bony defect was only one part of the decision-making process, whereas activity level, work and revision scenario were also considered.

Within the last decade, CT scans have been mandatory to evaluate glenoid side bone loss, especially in recurrent dislocations and have out-ruled plain Radiographs like the Bernageau view.

Glenoid defects in this age group can occur regularly in recurrent dislocators. Nevertheless, the degree of glenoid defect has no predictive value and does not affect the postoperative recurrence rate [354].

13. What method should be used to measure humeral bone defects?

13.1 Statement

The length (maximum distance in the longer axis of the defect), width (maximum distance in the shorter axis of the defect), and depth (maximum distance from deep to superficial) of the humeral head defect should be calculated using either 3D CT or conventional 2D axial view



of the CT scan. A circle including the entire humeral head on an axial view is recommended to measure the depth of the defect (Grade B).

It should be noted that the size of the humeral defect is not the only relevant parameter. The glenoid track concept defines the location of the defect concerning the infraspinatus insertion. In this method, the distance from the medial edge of the defect to the infraspinatus insertion is measured in a 3D CT reconstruction (Grade C).

Adolescents

For the adolescent population, MRI is an option to avoid radiation (Grade D).

Older adults

In this population, significant humeral defects are less common. Due to the lack of evidence in this age group, the Consensus group recommends the same measuring technique (Grade D).

Median (range): 8.5 (6-9)

13.2 Literature summary

13.2.1 Adolescents (Best evidence: 1 cohort study, 1 case-control study, 1 retrospective comparative study, 2 prospective cohort study, 7 case series-retrospective cohort study):

Humeral bone defects, also known as Hill-Sachs lesions (HSL), are present in 47-90% of anterior shoulder dislocators [133]. Their important role in the stratification of the risk of



recurrence is frequently mentioned in the enrolled literature. Nevertheless, in the majority of the papers the authors do not mention their preferred method of HSL measurement. Several authors used MRI axial slices to measure the Hill-Sachs interval, as part of determining the glenoid track in bipolar bone lesions [77,134,180]. Hughes and colleagues measure the width and depth of the Hill-Sachs on MRI, using the axial slice, considering the largest size of the lesion in the plane of the infraspinatus tendon insertion [133]. Lau and colleagues also use the MRI to measure the distance from the medial edge of the rotator cuff footprint to the medial margin of the Hill-Sachs lesion, but on a coronal slice [186]. Nakagawa used the CT 3D reconstruction images to assess the HSL according to Ozaki's method [234,248]. However, it was shown that In adolescent population HSL can be effectively measured using MRI or MRI arthrography [170]. Before development of advanced imaging techniques like CT and MRI, authors used methods based on X-Ray (Rowe classification) or arthroscopic findings (Calandra's classification) [42,188,277,292].

13.2.2 Young adults (Best evidence: 1 prospective cohort, 3 retrospective case series, 2 reproducibility studies, 4 cross-sectional observational, 1 systematic review, 1 biomechanical cadaveric study, 2 expert opinion):

The key aspect of humeral bone defect, or Hill-Sachs lesions (HSL), is not only the size of the injury (length, depth and width) but also its proximity with the humeral head cartilage (medialized location) [183]. Besides intraoperative evaluation of engaging/non-engaging Hill-Sachs during arthroscopy, there are 3 main ways to evaluate humeral bone defects: plain radiographs, CT, and MRI.

The methods for the measurement of humeral defects have not been standardized as clearly as the measurement of glenoid defects. A recent systematic review by Maio et al. [210] has



shown the paucity of studies available. From eight included studies, one used plain radiographs, one conventional MRI, one 3D MRI, one arthro-CT scan, three conventional CT scans, and four 3D-CT scans (some studies used more than one method).

Measurements in simple radiographs in various degrees of rotation were evaluated by Charousset et al. [50]. In this method, an AP plain radiograph was used, and the depth of the HSL calculated as the P/R ratio, with P being the maximum depth of the notch defect in internal rotation, and R the radius of the humeral head. The authors found very poor inter-observer and intra-observer reproducibility with this method.

Most of the studies in the literature have focused on CT to quantify Hill-Sachs lesions. The length, width and depth of the humeral defects can be measured in conventional or 3D CT scans using a method described and validated by Ozaki et al. [248]. In this method, the length (maximum distance in the longer axis of the defect), width (maximum distance in the shorter axis of the defect), and depth (maximum distance from deep to superficial) is expressed in mm and calculated using either the 3D CT or an axial view of conventional CT scans. The use of a circle including the entire humeral head on an axial view is recommended to measure the depth of the defect. Therefore, these measurements can be normalized dividing them by the diameter of the humeral head as recommended by Cho et al. [56] and Ozaki et al. [248]. It is likely that the age range of patients between 13 and 69 years included in this study [248] does not change its applicability in young adults. Stillwater et al. conducted a prospective study comparing measurements of humeral head height, width, HSL size, percentage of humeral head loss between 3D CT and 3D MRI [328]. The authors found that no statistically significant differences in these parameters between both imaging modalities. The use of 3D CT using the method described by Ozaki et al. has been shown to be reproducible and, pending further investigation, is considered the gold standard [210,248].



In cases of bipolar bone loss, the HSL has to be placed in context with the engaging/non-engaging concept, later developed to the on-track/off-track concept [68]. At the posterior end-range of movement (abduction and external rotation) the HSL gets closer to the anterior glenoid where the defect is also present. If the HSL is entirely covered by the glenoid, no dislocation will occur. Therefore, the risk of engagement/dislocation depends on the size of the HSL and its location relative to the glenoid bone defect [149]. Therefore, measuring the humeral defect is especially important in the context of glenoid track measurement. The methods to assess the glenoid track was developed by Yamamoto et al. in a cadaveric model using specimens from 63 to 79 years of age [355]. The authors suggest to perform measurements on a sagittal en face view of the glenoid (typically over a 3D reconstruction) and calculate the glenoid track as $0.83D$ minus d , where D is the AP measurement of an intact glenoid, and d is the AP measurement of the defect. If the length of the HSL is greater than the glenoid track, it is considered an “off-track” lesion with high risk of dislocation. This method is highly dependent on appropriate measurements of the humeral defect. In fact, this can be considered a limitation of the glenoid track concept if the humeral measures are not taken in a reproducible way. Some studies have found poor reliability of the glenoid track [304]. In contrast, Gyftopoulos et al. [117] also observed an overall diagnostic accuracy of 84%, a sensitivity of 72% and specificity of 88% of this method using MRI. The inter-observer agreement was 0.73 and the intra-observer agreement 0.85 for the glenoid track concept.

Two studies found that the glenoid track concept was useful in clinical practice [200,307]. Locher et al. retrospectively evaluated 100 patients who underwent arthroscopic Bankart repair [200]. The recurrence rate between on-track HSL was 6% compared to a 33% of the off-track lesions. Also, Shaha et al. observed a recurrence rate of 8% in patients with on-track HSL compared to a 75% in patients with off-track lesions [307]. The positive predictive value



of off-track concept to predict recurrence of shoulder instability was 75% compared to a 43% of a glenoid bone loss >20%.

None of the proposed methods help the surgeon in defining the true spatial orientation of the humeral defect. Burkart and de Beer [39], more than twenty years ago, showed that defects of the same size can have a very different impact on instability depending on their location and angulation. This issue is only partly addressed by the glenoid track concept. Therefore, the glenoid track concept needs further investigation so as to be placed in context of the complex problem of shoulder instability.

13.2.3 Older adults (Best evidence: 1 expert opinion):

No study has evaluated different techniques regarding age. CT scans generally remain the gold standard for assessing humeral bone defects. No specific cut-off value or classification does specifically include age over 40. Therefore, the on/off track concept remains a standardized method for evaluating humeral-sided defects [68].

14. What is the Hill-Sachs lesion size cut-off to indicate an associated procedure (i.e., remplissage or bony procedure) in first-time anterior dislocation?

14.1 Statement

Hill-Sachs lesions should be evaluated in the context of the glenoid track. Without glenoid bone loss, off-track Hill-Sachs lesions indicate the necessity for an associated procedure (Grade B).



The consensus group cannot propose any cut-off value to indicate an associated surgical procedure for first-time dislocations. Most off-track Hill-Sachs lesions are converted to an on-track lesion after bony procedures of the glenoid (Grade B).

Adolescents

The threshold for recommending additional procedures (i.e. a remplissage) will be lower in adolescents than in the other age groups (Grade D).

Median (range): 8 (6-9)

14.2 Literature summary

14.2.1 Adolescents (Best evidence: 3 retrospective cohort studies):

The size of the Hill-Sachs lesion has a very important application on preoperative planning. Presence of an off-track Hill-Sachs lesion leads to significantly higher recurrence rate after nonoperative management following first-time anterior shoulder dislocation [77]. In the case of operative treatment, larger Hill-Sachs lesions are predictive factor of recurrence, thus stability is required through arthroscopic remplissage. Apart from stating the scale of a Hill-Sachs lesion (small vs large), no size cut-off for recurrence and surgical intervention was determined from the current literature regarding the adolescent population [134,170].

14.2.2 Young adults (Best evidence: 4 review articles, 1 retrospective cohort study, 1 case series):



There are no specifically dedicated studies in the literature evaluating the Hill-Sachs lesion cut-off to recommend Bankart repair with an associated procedure in first-time anterior dislocation.

It has been demonstrated that surgical stabilization after first-time anterior shoulder dislocation results in a significantly lower rate of re-dislocation compared to conservative treatment [158,163]. However, Barlow et al. failed to demonstrate a clear benefit of surgical treatment for first-time anterior shoulder dislocation regarding re-dislocation compared to conservative treatment [13]. If the issue of whether operating or not patients with first-time dislocation has no clear consensus, the cut-off Hill-Sachs lesion size by which an associated procedure during Bankart repair is recommended must be necessarily unclear [331].

Dyrna et al. observed that patients with off-track Hill-Sachs lesions undergoing conservative treatment for first-time anterior shoulder dislocation had a significantly higher rate of re-dislocation compared to patients with on-track lesions [77].

Itoi and Yamamoto [151] reported that if the glenoid defect was equal to or greater than 25% of the glenoid width, bone graft or coracoid transfer would be required, and it should be performed first. After this procedure, if the Hill-Sachs lesion was still engaging, further treatment for the Hill-Sachs lesion would be necessary. None of the series showed an engaging Hill-Sachs lesion after bone grafting to the glenoid, which means that bone grafting of the glenoid converted an engaging Hill-Sachs lesion to a nonengaging one. If the Hill-Sachs lesion was repaired first by a remplissage procedure, for example, there would be no more end-range instability; however, mid-range instability could persist so the shoulder may dislocate in the hanging arm position. If the glenoid defect is less than 25%, no treatment would be required for the glenoid defect, so treatment for the engaging Hill-Sachs lesion (i.e., remplissage) can be performed.



Other surgeons might consider performing a coracoid transfer to the glenoid defect, which will enlarge the glenoid track and convert the Hill-Sachs lesion from an engaging to a nonengaging lesion [43]. Despite these recommendations would be more clearly applicable to recurrent anterior shoulder instability, many authors would agree on applying this management strategy also for first-time anterior shoulder dislocation [331].

In summary, the presence of engaging or off-track Hill-Sachs lesions would require surgical treatment consisting of Bankart repair plus remplissage, or bone block/Latarjet procedure with or without remplissage in patients with first-time anterior shoulder dislocation to decrease the rate of recurrent dislocation, however there is a lack of literature recommending this concept in this specific setting of first-time anterior dislocation.

14.2.3 Older adults (Best evidence: 1 review):

No study has evaluated different techniques regarding age. CT scans generally remain the gold standard for assessing humeral bone defects. No specific cut of value or classification does specifically include age over 40. Therefore, the on/off track concept remains a standardized method for evaluating humeral-sided defects [68].

15. What is the Hill-Sachs lesion size cut-off to indicate an associated procedure (i.e., remplissage or bony procedure) in recurrent anterior dislocation?

15.1 Statement



Although a cut-off value of 20-25% of Hill-Sachs lesions has been suggested, this number is not adequately supported in the existing literature (Grade C).

The consensus group cannot provide a cut-off value of Hill-Sachs lesions upon which an associated procedure is recommended. Because of the recurrent nature of the instability, a lower threshold should be applied to indicate an additional procedure (i.e. a remplissage or bony procedure), particularly in the adolescent and young adult groups (Grade D). Therefore, the glenoid track, individual patient factors (including age, sports and activity levels) and associated injuries other than the HSL (bipolar bone loss) must be evaluated when considering an additional procedure (Grade B).

Median (range): 9 (6-9)

15.2 Literature summary

15.2.1 Adolescents (Best evidence: 1 meta-analysis, 1 prospective cohort, 3 retrospective cohort):

The prevalence of Hill-Sachs lesions (HSL) is high, and the lesions tend to be larger in patients with recurrent episodes of complete dislocation [170,180,248]. Some authors report a higher prevalence in adolescent population [186,333]. Even more, one study reports that adolescent patients with shoulder instability have a greater likelihood of having an off-track lesion when compared to the adult population [162].

The literature is heterogenous concerning the HSL as a risk factor for recurrence after a soft tissue stabilization procedure. The majority of studies show that patients aged under 18 years



with an HSL are more likely to experience recurrent instability when compared with those without it [244].

Evaluation of the HSL is complicated by several facts. Firstly, to define Hill-Sachs lesion it is important to know length, width and depth. The volume of the lesion seems to be significantly related to the incidence of recurrent shoulder dislocation [170]. Nevertheless, the best method for quantifying Hill-Sachs lesion has not yet been established [234]. Secondly, the assessment of an HSL position and orientation regarding the humeral axis is important.

Current evidence suggests that the presence of a bipolar bony lesion significantly influences the redislocation rate, but lesion size did not [233]. To reduce the risk of postoperative recurrent instability, it might be the best to limit isolated arthroscopic Bankart repair to shoulders without bony lesions or with monopolar bony lesions [180,233,333]. In the adolescent population the surgeon should address the HSL in shoulders with a bipolar bony lesion [134]. Some authors suggest to have a lower threshold for performing a remplissage in this population [180].

15.2.2 Young adults (Best evidence: 1 cohort, 1 controlled laboratory study, 2 case-control, 2 retrospective comparative studies, 2 retrospective case series, 4 systematic reviews, and 2 narrative reviews):

Large Hill-Sachs lesions are relevant at deciding the type of surgical treatment in recurrent shoulder instability. The reason is because the larger the lesion is, the greater the chances for the humeral head to become off-track on the glenoid and “fall” anteriorly out of the glenoid socket and dislocate. This is particularly true in cases of bipolar defects and lax or incompetent soft tissues. In these circumstances, an associated soft tissue procedure or a bony



procedure is recommended [3,26,122,143]. The failure rate of capsulolabral repair in cases of off-track Hill-Sachs lesions left untreated has been reported as high as 75% [307].

The most common associated procedures to the regular capsulolabral repair (Bankart repair) is the remplissage procedure by which the humeral head defect (Hill-Sachs) is filled with capsulotendinous (infraspinatus) tissue. Other procedures for significant Hill-Sachs injuries are bone block procedures or the Latarjet procedure (and its variants).

A specific procedure to treat the Hill-Sachs lesion is recommended if the lesion is larger than 20-25% of the humeral head, the depth is more than 16% of the humeral head diameter, or when the volume is more than 1000mm [151]. In general, the larger the Hill-Sachs lesion the higher the chances for the injury to become off-track; these injuries need to be specifically treated. The Hill-Sachs Interval is the distance between the medial most portion of the lesion to the insertion of the rotator cuff. The glenoid track is obtained by multiplying 0.83 to the distance of the inferior glenoid diameter (best-fit circle to the inferior glenoid on sagittal plain of the MRI) and then subtracting the distance of the glenoid bone loss [223]. Lesions are considered off-track when the Hill-Sachs Interval is greater than the glenoid track. The interesting aspect of this method is that it takes into account the glenoid part and does not only represent a measure of the humeral head bone defect. Park et al. compared a series of patients with off-track and on-track lesions undergoing Bankart repair with or without remplissage [254]. The authors found that adding the remplissage procedure in patients with off-track lesions was effective at preventing re-dislocation. They found that the glenoid bone loss was a better predictor of recurrence. Hartzler et al. found that Hill-Sachs lesions of 30% in the presence of 15% glenoid bone loss (bipolar injuries) should be treated with a remplissage procedure to revert the off-track condition [123]. Also, Ren et al. performed arthroscopic subscapularis augmentation (with allograft or autograft tenodesis of the upper subacapularis) in young adult patients with humeral bone loss of < 20% (and glenoid bone



loss < 25%) and compared this technique to a Bankart repair group [273]. They found that the subscapularis augmentation group had better clinical and functional outcomes, return to sports, and recurrence rate compared to the Bankart group. However, the authors did not report the outcomes as a functional of humeral head bone loss.

The Latarjet procedure is a very effective procedure at preventing recurrence of anterior shoulder instability after surgery. Calvo et al. were able to demonstrate that the Latarjet procedure was able to convert off-track Hill-Sachs lesions into on-track lesions in 88% of the patients [43]. Interestingly, 33% of those who had persistent off-track lesions had subluxation episodes. There are several studies comparing the outcomes of Bankart repair and remplissage (or other soft-tissue procedures) with the Latarjet procedure. Paul et al. found a similar recurrence rate in patients treated with Bankart and remplissage compared to the Latarjet, despite 82% of the patients in the Bankart group had off-track Hill-Sachs lesions (compared to 47% in the Latarjet group) [261]. Russo et al. compared the outcomes of arthroscopic Bankart repair plus subscapularis augmentation versus open Latarjet for recurrent shoulder instability [296]. The sample was had a mean age of 23 years and up to 39 years, with a mean glenoid bone loss of 18.5% (Pico method) and minimum Hill-Sachs of 33% of the humeral head size. In the arthroscopic group there were 83.3% of patients with engaging Hill-Sachs. The authors found no differences in functional and clinical outcomes between both groups. The study confirms that an engaging Hill-Sachs can be satisfactorily treated with an associated procedure, but the study did not compared with an arthroscopic Bankart repair group alone. Yang et al. conducted a similar study but comparing the arthroscopic Bankart repair plus remplissage versus versus modified Latarjet procedure for recurrent shoulder instability in patients with off-track Hill-Sachs lesions and subcritical glenoid bone loss [359]. The patients had a mean age of 29 years (standard deviation of 10 years) and all presented with <25% of glenoid bone loss (best-fit circle method) and either an evidenced engaging



Hill-Sachs or off-track Hill-Sachs according to the preoperative measurements. The authors observed no differences in SANE and WOSI scores, but the remplissage group had higher VAS for pain and less internal rotation at abduction compared to the Latarjet. On the other hand, the latter group had higher complications but better WOSI scores and lower recurrence compared to the arthroscopic Bankart repair plus remplissage for collision and contact athletes, those with previous surgeries, and those with glenoid bone loss >10% [359].

The conclusion is that off-track Hill-Sachs can be effectively treated with remplissage. The cut-off size is difficult to be established, as it depends on the presence of glenoid bone defect and the soft tissue laxity.

15.2.3 Older adults (Best evidence: 1 review):

No study has evaluated different techniques regarding age. CT scans generally remain the gold standard for assessing humeral bone defects. No specific cut of value or classification does specifically include age over 40. Therefore, the on/off track concept remains a standardized method for evaluating humeral-sided defects [68].

16. What is the recommended method to evaluate soft tissue quality before surgery?

16.1 Statement

MRI or MRA are the best methods to evaluate soft tissue quality, i.e. looking for capsular volume, labral ring integrity, and labral tissue degeneration (size and signal) (Grade B). Evaluation of soft tissue quality should also take into account medical records (time from



dislocation and number of dislocation episodes), mechanism of injury, and clinical examination (Grade D).

Older adults

In this age group, the most critical soft tissue lesion is the rotator cuff tear. The best method for the evaluation of rotator cuff quality is the MRI. Ultrasound can also be used, but the results depend on the user's experience.

Grade B.

Median (range): 9 (5-9)

16.2 Literature summary

16.2.1 Adolescents (Best evidence: 1 prospective comparative study, 1 retrospective cohort):

Soft tissue injuries were evaluated using native magnetic resonance imaging (MRI) to check for avulsion of the anterior labrum and anterior inferior glenohumeral ligament (Bankart lesion), humeral avulsion of the glenohumeral ligament (HAGL lesion), glenoid labral articular defect (GLAD lesion), anterior labral periosteal sleeve avulsion (ALPSA lesion), or other intraarticular lesions [103,180,194,250]. Alternatively, an MRI arthrogram can be considered [133].



16.2.2 Young adults (Best evidence: 2 diagnostic (level I) study, 1 cohort study, 1 prospective case series, 1 retrospective comparative study, 3 retrospective case series, 2 systematic reviews, 1 narrative review, 1 Expert opinion):

Soft-tissue injuries are almost always present in traumatic anterior shoulder dislocation. However, the presence or absence of soft-tissue injuries is not the only relevant issue. Soft tissue quality is also relevant, as it is the case of very lax or pathologic capsuloligament complex thin enough to be incompetent as static stabilizers. On other occasions, the labral tissue has suffered a radial tear that ends up with loss of labral tissue (retraction) and therefore loss of any ability to contribute as a static stabilizer either. This is a relevant aspect to consider, as some authors recommend associated procedures as opposed to regular Bankart repair in cases of poor soft tissue quality (i.e. capsular shift, arthroscopic subscapularis augmentation, or the dynamic anterior stabilization or the Latarjet procedure with their sling effect) [62,284,296].

In general, magnetic resonance imaging (MRI) or magnetic resonance arthrogram (MRA) can be considered the most valuable, or even the gold-standard, imaging studies to evaluate the presence and type of soft-tissue injuries and quality of the tissue [158,331]. For a better evaluation the image acquisition should be obtained with high magnetic field devices (1–3 Tesla), equipped with dedicated surface coils, small field of view, and 2– 4 mm thick slices. The images should be presented so that a clock face view of the glenoid is showed.

MRI performed in specific positions or using contrast can facilitate adequate soft tissue injuries evaluation. The ABER position acquisitions (abduction extra-rotation of the arm) tenses the capsular-labral complex and allows a better evaluation of the anterior labrum [60].

In contrast, the ADIR position acquisitions (adduction internal rotation of the arm) can facilitate the identification of an ALPSA lesion [323]. Also, using MRA can increase



sensitivity and specificity to detect humeral avulsions of the glenohumeral ligament (HAGL) involving the inferior glenohumeral ligament, the most important anterior stabilizer of the shoulder. These conditions are very difficult to recognize and are commonly missed on regular MRI. In addition, these injuries can easily evoke into recurrent dislocation with conservative treatment or inadequate surgical treatment [31,203]. MRA is a better tool than conventional MRI to detect HAGHL lesions [31,37], but imaging findings have to be differentiated from iatrogenic contrast extravasation [345]. HAGHL lesions can be evaluated in oblique coronal MR arthrography images; the ligamentous disconnection is usually on the humeral side (poorly detectable in arthroscopy) configuring the arthro-MRI “J sign” in contrast to the normal U-shaped inferior glenohumeral recess [37,345].

MRI has demonstrated to be a useful and even objective method to evaluate capsule laxity in patients with recurrent anterior shoulder instability [239]. The authors evaluated capsular width and tightening in the neutral and ABER positions. Hyperlaxity is out of the scope of this consensus, but on occasions, patients may have unilateral joint laxity due to injury or stretching, only affecting the shoulder suffering from repetitive dislocations. Demonstration of capsule laxity may indicate poor soft tissue quality, especially if the non-affected shoulder has decreased mobility compared to the injured side.

16.2.3 Older adults (Best evidence: 2 case series studies):

In this age group, the evaluation of soft tissue quality is considered less important and, therefore, not displayed in the literature. However, capsular lesions like HAGL are much more common, especially in recurrent instabilities without cuff tears [1,222].



17. What soft tissue injuries are indications for surgical treatment in first-time anterior shoulder dislocation according to each specific age subgroup?

17.1 Statement

Adolescents and Young adults

Humeral avulsion of the glenohumeral ligament (HAGL lesion) should be considered an indication for surgical treatment in first-time dislocations in the adolescent and young adult populations. In addition, other labral injuries like isolated Bankart lesion, anterior labral periosteal sleeve avulsion (ALPSA lesion), Perthes lesion, and glenoid labral articular defect (GLAD lesion) could be considered for surgical treatment in patients with high risk of recurrence, especially in the high risk population of adolescents (Grade C).

If soft tissue surgery is performed in the context of instability, any additional superior labrum anterior to posterior (SLAP) tear type equal or more than II may be addressed (Grade D). Concomitant full-thickness rotator cuff tears, particularly in the young adult population, should be repaired in association with labral injuries (Grade B).

Older adults

After a first-time dislocation in this age group, surgical treatment is strongly recommended in case of a concomitant acute or acute-on-chronic full-thickness rotator cuff tear (Grade B).

If the cuff can be successfully repaired, no stabilising or functional benefit seems to be added by performing a labral repair. Consensus group cannot recommend surgical treatment of



isolated anterior capsulolabral tear after a first-time shoulder dislocation in this age group (Grade C).

Median (range): 9 (7-9)

17.2 Literature summary

17.2.1 Adolescents (Best evidence: 1 prospective comparative study, 1 retrospective comparative study):

In the presence of structural damage to the capsulolabral complex in first-time dislocation, surgical treatment is recommended [103]. Patients presenting with isolated Bankart tears, small bony Bankart lesions, Perthes lesions, and anterior labrum periosteal sleeve avulsions are considered to have surgical treatment following first-time anterior shoulder dislocation [318].

17.2.2 Young adults (Best evidence: 1 prospective cohort, 3 retrospective cohort, 2 systematic reviews with a meta analysis, 4 systematic reviews and 1 narrative reviews):

Anterior shoulder dislocation is a common injury that can result in significant damage to the soft tissue structures of the shoulder joint sometimes from the first episode. While some patients may respond well to conservative treatment, others may require surgical intervention from the first episode to prevent recurrent instability and associated complications. Several clinical investigations have demonstrated progressive intra-articular damage with repeated episodes of shoulder dislocation [166]. Therefore, adequate identification and treatment of



those soft-tissue injuries related to recurrent anterior shoulder instability after first-time dislocation is paramount to prevent or decrease the likelihood of future shoulder problems.

Soft-tissue injuries found at the time of first-time dislocation that may be related to recurrence or poor outcome after conservative treatment include: significant SLAP lesions, ALPSA lesions, HAGL and full-thickness rotator cuff tears [31,90,109,203,227].

In a retrospective study, Gutierrez et al. compared findings in first-time dislocates and recurrent dislocators who underwent arthroscopy and found a higher prevalence of SLAP tears and rotator cuff tears among recurrent dislocators [115]. However, incidence of these injuries at the time of first-time dislocation in the recurrent dislocation group was not evaluated, so the association of these injuries to the recurrence factor cannot be established.

Murray et al. performed a review on traumatic anterior shoulder instability in the athlete [227]. The authors advocated repairing SLAP lesions first to stabilize the superior pole of the labrum. According to their recommendation, SLAP lesions, HAGL, and rotator interval lesions have to be addressed at the time of surgery for patient with first-time dislocation. Eventually, in their systematic review of 7 articles, Feng et al. demonstrated good outcomes in patients treated with concomitant arthroscopic repair of Bankart and SLAP lesion with a low recurrence rate, satisfactory functional outcomes and no significant loss of motion compared with isolated Bankart repair [90]. This is a reason for an arthroscopic combined repair of the both lesion when an stabilization is indicated after a first-time anterior dislocation.

Shin et al. studied intra articular lesions and their relationship to arthroscopic stabilization failure in young patients with first-time and recurrent shoulder dislocations [313]. The authors found an increased rate of ALPSA lesions in recurrent dislocators but no difference in the rate of rotator cuff injury or SLAP tears compared with first-time dislocators. Verweij et al.



observed that ALPSA lesions were a risk factor for recurrence after surgical treatment [341]. Unfortunately, recurrence after conservative treatment of this lesion was not evaluated.

Concerning HAGL lesions, a comparative cohort study of Davey et al. found excellent functional outcomes after open repair with low rates of recurrence and high rate of return to sport compared with patients without HAGL lesion undergoing arthroscopic Bankart repair [61]. Longo et al. in his systematic review also demonstrated good clinical outcomes and a lower rate of recurrence compared with nonoperative treatment after arthroscopic or open repair [203].

Shoulder dislocation in combination with rotator cuff lesion is not uncommon. Hasebroock et al. performed a study on the management of primary anterior shoulder instability and concluded that rotator cuff tears also occur alongside dislocations at a frequency ranging from 7 to 32 % [125]. Older individuals were more commonly affected, and these tears require to be confirmed with MRI if suspected due to the risk of continued shoulder instability. In a systematic review of 11 articles, Gombera et al. found that surgical repair of rotator cuff tears improved pain and satisfaction compared to conservative treatment [109]. Tendon repair along with capsulolabral repair helped restore shoulder stability [109]. According to their conclusions, the presence of rotator cuff tears (commonly seen in patients with shoulder pain) would be an indication for surgical management, which would be regardless on the number of dislocations.

In conclusion, soft-tissues lesion that would require surgical treatment in first-time anterior shoulder dislocations would be full-thickness rotator cuff tears, SLAP lesions, HAGL lesions, and ALPSA lesions [31,90,109,203,227].



17.2.3 Older adults (Best evidence: 5 case series, 2 reviews, 1 diagnostic case control study):

The importance of rotator cuff evaluation in this age group is highlighted throughout the literature. Even after first-time dislocation over the age of 40, imaging is recommended. Ultrasound may be used as the primary option to detect full-thickness tears. However, MRI scans are the gold standard for evaluating tear patterns, excursion, and muscular atrophy.

The rotator cuff is considered the main stabilizing force, and there is a strong recommendation for surgical repair. By repairing the full-thickness cuff tears, the functional outcome and the recurrence rates can be improved drastically. There is a discrepancy in formulating a recommendation for the anterior labral lesion in case of a full-thickness cuff tear. In contrast, no stabilizing or functional benefit can be added by adding labral repair once the cuff can be restored.

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18. What soft tissue injuries are indications for surgical treatment in recurrent shoulder dislocation according to each specific age group?

18.1 Statement

Adolescents and Young adults

Recurrent anterior shoulder dislocation is an indication for surgery if an evident soft tissue injury can be identified (Grade B).

If soft tissue surgery is performed in the context of instability, any additional superior labrum anterior to posterior (SLAP) tear type equal or more than II may be addressed (Grade D).



Concomitant full-thickness rotator cuff tears, particularly in the young adult population, should be repaired in association with labral injuries (Grade B).

Older adults

In the setting of recurrent anterior instability and concomitant full-thickness rotator cuff tear, if the cuff can be successfully repaired, no stabilising or functional benefit seems to be added by performing a labral repair (Grade C).

Median (range): 9 (5-9)

18.2 Literature summary

18.2.1 Adolescents (Best evidence: 1 prospective comparative study, 1 retrospective comparative study):

Due to the high recurrence rate following first-time anterior shoulder dislocation in adolescents' surgical treatment of labral tears, Perthes lesion and anterior labrum periosteal sleeve avulsion (ALPSA) is recommended. Survivorship of open or arthroscopic Bankart repair has been found to be 86% and 49% at 2- and 5-year, respectively [318]. Similar results in patients aged 15-18 years with labral tears were found in the comparison of arthroscopic Bankart repair versus conservative treatment for traumatic first-time dislocation, demonstrating a recurrency rate of 13% versus 70%, respectively [103].



18.2.2 Young adults (Best evidence: 3 therapeutic case series, 3 systematic review, 1 narrative review, 1 retrospective comparative study, 1 prospective cohort study, 1 prospective comparative study, and 1 prognostic case series):

In general, it is accepted that recurrent anterior shoulder dislocation requires surgical treatment, regardless of the type of injury. This is because it is assumed that conservative treatment has failed. There are several soft-tissue injuries associated with poorer outcomes or higher recurrence rate. Therefore, in the present of these injuries, surgical treatment would be strongly recommended.

In some patients the capsule labral complex involved in the Bankart lesion is detached and healed in a medial position on the anterior glenoid. This injury named anterior ligamentous periosteal sleeve avulsion (ALPSA), is thought to be associated with a higher number of dislocations before surgery and inferior outcomes after surgery including higher re-dislocation rate compared to the classic Bankart lesion [249].

In bony instability procedures the need of capsular repair is debated. Is the bony procedure sufficient for a stable joint or do we need to repair the torn anterior capsule as a concomitant procedure? In patients with anterior capsular redundancy Ropart et al suggest a beneficial outcome of patients treated with a capsulorraphy in addition to the Latarjet compared to a Latarjet procedure alone [282].

The HAGL might in some patients be the reason for recurrence after a Bankart procedure. Repairing a Bankart lesion in cases with an additional HAGL lesion will not solve the instability problem, the capsule will still be loose. The symptoms of the patient will sometimes be diffuse, and the surgeon must have this injury in mind, especially in those patients who have recurrence after Bankart surgery. Surgical treatment of HAGL lesions are



associated with lower recurrence rates compared to non-operative treatment, however the quality of literature is low [32,203].

SLAP tears are often seen in combination with anterior instability and anterior labral injury. In a study from 2017, Aydin et al compared the outcome of patients treated with suture of a SLAP lesion in addition to a Bankart repair to patients treated for a Bankart lesion alone [8]. The preoperative and post operative values in the two groups were not significantly different measured by Constant and Rowe scores. They concluded that an accompanying SLAP repair does not affect the outcome of a Bankart repair negatively, however, this study does not debate whether the SLAP lesion must be repaired at all.

Gomberawalla and Sekiya published a systematic review on rotator cuff tears and glenohumeral instability [109]. Despite the association of both conditions was more prevalent in middle-aged to elderly individuals, several studies have been published in the age range of 20-40 years old [108,127,147]. The outcomes of rotator cuff repair in the setting of anterior shoulder instability are good [109], but a comparison with patients undergoing no cuff repair has not been reported for young adults to date. Whether to repair partial rotator cuff tears is debatable, but full-thickness tears should be repaired in the setting of anterior shoulder instability [109].

When comparing soft tissue injuries in patients with first time dislocation to those with recurrent instability there are not proven to be any difference in frequency when it comes to SLAP or partial-thickness rotator cuff tears, however, ALPSA is more frequently seen in recurrent dislocation [315,363].

In conclusion, there is weak evidence suggesting that ALPSA and HAGL injuries need to be treated surgically in patients with recurrent anterior shoulder instability. Full thickness rotator cuff injuries should be repaired in these patients.



18.2.3 Older adults (Best evidence: 5 case series, 2 reviews, 1 diagnostic case control study):

The importance of rotator cuff evaluation in this age group is highlighted throughout the literature. Even after first-time dislocation over the age of 40, imaging is recommended. Ultrasound may be used as the primary option to detect full-thickness tears. However, MRI scans are the gold standard for evaluating tear patterns, excursion, and muscular atrophy.

The rotator cuff is considered the main stabilizing force, and there is a strong recommendation for surgical repair. By repairing the full-thickness cuff tears, the functional outcome and the recurrence rates can be improved drastically. There is a discrepancy in formulating a recommendation for the anterior labral lesion in case of a full-thickness cuff tear. In contrast, no stabilizing or functional benefit can be added by adding labral repair once the cuff can be restored.

No differences in the recommendation, outcome, or other item can be found regarding recurrent dislocations.

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D) Treatment:

Conservative treatment:

19. Is immobilization recommended after first-time anterior shoulder dislocation (yes/no, type, position and timing)?

19.1 Statement



Adolescents and Young adults

After first-time anterior shoulder dislocation, immobilisation in a sling is recommended for pain management, but early mobilisation in the first week might yield similar results as using a sling for three weeks.

The preferred type of immobilisation is internal rotation. Evidence in the literature on the effectiveness of immobilisation in external rotation is controversial (Grade C).

Older adults

No comparative studies on this subject have been published for older people. Immobilisation is recommended for pain management until concomitant injuries have been excluded (Grade C).

Median (range): 9 (5-9)

19.2 Literature summary

19.2.1 Adolescents (Best evidence: 2 meta-analyses, 2 prospective cohort studies, 1 narrative review):

Following reduction after a first-time anterior shoulder dislocation, immobilization in a sling is advised [194,246,277,340,348]. In a prospective cohort study, Olds et al. found that immobilization of the limb following a shoulder dislocation was found to decrease the risk of



recurrent instability at 1 year follow-up [246]. Regarding position of immobilization, in a meta-analysis including six randomized controlled trials the authors concluded that immobilization in external rotation was not significantly more effective in reducing the recurrence rate after primary anterior shoulder dislocation than immobilization in internal rotation [348]. Also, in a LOE III systematic review, Vavken and colleagues found no evidence to support a relative effectiveness of immobilization in external rotation compared with internal rotation to avoid recurrent shoulder dislocations in patients with traumatic anterior shoulder dislocations [340]. Regarding time of immobilization, the duration of immobilization across studies ranged from 3 to 4 weeks [348]. Several authors reported no association between the number of days patients were immobilized and recurrent shoulder instability [246,277].

19.2.2 Young adults (Best evidence: 6 randomized controlled trials, 1 prospective cohort, 5 systematic reviews, 1 prospective case series, 1 retrospective case series, 1 longitudinal prospective study, 2 narrative review, 1 consensus statement):

Shoulder immobilization after first-time dislocation is something debated. When a traumatic anterior shoulder dislocation occurs, the soft tissues and/or bones are damaged. If the injury does not heal or heals in a wrong position or with wrong tension (for soft tissues), the shoulder has more chances of dislocating again. Therefore, the rationale of shoulder immobilization is to allow a better healing of the labral injury.

To immobilize or not to immobilize:

The use of post-reduction immobilization is generally recommended for patients (including young adults) with first-time dislocation undergoing conservative treatment [140,164,178,344]. There are many case series on conservative treatment of first-time anterior



shoulder dislocation for young adults (20 to 40 years or very close to this age range), and all of them used post-reduction immobilization [91,128,176,193,228,330,349].

There are no studies investigating if no immobilization at all has any impact on functional outcomes and re-dislocation rate in young adults.

Position of immobilization:

The position of immobilization (i.e., in external or internal rotation) has been studied in the last two decades. Itoi et al. observed a re-dislocation rate of 55% in patients immobilized in external rotation compared to a 33% in patients immobilized in internal rotation at a mean of 18 years after a first-time anterior shoulder dislocation [150]. However, the authors included a wide range of patients from 12 to 90 years old. These findings have been confirmed by a recent study from Murray et al. in which 50 subjects were randomized to bracing in external rotation and internal rotation [228]. Although they did not find differences in the whole group a reduction of recurrence was found in the 35 subjects between 20 and 40 years old (50% vs 18%). A recent study by Heidari et al. [128] further investigated the effectiveness of immobilization in external rotation but they added abduction with a custom brace. In a RCT including 102 patients followed for 2 years they found a radical difference in recurrence rate (33% vs 4%); this difference being especially important in subjects between 31 and 40 years old.

These results have not been reproduced by other authors. Finestone et al. [91] performed a randomized controlled trial in 51 subjects with a primary anterior shoulder dislocation investigating whether immobilization in external rotation improved results compared to a standard internal rotation sling. They did not find any significant differences in recurrence rate at a mean of 3 years follow-up. Two other RCT performed by Liavaag et al. [193] (188 patients with only 50% compliance) and Whelan et al. [349] (60 patients) failed to show differences.



Two meta-analyses have been published regarding the type of immobilization recommended. Both studies came to the same conclusion; immobilization in external rotation does not decrease re-dislocation rate with the numbers available [260,348]. In contrast, two other meta-analyses have found that immobilization in external rotation does reduce the re-dislocation rate compared to internal rotation [317,365].

This discrepancy might be likely related to (1) re-dislocation is multifactorial; and (2) as the aim of external rotation bracing is to reduce the torn labrum in its place so that it can heal, healing may only occur in 35 % according to a systematic review by Jordan et al. [156]. Acute MRI with the shoulder in external rotation might allow identification of the group of subjects who could benefit from external rotation bracing.

Length of immobilization:

Kiviluoto et al [174] followed for one year a group of 226 subjects with a first time dislocation. Despite they included a wide range of patient ages (16 to 86 years old), the authors provided some information for young adults. Patients under 30 years old were assigned to one or three weeks of sling immobilization. Those with shorter immobilization had higher recurrence rates (56% vs. 22%). The authors concluded that patients younger than 30 years had a higher re-dislocation rate compared to older patients. However, many of the re-dislocations in the under 30 group were seen in patients aged < 20 years of age.

In the classic study by Hovelius et al. [131], the authors looked at differences between one week immobilization and 3 weeks immobilization. The author observed that 18% of patients between 26 and 40 years needed surgical stabilization because of recurrence. They failed to identify relevant differences between one week immobilization and 3 weeks immobilization.

A posterior meta-analysis of these two studies [260] did not show a relevant effect of the length of immobilization in the recurrence rate in patients under 30 years of age. However, the included studies had a relevant number of patients under 20 years, even down to 12 years



of age, so that age was not adequately controlled for its influence on re-dislocation rate and this result might not be applicable to subjects in the 20-40 age range.

19.2.3 Older adults (Best evidence: 4 case series studies)

Few studies reported immobilisation in a sling from one [347] to four weeks [316] after closed reduction. Only one study [114] specified the type of immobilisation in this age group: adduction and internal rotation.

Ultrasound was recommended by Shin et al. [316] after two weeks of immobilisation, even in asymptomatic patients, to rule out concomitant injuries and before starting the rehabilitation program. An MRI was suggested by the same authors [316] only in case of persistent pain after four weeks. On the other hand, Sonnabend et al. [324] proposed a CTA in symptomatic patients after 3 weeks of immobilisation followed by a free range of motion.

20. Is immobilization recommended after recurrent anterior shoulder dislocation (yes/no, type, position and timing)?

20.1 Statement

Most patients with recurrent anterior shoulder dislocation should be offered surgical treatment.

There is no evidence in favour of immobilisation after recurrent anterior shoulder dislocation.

A simple sling should be recommended for pain management (Grade C).



Median (range): 9 (6-9)

20.2 Literature summary

20.2.1 Adolescents (Best evidence: none)

For this specific age group none of the included studies reported on the type of nonoperative treatment after recurrent dislocation. Length or type of immobilization or rehabilitation protocol was either not recorded or too variable to analyze.

20.2.2 Young adults (Best evidence: 5 meta-analyses, 1 case series):

To the best of our knowledge, there is no data available on the literature evaluating the benefit of immobilization for recurrent anterior shoulder dislocation in young adults. Nearly all studies have investigated the effects of shoulder immobilization after the first episode of dislocation.

Recurrent anterior shoulder dislocation is associated with the presence of bony injuries that highly predispose to re-dislocation [316]. Whenever a bony injury occurs, the re-dislocation rate is affected by other parameters: displacement of the initial bony Bankart fragment, size of the Hill-Sachs in relation to the glenoid (glenoid track), or amount of bone loss in cases of chronic erosion. Whether using or not the immobilization in these cases is unlikely to affect the re-dislocation rates. Data on the type of immobilization (whether in external or internal rotation) is confusing and it is not specific for recurrent anterior shoulder instability. Three meta-analyses found that immobilization in external rotation does not decrease re-dislocation rate compared to that in internal rotation [195,260,348]. However, other studies have been



able to find significant differences in the rate of re-dislocation, being higher in those patients treated with immobilization in internal rotation [317,365]. All these studies are not specific for recurrent anterior shoulder instability in the young adults group.

The length of immobilization is something that has not been specifically studied in the setting of recurrent anterior shoulder instability in young adults. This condition is multifactorial; many risk factors can influence the re-dislocation rather than the immobilization factor alone. Some individuals may not require immobilization versus others who may require 1–2 weeks of sling immobilization depending on symptoms, mechanism, and energy needed to dislocate the shoulder. In conclusion, there is no data in the literature to favor immobilization in recurrent anterior shoulder instability in young adults.

20.2.3 Older adults (Best evidence: none):

No literature is available on this topic in this age group.

21. Is rehabilitation recommended after first-time anterior shoulder dislocation (yes/no, timing and goal)?

21.1 Statement

There is a lack of evidence supporting any specific answer to this question. The consensus group recommends rehabilitation. Recommendation is independent of forecoming surgical treatment or not. Following the period of immobilization, a pain-controlled passive range of motion is started with gradual progress to active-assisted exercises. When pain allows,



periscapular and rotator cuff muscle strengthening can begin. Concomitant injuries must be ruled out at this phase (Grade D).

Median (range): 9 (7-9)

21.2 Literature summary

21.2.1 Adolescents (Best evidence: 2 meta-analysis)

There is little scientific evidence about rehabilitation after a first-time traumatic anterior shoulder dislocation. Few papers report on the rehabilitation process. Rehabilitation starts after initial immobilization following first-time dislocation event and lasts for 3-4 weeks [348]. Current literature finds no difference between immobilization in external and internal rotation [23,132,340]. Early physical therapy is advocated as the cornerstone of nonoperative management, focusing on strengthening of periscapular and rotator cuff muscles [194]. After sling removal, patients are advised to start with passive circumduction followed by active-assisted range of movement exercises. Isometric rotator cuff strengthening is started at the physiotherapist discretion and progressed to isotonic exercises. Patients are advised to continue strengthening exercises for a year and to return to general fitness training and noncontact sports at 12 weeks, but to delay return to competitive sports until 16 weeks after the first-time dislocation event [277].

21.2.2 Young adults (Best evidence: 1 randomized controlled trial, 3 systematic reviews, 3 narrative reviews):



In general, rehabilitation is recommended after first-time anterior shoulder dislocation [105,125,227]. However, there is no clear evidence comparing surgery or conservative treatments with or without rehabilitation. Therefore, it is difficult to answer this question in relation to whether the patient underwent conservative or surgical treatments. Nonetheless, most studies comparing surgical versus nonsurgical treatment, or comparing different surgical techniques have applied some kind of rehabilitation in their investigations [105,139]. Some kind of rehabilitation is always helpful whenever an injury occurs. This is true regardless on the immobilization and the type of treatment. Hurley et al. conducted a systematic review and meta-analysis comparing the arthroscopic Bankart repair and conservative treatment in first-time anterior shoulder dislocation [139]. The authors found that surgical treatment allowed a higher return to play and a 7-fold lower recurrence rate compared to conservative treatment after evaluating 10 prospective studies involving 569 patients. All studies included in the systematic review applied a rehabilitation protocol for both of the treatments.

Most studies apply a rehabilitation protocol after immobilization, consisting on different phases with different goals. Initially, the patient should gain full painless motion, after which they are instructed to recover full strength and, finally, to gain function for their specific sports [227]. In a randomized controlled trial, Robinson et al. compared the outcomes of arthroscopic Bankart repair and rehabilitation with sham surgery and rehabilitation in patients under 35 years old with first-time anterior shoulder dislocation [279]. After sling removal, the patients underwent a physical therapy program to gain full active-assisted range of motion from weeks 6 to 12 avoiding abduction above 90° and external rotation above 30°. Also starting at 6 weeks the patients initiated strength training with isometric exercises, progressing to isotonic exercises at 12 weeks. After 12 weeks the goal was to have full range of motion and adequate strength to resume non-contact sports. Return to full unrestricted competitive



sport was allowed at 6 months. The authors observed that surgical treatment allowed a lower risk of recurrent instability and better return to play. However, patients without recurrence had similar functional outcomes at two years, irrespective on the treatment allocation [279]. While initiation of range of motion exercises is more heterogeneous, the addition of strengthening through isometric contractions starting at 6 weeks seems to be something more homogeneous across authors [92]. Starting of sports-specific training at 4 months and return to play clearance after 6 months is also quite homogeneous in first-time anterior shoulder dislocation [139].

The length of immobilization is controversial. While some authors just leave 2 weeks of immobilization, others advocate for 3-4 weeks [92], regardless on the type of treatment [139]. Another aspect related to immobilization that has been investigated has to do with the position at which the shoulder should be placed. Hurley et al. conducted a systematic review and meta-analysis to compare the outcomes of immobilization in external or internal rotation after traumatic first-time anterior shoulder dislocation [135]. The authors included nine randomized controlled trials involving 795 patients at a mean age of 29 years. They found that immobilization in external rotation resulted in better compliance, lower recurrent shoulder dislocations and higher return to play at the pre-injury level. Interestingly, the lower recurrence rate for immobilization in external compared to internal rotation was particularly evident in patients aged 20 to 40 years old [135].

21.2.3 Older adults (Best evidence: 4 case series):

Few studies highlighted that conservative management was initially presented in all cases [280,347]. Wenner et al. [347] started rehabilitation one or two weeks after the injury. It consisted of a passive and active assisted range of motion in each direction. The active



movement was allowed as tolerated. Only extension behind the plane of the body was prohibited for four weeks.

Simank et al. [319] described a six weeks program. First, the pain was released by detonation exercises combined with oral medication. Then, flexibility and range of motion were restored by stretching exercises. The next step involved the restoration of the strength of the internal and external rotators against resistance using a rubber tube or weights and improving the deltoid strength.

Shin et al. [316] allowed pendulum and passive range of motion exercises after two weeks of immobilization if no concomitant injuries were found at the ultrasound examination. Strengthening exercises were followed by pain-free restoration of the full range of motion.

22. Is rehabilitation recommended after recurrent anterior shoulder dislocation (yes/no, timing and goal)?

22.1 Statement

Surgical treatment is generally recommended in recurrent anterior shoulder dislocation.

There is a lack of evidence supporting any specific answer to this question. In case of recurrent anterior shoulder dislocation, especially in contact and collision athletes, a rehabilitation program is not likely to be sufficient to make the shoulder stable. As a preoperative management, rehabilitation may be useful to achieve pain-free shoulder function for daily activities. The patient should start passive and active-assisted exercises as soon as pain is tolerated, followed by proprioceptive and strengthening exercises for the rotator cuff,



deltoid and periscapular muscles. Rehabilitation is also helpful to prepare patients for rehabilitation after surgery (Grade C).

Median (range): 9 (6-9)

22.2 Literature summary

22.2.1 Adolescents (Best evidence: 1 systematic review)

Little evidence on rehabilitation after recurrent anterior shoulder dislocation exists. A 2016 systematic review on surgical versus non-surgical treatment in adolescent patients identified 6 studies reporting on non-surgical management, and another 6 studies evaluating both, surgical and non-surgical treatment between level of evidence grade II to IV [206]. Traditionally, the conservative treatment of recurrent anterior shoulder dislocation consisted of no immobilization versus immobilization, physical therapy, and restricted activity. However, the non-surgical management was considerably different among the included studies:[206] for example Immobilization ranged between no immobilization to 8 weeks. The majority of shoulders (133 of 411 shoulders) were treated by one week of immobilization in adduction and internal rotation, followed by physical therapy. Timing and goals of the physical therapy are typically not described. However, conservative treatment after recurrent anterior shoulder dislocation plays a minor role in adolescent patients due to the high recurrence rate of 71% following non-surgical treatment versus 18% following surgical stabilization [206]. In summary, primary conservative treatment after recurrent anterior shoulder dislocation is not recommended.



22.2.2 Young adults (Best evidence: 1 randomized control trial, 2 retrospective cohort studies, 1 narrative review and 1 expert opinion):

The main difficulty to answer this question is the lack of high-level evidence studies that have specifically evaluated non-operative management with only rehabilitation at a medium or long-term for patient with recurrent shoulder instability. Most of the comparative studies compared non-operative management to surgical treatment for patients with recurrent anterior shoulder instability. Moreover, most of the studies that evaluated rehabilitation in this specific indication had different protocols and therefore we cannot recommend a specific one based on the literature. Thus, it is difficult to give a validated answer for this question concerning timing and goals of the rehabilitation for this indication. Almost all of the protocols found were derived from expert opinion and clinical experience rather than from well-designed studies.

In a Danish randomized controlled trial, Eshoj et al. demonstrated that physical therapist-supervised shoulder instability neuromuscular exercises were proven to give better functional results measured by WOSI score compared to home-based exercises twelve weeks for both primary and recurrent anterior shoulder dislocation (Level 2) [87]. For both protocols, rehabilitation was introduced at the first week following surgery. Nevertheless, the results were evaluated at a 12 weeks follow-up and thus data on long-term results for these patients are not available.

The nonoperative treatment can be first line treatment option for the first time dislocator however for recurrent dislocation surgery is the gold standard.

Novakofski et al reported in their retrospective geographic cohort study of 254 patients who were treated non-operatively for anterior shoulder instability poor outcomes after non-operative treatment in a follow up after 17 years [242]. Up to 58% of the patients had



recurrent pain, 37% had recurrent instability and 12.2% of the patients developed progression of symptomatic OA. Well-known factors for recurrence risk include younger age (age < 30 have 6 times increased risk), male sex (2.68 times risk compared to females), and occupation with arm use above level of the chest. Also, glenoid bone defects and Hill Sachs lesions should be the indications for surgical treatment. Contact and collision athletes are another group of low success rates with conservative treatment. Recurrence rates in these athletes have been shown to be between 9% and 29%.

Duethman et al. in a retrospective database review (Level 3) found that patients who experienced recurrent anterior shoulder instability with an initial non-operative management were more likely to convert to surgery at their last follow-up [76].

Cools et al. in their narrative review (Level 5) summarized evidenced-based guidelines to assist clinicians in the prevention and rehabilitation of the overhead athlete with a combined approach [57]. They described exercise treatment focussed on the glenohumeral joint including mainly neuromuscular control and strength training of the rotator cuff, a restoration of range of motion, exercise focused on the scapulothoracic joint and a management of flexibility deficits in the scapular muscles. Nevertheless, in comparison with first-time anterior shoulder dislocation, the authors recommended surgical stabilization in case of recurrent anterior shoulder dislocation.

Ma et al. in their review on current concepts in rehabilitation for traumatic anterior shoulder dislocation described their protocol but without differentiation between first-time and recurrent anterior dislocation (Level 4) [208]. They described 3 phases. The acute phase with the objectives to reduce pain, inflammation, and muscle guarding; protect healing of soft tissues and minimize further injury to the joint capsule; minimize the negative effects of immobilization;) and reestablish dynamic joint stability and proprioception. This phase include restoration of dynamic joint stability to minimize shoulder muscle atrophy. Then



active-assisted motion is added in a restricted arc and stabilization and proprioceptive exercises are performed to reestablish dynamic joint stability. The intermediate phase is initiated when certain criteria are obtained that include reduced pain, satisfactory shoulder static stability, and adequate neuromuscular control. The objectives of this phase are to attain near full passive motion and active motion. Isotonic exercises are started such as rotator cuff exercises above 90°. Dynamic stability and core strengthening are promoted and underlying scapular dyskinesis should also be addressed at this phase. Eventually, the third phase is initiated for advanced strengthening and return to sport when patient has achieved to obtain minimal to no pain in the injured shoulder, full shoulder motion and capsular mobility and a good strength, endurance and dynamic stability of the scapulothoracic and upper extremity.

22.2.3 Older adults (Best evidence: 1 case series, 1 comparative study)

Two studies reported that one of the indications of surgical treatment in patients affected by recurrent instability in this age group was the “failure of conservative treatment”. However, no description of conservative management was reported [207,209].

23. What are the criteria to return to sports after anterior shoulder dislocation treated conservatively?

23.1 Statement



The main criteria to define the return of a patient suffering from an anterior shoulder dislocation treated conservatively to sporting activity (recreational or competitive) are the following:

- Obtaining a full range of motion
- Absence of pain
- Clinically stable shoulder with negative apprehension test
- Satisfactory muscular strength and endurance

The patient's return to sporting activity is advised when all of these criteria are met. In most cases, this is achieved after 6-16 weeks post-traumatic (Grade C). In individual cases return to sport might be allowed even with minor loss of external rotation or residual apprehension (Grade D).

Median (range): 9 (7-9)

23.2 Literature summary

23.2.1 Adolescents (Best evidence: 1 prospective clinical study)

Literature is lacking specific criteria to return to sports after anterior shoulder dislocation treated conservatively. General recommendations to return to general fitness training and non-contact sports following 12 weeks, and to delay return to competitive sports until 16 weeks



posttraumatic were made, however, recurrency rate was found to be 77% in this adolescent population [277].

23.2.2 Young adults (Best evidence: 3 randomized controlled trials, 1 prospective comparative, 1 prognostic cohort study, 1 prospective cohort study, 1 systematic literature review, 7 narrative reviews)

Ability to return to sport (RTS) is a key-concern for patients involved in sport activities the main criteria of success of the treatment and few studies have evaluated whether the nonoperative treatment can lead patients to return to sport at the same level.

Once the strengthening and posture goals are met the objective is to change to end-range stabilization through perturbation training, end-range stabilization, and endurance are accomplished, the patient must initiate a gradual return to sport program in which symptoms must be carefully monitored and progressed accordingly. Scapular control is very beneficial at this phase [165].

Even though patients treated nonoperatively may not experience recurrent instability, many of them have low-level pain and instability with missed shoulder instability events. Some of them experience meaningful functional impairment with residual apprehension that leads them to limit their recreational and sporting activities [173].

Functional criterion to allow RTS:

Clinical recommendations are mostly based on individual experience instead of clear guidelines and very few clinical studies evaluated return to sport in that specific indication [153]. One of the most used criteria to allow patient to return in sport activities is possible when range of motion and strength are near normal [182]. Watson et al. concluded that the



patient should be pain free with symmetric scapular strength before returning, generally occurring within 2–3 weeks [346].

Ma et al. performed a review to evaluate the current evidence based literature and concepts surrounding rehabilitation in patients with anterior shoulder instability injuries and surgical repair [208]. They described rehabilitation for patient with first-time after traumatic anterior instability treated non-operatively in 3 phases (Acute phase after injury, intermediate phase after surgery and advance strengthening and return to sport after injury).

Criteria to start the third phase for the patients were:

- Minimal to no pain in the injured shoulder
- Full shoulder motion and capsular mobility
- Good strength (4/5 on manual test), endurance and dynamic stability of the scapulothoracic and upper extremity.

The return to sport criteria they used were the following:

- Full functional range of motion
- Satisfactory muscular strength and endurance
- Adequate static and dynamic stability
- Good clinical evaluation without pain.

In their narrative review, Hasebroock et al. evaluated the management of primary anterior shoulder dislocations [125]. Without current evidence-based parameters on goal rotator cuff strengths before return to sport, one recent study found weakness in internal and external rotator strength was associated with recurrent anterior shoulder instability [80]. This suggests symmetric rotator cuff strength between shoulders may be a sensible recommendation before allowing full return to sport following conservative management.



For Murray et al. rehabilitation should also progress following a stepwise protocol with a short phase of immobilization to protect soft tissue healing and reduction inflammation for a short period to prevent stiffness, loss of proprioception muscle wasting [227]. Then pain-free range of motion must be obtained followed by strengthening of rotator cuff and periscapular muscle. Return to sport requires motion and strength comparable with the uninjured extremity to progress to sport-specific drills. Proficiency in sport-specific drills as shoulder stability are required to let the patients return to competition or contact training.

Delay for RTS:

Kraeutler et al performed a systematic review of operative versus nonoperative management on traumatic primary anterior glenohumeral joint dislocation in sports [178]. They found that athletes have an increased risk for recurrence or further instability especially if it's a throwing or overhead athlete. One of the studies they evaluated expressed concern that speedy return to play with nonoperative management may increase the risk of recurrence. They concluded that nonoperative management may be indicated in patients older than 30 years who are at low risk of recurrence. They also cited in their review the article of Owens et al. that suggested that nonoperative management of an in-season injury can allow a quick return to play in as little as 7 to 21 days [247]. However, the authors also suggested that this places the athlete at an increased risk for recurrence or further instability, especially if that athlete is a throwing or overhead athlete

Buss et al. demonstrated that athletes patients treated conservatively missed an average of 10,2 days of participation and 90% of patients returning to play within 2-3 weeks [41]. Dickens et al found that 73% of NCAA athletes could return to sport at a median 5 days after injury among which 30% had a recurrence but could complete the season and 33% had a recurrence and were not able to complete the season [69]. They also found that patients with initial subluxation were 5.3 times more likely return to sport than those with a dislocation.



23.2.3 Older adults (Best evidence: 4 case series studies, 1 narrative review):

There is a lack of consensus on the return to sports after shoulder dislocation treated conservatively in elderly patients. None of the published studies describes the return to sports after conservative treatment. Most of the studies talk about results after surgical treatment.

Only five studies describe the return to daily activities after conservative treatment. The main criterion is the absence of RC tears [114,229,316,319,347].

Simank et al. only describe modifying work and sports activities after 6 weeks of conservative treatment [319].

Wenner et al. described that the patient had limitation of ROM during the first 6 weeks post-trauma. However, this was improved during the next 6 weeks. Finally, equal ROM with the unaffected shoulder was gained at 3.5 months post-operatively [347].

Surgical treatment:

24. What are the indications/contraindications for soft tissue procedure after first-time anterior shoulder dislocation?

24.1 Statement

When surgery is indicated after a first-time anterior shoulder dislocation the surgical technique might be either a soft tissue procedure or a bony procedure. Acute surgical stabilization of first-time anterior shoulder dislocation in young, active patients is more



effective than conservative treatment at long-term follow up, based on lower recurrence rate, better return to sports, and higher patient-perceived improvement. No definite indications and contraindications have been defined in the literature for soft tissue procedures after first-time anterior shoulder dislocation in older adults patients.

Some surgeons would recommend systematically bony procedures and have no indications for soft-tissue procedures (Grade D).

Indications for soft tissue procedures in first time anterior shoulder dislocation are:

- Injury of the capsulolabral complex including the anterior inferior glenohumeral ligament (IGHL) without critical glenoid bone loss requires a Bankart procedure. Bony Bankart fractures of a size that cause acute instability and new dislocations after the reduction, should be repositioned, and fixated in the acute phase (Grade B).
- In cases of a humeral avulsion of the glenohumeral ligament (HAGL) the ligament has to be repaired at the humeral side (Grade B).
- Additional remplissage procedure is recommended in cases of an off-track Hill-Sachs Lesion (Grade B).
- When a concomitant posterior labral lesion is present this can be addressed at the same time (Grade D).
- ALPSA lesion must be released and mobilized to the glenoid rim before fixation as they represent an increased risk of recurrence compared to a Bankart lesion (Grade B).
- Arthroscopic subscapular augmentation (ASA) may be considered in hyperlax patients (Grade C).



- Dynamic anterior stabilization (DAS) may be considered in cases of subcritical glenoid bone loss (Grade D).

- Patients with a full thickness rotator cuff tear as a consequence of an anterior shoulder dislocation need a rotator cuff repair to stabilize the joint and prevent degenerative changes. This is the main indication for a soft tissue procedure in the older adults group and the most performed procedure is rotator cuff repair and not labral repair (Grade B).

Contraindications for soft tissue procedures in first time anterior shoulder dislocation:

- Severe humeral, glenoid, or bipolar bone loss (Grade B).

- Presence of severe osteoarthritis (Grade B).

Special attention is needed in patients with collagenous and soft tissue pathology (e.g., Marfans, Ehlers-Danlos, Down Syndrome).

Median (range): 9 (4-9)

24.2 Literature summary

24.2.1 Adolescents (Best evidence: 1 prospective comparative study, 2 case series, 1 narrative review)

Recurrence after a first time dislocation in this specific age group is particularly high when compared to older patients. In a retrospective study of prospectively collected data including 133 adolescents diagnosed with a primary anterior dislocation and treated conservatively, Roberts et al. reported a recurrence rate of 76.7%, concluding that these patients should be considered for early operative stabilization [277]. Similarly, in a prospective cohort study



involving patients between 15 and 18 years old, the authors concluded that conservative treatment after a first traumatic shoulder dislocation leads to unacceptable high failure rates [103]. In both of these papers the authors performed soft tissue procedures to recurrent patients, excluding from the study patients with glenoid bone loss, without specifying the % or localization. Other factors were also considered exclusion criteria, like multidirectional instability, generalized hyperlaxity or posterior instability [103,180]. Kramer et al. considered that patients with >25% of glenoid bone loss necessitated open surgery, but the type of surgery is not specified [180]. In a case series of prospectively collected data involving adolescent rugby players treated with an arthroscopic labral repair, the authors excluded patients with an HSL >25% or a bony Bankart lesion >20% [333].

Besides what is mentioned above, in the revised literature for this specific subgroup we found no study specifying indications/contraindications for a first time dislocator regarding surgical technique (bony vs soft tissue).

24.2.2 Young adults (Best evidence: 1 cost-effective analysis, 1 meta-analysis, 1 non-randomized prospective study, 1 randomized controlled trial, 1 retrospective comparative study, 1 cross-sectional study):

Surgical treatment of first-time anterior shoulder dislocation is proven to lower the recurrence rate compared to non-surgical treatment. One of the reasons the surgical treatment is not widely used as first line management might be the cost of a surgical procedure, however several authors argue that the surgical treatment is cost effective compared to non-surgical treatment with physiotherapy [74].

Patients age play a significant role in predicting the rate of recurrence. In Hurley et Al's Meta-analysis from 2020, reporting from 10 prospective studies, all level 1-2, they concluded



that arthroscopic Bankart repair resulted in a 7-fold lower recurrence rate and higher return to sport compared to conservative management [138]. The mean age in these ten studies were from 16 to 25 and the conclusion is hardly applicable for the scope of this summary focusing on the age group from 20 to 40. In a review from Kane et al analysing the natural history after first time dislocation, the group aged from 30 to 39 had a recurrence rate of 17-39% after the first dislocation and the patients aged 40 or older had a recurrence rate of 10-22%. In comparison, the age group below 30 years had a 47-89% recurrence rate.

Uhring published a study with comparison between “emergency stabilization” and immobilisation or secondary stabilisation. Mean follow up was 19 months for operative treatment and 25 months for non-operative group. There were no failures in the “emergency stabilization group” compared to a 77% rate in the “non-operative” group with onset at a mean 7.5 months and a mean 2.6 episodes of recurrence. For patients treated non-operatively who were treated with secondary stabilization the clinical scores were lower compared to “emergency stabilization” [337].

A ten year follow up of first-time anterior traumatic dislocation in a prospective randomised trial reported a recurrence rate of 9% of patients treated with open Bankart procedure compared to 62% recurrence in the group treated non-surgically [153]. In the same study the recurrence after two years was 3% and 54%, respectively.

In first time anterior shoulder dislocation most surgeons would consider a soft tissue procedure. However, there are cultural differences from country to country and for different kind of sports. The limit for performing a soft tissue procedure can be argued by glenoid bone loss or ISIS score. The following risk factors were identified in ISIS score: patient age under 20 years at the time of surgery; involvement in competitive or contact sports or those involving forced overhead activity; shoulder hyperlaxity; a Hill-Sachs lesion present on an



anteroposterior radiograph of the shoulder in external rotation and/or loss of the sclerotic inferior glenoid contour. Bessiere et al. propose the limit at 3 points in ISIS score [19].

An argument for primary stabilization of the first-time dislocation is to decrease the risk of future osteoarthritis of the glenohumeral joint associated with recurrent dislocation [75].

24.2.3 Older adults (Best evidence: 1 prognostic prospective multicenter study, 1 case report, 3 case series, 1 descriptive epidemiology study, 1 diagnostic case control, 1 narrative review – book chapter):

There is a lack of consensus concerning managing first-time anterior shoulder dislocation in elderly patients. Recommendations vary from conservative treatment to more aggressive surgical interventions [319]. Regardless of the different opinions, the goals should be based on preventing instability, patient choice, range of motion (ROM) restoration and strength [366]. Recurrent anterior shoulder instability in elderly patients is rare [72,86], and patients over 40 years account for 10% of patients with recurrent anterior shoulder dislocations [130,321]. Given this significantly lower risk for recurrence with increasing age at first-time dislocation [130], the need for surgical stabilisation shows a reverse linear relationship: only 14% of first-time traumatic anterior dislocations sustained in patients aged 30 to 40 years ultimately need an operation and 17% in patients over 50 years [130,321]. This is opposed to 50% of those suffered in adolescent patients [130]. This may be due to differences in biomechanical properties, collagen fibre type, capsule elasticity, or changes in activity level as a function of age [267]. Ultimately, 26% of all patients in this age group need surgical treatment, with almost half needing RC repair [321]. Identifying an associated injury will help predict the recurrence of shoulder dislocation. Meanwhile, the decision for surgery on elderly patients would also help the surgeon avoid prolonged immobilisation morbidity [267].



25. What are the indications/contraindications for soft tissue procedure after recurrent traumatic anterior shoulder dislocation?

25.1 Statement

Surgical stabilization is indicated in most patients suffering from recurrent anterior shoulder instability. The surgical technique might be either a soft tissue procedure or a bony procedure. An increasing number of dislocations will lower the threshold for additional soft tissue procedures or bony procedures. Soft tissue procedures such as open and arthroscopic Bankart repair have proven to lower the recurrence rate in anterior shoulder dislocation.

Some surgeons would recommend systematically bony procedures and have no indications for soft-tissue procedures (Grade D).

Indications for soft tissue procedures in recurrent anterior shoulder dislocation:

- Injury of the capsulolabral complex including the anterior inferior glenohumeral ligament (IGHL) without critical glenoid bone loss requires a Bankart procedure. Bony Bankart fractures of a size that cause acute instability and new dislocations after the reduction, should be repositioned, and fixated in the acute phase (Grade B).
- In cases of a humeral avulsion of the glenohumeral ligament (HAGL) the ligament has to be repaired at the humeral side (Grade B).
- Additional remplissage procedure is recommended in cases of an off-track Hill-Sachs Lesion (Grade B).



- When a concomitant posterior labral lesion is present this can be addressed at the same time (Grade C).
- ALPSA lesion must be released and mobilized to the glenoid rim before fixation as they represent an increased risk of recurrence compared to a Bankart lesion (Grade B).
- Arthroscopic subscapular augmentation (ASA) may be considered in hyperlax patients (Grade C).
- Dynamic anterior stabilization (DAS) may be considered in cases of subcritical glenoid bone loss (grade D).
- Patients with a full thickness rotator cuff tear as a consequence of an anterior shoulder dislocation need a rotator cuff repair to stabilize the joint and prevent degenerative changes. This is the main indication for a soft tissue procedure in the older adults group and the most performed procedure is rotator cuff repair and not labral repair (Grade B).

Contraindications for soft tissue procedures in first time anterior shoulder dislocation:

- Severe humeral, glenoid, or bipolar bone loss (Grade B).
- Presence of severe osteoarthritis (Grade B).

Special attention is needed in patients with collagenous and soft tissue pathology (e.g., Marfans, Ehlers-Danlos, Down Syndrome).

Median (range): 8 (4-9)



25.2 Literature summary

25.2.1 Adolescents (Best evidence: 1 cohort study, 6 retrospective comparative studies, 1 case series, 1 systematic review):

The soft tissue procedures after recurrent traumatic anterior shoulder dislocation were highly dependent on the level of activity exerted and the type of sport practiced by the young population. Throwing athletes could benefit more from an arthroscopic Bankart repair than an open Bankart repair due to the lower loss of external rotation that this procedure brings [126]. Rugby, Water Polo and other high-energy contact sports with/without the overhead position of the arm presented high recurrence rate after arthroscopic repair, but the open repair proved to be more reliable and it should be considered [126,170,285].

Another concern was the presence of bone lesions on MRI or CT. In this case isolated arthroscopic Bankart repair should not be performed if the glenoid bone loss surpasses the 20% to 25% threshold, instead a bone block procedure or sometimes even an open repair should be achieved [161,186,285,318,333]. Arthroscopic Bankart repair with a remplissage procedure was a reasonable option for treating recurrent anterior shoulder dislocation in adolescents with Hill-Sachs deformity without significant glenoid loss (13.5% for high level athletes) [133,134].

Other contraindication identified for arthroscopic and open repair were: multidirectional instability, posterior instability, atraumatic or volitional instability, connective tissue pathology (e.g. Marfans, Ehlers-Danlos, Down Syndrome), familial history of connective tissue pathology, neurologic complications, fractures of the humerus or scapula, instability due to hyperlaxity or muscle patterning problems, full-thickness rotator cuff tear and humeral avulsion of the glenohumeral ligament [126,285].



25.2.2 Young adults (Best evidence: 1 systematic review, 1 randomized controlled trial, 1 prospective case series, 21 retrospective case series)

Arthroscopic soft tissue procedures, in particular arthroscopic Bankart repair, have been extensively used since their development in the nineties. They are still very popular and there is no subset of patients with recurrent anterior shoulder instability in which good outcomes have not been reported. Defining whether these procedures are indicated or not can only be done stratifying the studies according to different populations.

Unselected patients:

The results of Arthroscopic Bankart repair in unselected patients are worrisome. In this population when mid term follow-up (56 years) outcomes are compared to the Latarjet procedure the recurrence rate is half in the Latarjet group with improved Rowe scores. Younger age worsened the results in both groups but practice of competitive sports and shoulder hyperlaxity only worsened the outcomes in the Bankart group [21]. In the long term the expected recurrence rate can be of 16%, instability rates of 31% and reoperation rates of 17% [226]. A systematic review of patients treated with either Bankart repair or Latarjet including >3000 patients found that the Latarjet procedure was clearly superior regarding recurrence (especially in the long term) but had an increased risk of infection [146].

The ISIS score was developed by Boileau in 2007 [12] to try to define which patients would not benefit from a soft tissue procedure and were best served by a bony procedure such as Latarjet. It is widely used around the world, but its efficacy has been challenged by two recent studies [243,293].

When dealing with patients participating in contact or high-level sports the comparison with Latarjet finds similar clinical outcomes and return to sport rates and times, but Bankart



procedures had a clearly increased rate of recurrence (19% vs.0%) that worsens with time. In contrast Latarjet procedures have way more complications (16% vs 2%) [263].

The degree of glenoid bone loss seems to affect dramatically the outcomes of arthroscopic Bankart repair. If no bone loss is present good clinical outcomes can be expected [6] even when compared to open Latarjet[63]. In contrast if a large (>20%) glenoid bone defect is present worse outcomes can be generally expected [259]. In particular if contacts sports are involved the Latarjet procedure has better recurrence rates [286]. In patients with large defect the addition of an arthroscopic bone block procedure allows for dramatic reduction in the recurrence rates (3% vs 49%) [145].

If the bone defect is considered subcritical (between 13.5% and 20%) the picture is not as clear: some studies have found that defects over 10-17% have an impact in the worsening of the outcomes of Bankart repair [315,362] but others have not found much differences with the outcomes of the Latarjet procedure [27] specially if an ASA procedure is associated [294] or if a remplissage is used to address concomitant humeral defects [255].

To finish a specific subset of patients with glenoid bone defects are those with a bony Bankart. Classically the outcomes of these subjects after arthroscopic Bankart repair were considered to be worse than those obtained with a Latarjet procedure [101] but healing of the Bony Bankart after arthroscopic repair seems to improve greatly the outcomes [235] reducing the recurrence rate [230]. It seems that if a large bony Bankart is present and included in the repair the outcomes can be good (recurrence rates of 0% in small defects, 7.9% in medium defects, 5.9% in large defects) [257].

When a large Hill-Sachs lesion is present in the abscesce of a glenoid defect the addition of a remplissage procedure to an arthroscopic Bankart repair reduces dramatically the recurrence rate at 2 year follow-up compared to isolated Banakrt repair (from 25% to 5%) with only minor limitation of external rotation (8° vs 3°) [53]. In fact the results seem to be comparable



to an open Latarjet procedure with low and similar recurrence rates. However, loss of external rotation and residual pain are more common with the combined Bankart-remplissage procedure [9].

The characteristics of the labral injury do not seem to affect the outcome of arthroscopic Bankart repair. In particular ALPSA lesions do not worsen the outcomes of Bankart repair [249].

25.2.3 Older adults (Best evidence: 4 case series, 2 comparative/cohort studies):

Existing studies with middle-aged or elderly patients affected with recurrent anterior shoulder dislocations have not been consistent in selecting treatment methods and had limitations in deriving significant conclusions owing to the lack of clinical evaluations or a small patient group [276].

The recurrence rate after a traumatic shoulder dislocation is lower in elderly patients because Bankart lesions are observed less frequently [209]. A study showed that as characteristics of recurrent anterior shoulder dislocation in older patients in the absence of rotator cuff tears, the prevalence of an isolated Bankart lesion was lower, and that of isolated and associated capsular tears was higher than those of younger patients. Thus, a capsular tear should be expected, and the anterior capsular mechanism should be evaluated meticulously [222].

The arthroscopic Bankart repair is still considered the gold standard of surgical treatment for recurrent glenohumeral instability, especially in patients with minimal or no glenoid bone loss. Solid documentation of the long-term results of the arthroscopic Bankart repair for recurrent anterior shoulder dislocation in patients at least 40 years of age, however, is unavailable [86].



A level 4 study showed that arthroscopic surgery for recurrent anterior shoulder instability after the age of 40 years showed significantly improved clinical outcomes [276]. The ROM revealed some limitations in forward flexion, external rotation at the side, internal rotation, and cross-body adduction. However, there was no significant loss of muscle strength at the last follow-up [276].

After multiple dislocations, stabilisation procedures are needed in addition to repair of the cuff, especially when preoperative CT or MRI has shown lesions of the glenohumeral ligaments, the glenoid labrum or both [114]. A re-evaluation of the patient after 3 months has been proposed to select the patients that have developed recurrent instability. These patients are candidates for operative treatment [324].

26. Is there an optimal method for labral fixation?

26.1 Statement

The literature regarding the optimal method for labral fixation across all age groups is scarce.

The consensus group recommends

- arthroscopic over open repair (Grade C)
- labrum and capsule release and mobilization until the subscapularis muscular fibers are visualized (Grade D).
- debridement of the anterior bony surface of the glenoid and glenoid rim (Grade D).
- create a bleeding bed into which the repaired tissue can better heal (Grade D).



- 3 anchors or passage of at least 4 sutures through soft tissue (Grade C).
- Inclusion of small glenoid bony fragments in capsulolabral repair (Grade C).
- To restore height and width of the labral tissue to create bumper effect (Grade D).

Median (range): 8.5 (5-9)

26.2 Literature summary

26.2.1 Adolescents (Best evidence: 1 retrospective comparative study, 1 retrospective clinical study):

The literature regarding optimal or even standard method for labral fixation is lacking. Recent advances in arthroscopic techniques have led to a shift to arthroscopic repairs over the open Bankart procedure. Varying results in functional outcome and redislocation rates are published comparing open and arthroscopic Bankart repair. Early reports criticized repair via arthroscopy due to significant recurrence rate compared with the open technique [126]. However, recent comparison showed no difference between open and arthroscopic soft tissue repair [318].

Searching the literature, there are insufficient data to suggest optimal method. Regarding arthroscopic technique there is no clear data to show advantage of patient position (beach chair vs lateral decubitus), number and position of portals, arthroscope used (30 deg vs 70 deg), usage of instruments for soft tissue mobilization, manipulation and penetration, anchors (number, position, type), sutures (number, type, configuration), knotted or knotless repair, appropriate vertical shift and soft tissue tightening; mentioning only some of them. However,



few necessary steps are nearly always mentioned: labrum and capsule release and mobilization until the subscapularis muscular fibers are visualized and debridement of the anterior bony surface of the glenoid and glenoid rim itself.

26.2.2 Young adults (Best evidence: 2 randomized controlled trials, 1 comparative study; 2 therapeutic Studies; 1 retrospective Study):

There are multiple techniques of labral fixation and surgical variations of Bankart procedure, either open or arthroscopic, described in the literature. Besides that, the goal is restoring the normal anatomy, reestablishing the labral height and width, recreating a normal glenohumeral biomechanics.

In a prospective randomized study by Fabbriciani et al. [88] comparing arthroscopic versus open treatment of Bankart lesions using 3 suture anchors, the arthroscopic repair with suture anchors showed to be an effective surgical technique for the treatment of an isolated Bankart lesion. Open repair does not offered a significantly better 2-year result.

In a prospective study by Uchiyama et al. [336] compared open Bankart repair plus inferior capsular shift versus arthroscopic Bankart repair without augmentations, authors method of repair included anatomical repair using two or three bio-absorbable suture anchors. The open repair was performed using bio-absorbable sutures. Open repair leaded to a lower rate of recurrent instability (0%) than arthroscopic repair (26.6%).

In their study, Aydin et al [7] showed higher recurrence rate in patients that underwent a modified arthroscopic Bankart repair with two knotless suture anchors and an additional capsular plication procedure comparing to repairs with three knotless suture anchors, suggesting that two anchor usage might not be sufficient for Bankart repair in terms of better stability and less recurrence risk.



Shim et al. [312] performed an evaluation of patients that underwent arthroscopic Bankart repair using suture anchors with an additional creation of a trough on the anterior glenoid rim. Minimum of 3 or 4 suture anchors were used. The first suture anchor was inserted onto the anterior glenoid rim at approximately the 5:30 / 6:00 o'clock position and the repair was performed with bioabsorbable suture anchors and capsular plication. The additional procedure did not improve clinical outcomes, however, at the final follow-up, patients with the trough showed less anterior apprehension. Overall, arthroscopic Bankart repair using suture anchors had relatively good clinical outcome, with a redislocation rate of 6.8%.

In a paper of Ozbaydar et al. [249] comparing the results of arthroscopic capsulolabral repair of Bankart versus ALPSA lesions, the authors used a mean number of anchors of 3.26 (range, 1 to 5), with 3.46 (range, 2 to 5) in the ALPSA group and 3.19 (range, 1 to 5) in the Bankart group. The first absorbable anchor was routinely placed at the 5-o'clock position or lower.

Desai et al. [67] performed a RCT evaluating arthroscopic Bankart repair with and without curettage of the glenoid edge. In their technique, the capsule-labrum complex was reattached using 3 bio-anchors from distal to proximal. In arthroscopic Bankart repairs, curettage of the cartilage on the anterior glenoid edge reduced the incidence of postoperative recurrence of instability.

26.2.3 Older adults (Best evidence: 2 case series, 1 cadaveric biomechanical study):

There is a lack of data in the literature and no definite answer to this question. However, an experimental study reported that in older people, calcification of tissues made the mid-substance of the capsule and subscapular tendon weaker. This contrasts with what happens to the younger subjects, where the weakest point is the attachment of the glenoid labrum. This



supposes that both capsular rupture and subscapularis tendon damage occurred at the time of an acute dislocation in older people [271].

Another study showed that as characteristics of recurrent anterior shoulder dislocation in older patients in the absence of rotator cuff tears, the prevalence of an isolated Bankart lesion was lower, and that of isolated and associated capsular tears was higher than those of younger patients. Thus, we should expect a capsular tear and meticulously evaluate the anterior capsular mechanism [222].

An open procedure that provides anterior stabilisation with capsular shift supplemented by Bankart repair has been proposed for middle-aged patients. Using only the anterior capsule for the shift, not the subscapularis tendon, does not compromise the subscapularis function [191]. This procedure also addresses the injury of the anterior capsulolabral complex and the co-exist massive rotator cuff tear. The capsule transfer is performed superiorly and posteriorly to close the defect in the cuff. In this way, a capsulodesis effect may be achieved that maintains the humeral head downward and produces re-centring of the head against the glenoid [191]. However, the recently proposed techniques of ASA and DAS should also be considered an alternative augmenting procedure of labral repair, even if no data is available for managing these patients' groups.

27. When should additional soft tissue procedure be added to the regular Bankart repair (remplissage/ASA/DAS or others)?

27.1 Statement



Both for a first time and a recurrent shoulder dislocation the decision for additional soft tissue procedures is based on the size and location of Hill-Sachs lesion, the anterior glenoid bone loss, the anterior glenoid soft tissue condition and on co-existing joint injuries. The purpose of additional soft tissue procedure is to lower the recurrence rate after Bankart repair in specific cases.

In the case of off-track Hill-Sachs lesion it could be argued that bony procedure is indicated, however if Bankart repair is chosen remplissage should be added to the regular Bankart repair (Grade B).

In patients with poor anterior soft tissue quality, an associated SLAP lesion or in overhead athletes, the DAS procedure could be considered. In patients with anterior soft tissue insufficiency and shoulder hyperlaxity ASA procedure as an augmentation of Bankart repair is a possible option. There is still limited evidence on both DAS and ASA procedures so they are not recommended for widespread use (Grade C).

Some surgeons would recommend systematically additional soft-tissue procedure to the regular Bankart repair (Grade D).

Older adults

In older adults, the Bankart repair is secondary and the focus should be placed at addressing the rotator cuff tear, whenever present (Grade C).

Median (range): 8 (3-9)

27.2 Literature summary



27.2.1 Adolescents (Best evidence: 1 cohort study):

The literature search for this specific age group reveals only one article about additional soft tissue procedures in addition to regular Bankart repair. Study compares arthroscopic Bankart repair with and without remplissage in patients with Hill-Sachs deformity [133]. The results show significantly lower recurrence rate in the group with remplissage but no difference in patient-reported outcome scores or In range of motion measurement between the groups [133]. Arthroscopic remplissage procedure seems to be effective surgical option in patients with Hill-Sachs lesion without significant glenoid bone loss also in adolescent population. However, literature search did not reveal information for other soft tissue procedures.

27.2.2 Young adults (Best evidence: 1 randomized controlled trial, 2 cohort, 3 case-control, 4 retrospective comparative, 1 retrospective case series, 2 systematic review, 1 narrative review):

The addition of soft tissue procedures in patients undergoing Bankart repair is relevant in some cases to decrease the likelihood of re-dislocation. Bah et al. compared the outcomes of arthroscopic Bankart repair plus remplissage to the Latarjet procedure in a sample of patients aged 16 to 37 years [10]. The authors used the remplissage technique in cases of Hill-Sachs greater than 30% of the joint surface and/or intraoperative engagement of the lesion. All patients had glenoid bone loss less than 30% according to the modified Sugaya index. The authors found no significant differences in functional outcomes and recurrence rates, but the remplissage group had loss of external rotation and residual pain more commonly than the Latarjet group [10]. Cho et al. evaluated the effects of remplissage on the outcomes after



arthroscopic Bankart repair in a series of patients aged 14 to 46 years (mean 26) with engaging Hill-Sachs and glenoid bone loss of less than 25% [54]. The mean depth of the Hill-Sachs (measured through the CT scan) was 6mm in the Bankart and 6.8mm in the Bankart plus remplissage group (range 4-11mm), while the mean glenoid bone loss was 9.9% and 8.5% (range 0-22%), respectively. The authors found that the recurrence rate was significantly lower in the Bankart plus remplissage group, while the improvement of functional outcomes was similar. They found a greater limitation in the external rotation within the Bankart plus remplissage group that was not significant between groups. The lower recurrence rate by adding the remplissage procedure to the Bankart repair was also concluded in a previous systematic review from Hurley et al. [143]. Other authors have failed to identify differences in recurrence rates between Bankart alone and Bankart plus remplissage [241]. The ISIS score was used for decision making, with <4 being treated with Bankart repair alone, and 4 or more with Bankart and remplissage. However, the degree of Hill-Sachs was not considered but only its presence or absence. The authors did find a higher posterosuperior pain in the remplissage group.

The engagement might be a more predictable and clinically relevant concept than the off-track/on-track. Park et al. found no differences in recurrence rate and clinical outcomes between patients with off-track and on-track lesions undergoing Bankart repair [254]. However, remplissage was added to those patients with engagement, likely explaining the absence of between-group significant differences.

Cho et al. also compared the outcomes between Bankart plus remplissage and Latarjet procedures in a sample of patients aged 14 and 52 years, with similar values of Hill-Sachs lesion size and glenoid bone loss[55]. The authors found similar outcomes in terms of function (Rowe and UCLA scores) and recurrence, with higher complication rate in the Latarjet procedure. Another systematic review and meta-analysis obtained a similar



conclusion. Engaging Hill-Sachs lesions (in the setting of subcritical glenoid bone loss) can be effectively treated by adding a remplissage procedure to the regular Bankart repair [122]. The effectiveness of this procedure was comparable to the Latarjet procedure. Some authors have found significantly higher rates of subjective instability after Bankart plus remplissage compared to Latarjet [262]. However, the former had significantly higher percentage of patients with off-track Hill-Sachs lesions compared to the latter.

Other studies have also evaluated the effects of other soft tissue procedures. Ren et al. compared the clinical and functional outcomes between the modified arthroscopic subscapularis augmentation plus Bankart repair and Bankart repair alone [273]. The patients had Hill-Sachs lesions less than 20% of the humeral head (and glenoid bone loss less than 25%) and mean age between 27 and 30 years for the 2 groups. The subscapularis augmentation group had better outcomes (ASES, VAS, OSISs), return to sports, and lower postoperative recurrent instability compared to the Bankart repair alone. Russo et al. compared the outcomes of Bankart repair and subscapularis augmentation with open Latarjet [295]. The patients (aged 18 and 39 years) had a Hill-Sachs >33% of the humeral head diameter and glenoid bone loss between 5 to 23% (evaluated with the Pico method). The authors found similar clinical and functional (Quick-DASH, Rowe, and Constant score) outcomes between the 2 groups. Salomonsson et al. compared function and strength after Bankart repair or Putti-Platt procedures in a randomized controlled trial [301]. They found no differences in the outcomes, but no mention was given to the humeral head bone loss.

There are other soft-tissue procedures that can be added to a regular Bankart repair or stand-alone. Dynamic anterior stabilization is a relatively recent technique consisting on transferring the long head of biceps (or conjoint tendon) to the anterior glenoid, thus creating the “sling” effect of the Latarjet procedure without the risks and difficulties of the coracoid transposition [62,353]. De Campos and Ângelo reported the outcomes of onlay dynamic anterior



stabilization in a group of patients with recurrent anterior shoulder instability and a mean age of 23.4 years with mean Hill-Sachs interval of 15mm, mean glenoid track of 18.8mm, and <20% of glenoid bone loss [62]. Despite one patient with hyperlaxity redislocated (6.7%), the authors observed a significant improvement in WOSI index and Rowe score, significant improvement in range of motion, and 100% return to play (60% at the same level), without complications and 100% biceps healing. Wu et al. compared the redislocation rate, complications, return to sports, and subjective shoulder function between patients undergoing dynamic shoulder stabilization with the long head of biceps or the conjoint tendon for recurrent anterior shoulder instability [353]. The patients had a mean age of 26 years and glenoid bone loss <15%. There were no significant differences in the outcomes between the two versions of dynamic anterior stabilization [353].

In conclusion, it seems that the remplissage procedure should be added to the regular Bankart repair in cases of off-track or engaging Hill-Sachs lesions with glenoid bone loss <20-25% [144]. In recurrent anterior shoulder instability with Hill-Sachs intervals of 15mm or less, and glenoid bone loss of 20% or less, the dynamic anterior stabilization with the long head of the biceps is a very pertinent option that can be also added to a regular Bankart repair.

27.2.3 Older adults (Best evidence: 1 cohort study, 1 case series study):

Increased patient age is generally considered protective against recurrent instability in the native shoulder and after an arthroscopic Bankart repair. However, patients ≥ 30 years of age treated with an isolated arthroscopic Bankart repair demonstrated a higher-than-expected recurrent instability rate (37%) at a mean follow-up of 12 years [85]. In addition, in a level 3 study, the long-term results of the classic arthroscopic Bankart repair for recurrent anterior instability in patients older than 40 years without chronic rotator cuff pathology showed a



25% of recurrent dislocation or subluxations and a 20% revision rate attributed to recurrent instability [66]. Augmentation of the stabilisation may need to be considered for managing these patients.

Two prognostic factors were found to be associated with failure. They may be considered a contradiction for an isolated arthroscopic Bankart repair stabilisation in this group of patients: ISIS score ≥ 3 and deep Hill-Sachs lesions $\geq 15\%$. 83% of patients with a preoperative ISIS score ≥ 3 developed recurrent instability versus 26% of the patients with a preoperative ISIS score < 3 ($p=0.02$). 47% of the patients who had a preoperative Hill-Sachs lesion $> 15\%$ developed recurrent instability versus 17% of the patients with a preoperative Hill-Sachs lesion $\leq 15\%$ ($p=0.001$) [85].

The limit for abandoning the augmentation of the classic Bankart repair with soft tissue procedures and selecting a bony procedure is not defined in the literature, not only for these patients' groups but also in the total instability cases. However, long-term results of the open Latarjet in patients older than 40 years at the time of surgery showed reliably restored stability and good to excellent function. However, one-third of the patients had advanced but clinically mild symptomatic arthropathy [66]. This should be taken into consideration for this specific age group.

28. What are the indications/contraindications for bone augmentation/Latarjet procedures after a first-time anterior shoulder dislocation?

28.1 Statement



A bony procedure is recommended in cases of a glenoid bone defect cut-off of 20% in adolescents and young adults (Grade B).

Patients with subcritical bone loss (10-15%) may require a bony procedure, especially in cases of significant bipolar bony injuries or other risk factors (Grade C).

Some surgeons would recommend systematically bony procedure and have no indications for soft-tissue procedure (Grade D).

The practice of collision sports, younger age or hyperlaxity can lower the threshold for a bone procedure even in patients with limited glenoid bone loss (Grade C).

Adolescents

In the adolescent patients the risk of bone loss, both on the glenoid and humeral side is increased when compared to the adult population (Grade B).

The threshold for the Latarjet procedure after first time dislocation in this group of patients should be high with the possible exception of high-risk contact sports (Grade D).

Older adults

Bone augmentation procedures after a first-time anterior shoulder dislocation have never been investigated specifically in this age group. The indication for a glenoid bone augmentation procedure in this age group after a first-time anterior shoulder dislocation is rare but might be performed in selected cases (Grade D).

Median (range): 8 (7-9)



28.2 Literature summary

Regarding bone augmentation:

28.2.1 Adolescents (Best evidence: 1 retrospective comparative study and 1 retrospective clinical study):

Bone loss on the glenoid or humeral site (Hill Sachs defect) is very common in adolescent patients with an increased risk of 9x compared to adults. In the presence of an off-track lesion, surgical bone augmentation procedures are recommended if reconstruction is not suitable [186]. Glenoid bone loss (>25%) was considered significant in the decision making to opt for bone augmentation procedure [187].

28.2.2 Young adults (Best evidence: 2 systematic review)

A limitation to answer this question regarding the indication and contraindication is the lack of randomized controlled trials in the literature which analyzed specifically this point for bony. This type of procedure is more commonly performed and evaluated for patients with recurrent anterior shoulder instability or after a failed previous surgery. In the literature conservative management, arthroscopic soft tissue procedures and Latarjet procedure represents almost all the proposed treatments for patients after a first-time anterior shoulder dislocation and seem to remain the gold standards. Therefore, most of the answers concerning the possible results of the bony procedures for first-time anterior shoulder dislocation must be extrapolated from the results of studies that explored recurrent anterior shoulder instability.



It has been established that nonoperative management for first-time anterior dislocations results in lower rates of return to play, with higher rates of recurrent instability. Stabilizing bony procedures that have addressed glenoid bone loss include the Bristow procedure, the Eden-Hybbinette procedure, Latarjet procedure, autogenous bone grafting and distal clavicle. These techniques are proven to be biomechanically superior compared to soft tissue procedures. Although these procedures have low recurrence rates, they have so many complications such as chronic painful anterior shoulder instability, degenerative changes of the glenohumeral joint, complications related to the coracoid transfer (non-union), hardware failure, neurovascular injury (axillary or musculocutaneous nerve palsy), and posterior instability.

The benefit in terms of large available size of reconstruction when using a bony procedure nevertheless lack the benefit of the soft tissue buttress provided by the conjoint tendon in the Latarjet or the Bristow procedure.

Longo et al in their systematic review with 27 articles included aimed to establish which percentage of glenoid or humeral bone loss needs to be treated with a bony procedure to avoid recurrence of dislocation. They found that patients with a glenoid bone loss $> 25\%$ were mainly managed with a bone graft during an open reconstruction (37% of the cases) while Bristow and Latarjet procedures were less frequent (respectively 26% and 22%) [202]. Unfortunately, the percentage of patients treated was not specify in the study.

In another systematic review, Longo et al found that Eden-Hybinette had superior result in anterior instability compared to the Bankart procedure and similar results with the Bristow-Latarjet procedure but still, no specific attention was given in the results to differentiate first-time and recurrent anterior shoulder instability [201]. They found a recurrence rate for this procedure of 9,8% (19 of 192).



28.2.3 Older adults (Best evidence: none):

Regarding the indications/contraindications for bone augmentation procedure after first-time anterior shoulder dislocation in older patients, no data are provided for the published-included studies. Using a free bone graft at the glenoid side in older patients with first-time anterior shoulder dislocation is almost impossible. In these patients, a bone augmentation could be necessary on the humeral side.

Regarding Latarjet:

28.2.1 Adolescents (Best evidence: 1 comparative study, 1 case series, 1 narrative review):

We found sparse information regarding indications/contraindications of the Latarjet procedure in this age subgroup for a first-time anterior dislocation. Recurrence after a first time dislocation in this specific age group is particularly high when compared to older patients, either if treated conservatively or surgically. In a retrospective study of prospectively collected data including 133 adolescents diagnosed with a primary anterior dislocation and treated conservatively, Roberts and colleagues reported a recurrence rate of 76.7%, concluding that these patients should be considered for early operative stabilization [277]. Similarly, in a prospective cohort study involving patients between 15 and 18 years old, the authors concluded that conservative treatment after a first traumatic shoulder dislocation leads to unacceptable high failure rates [103].

In a case series of prospectively collected data involving adolescent rugby players treated with an arthroscopic labral repair, the authors reported that the excluded patients with >20% of glenoid bony lesion were treated with a bone block procedure, but the study mentions no



results regarding these patients. In this same paper the authors discuss that the role of bony surgery in the adolescent immature skeleton has not been defined in the literature, and the longer-term outcomes and complications remain uncertain [333].

28.2.2 Young adults (Best evidence: 3 comparative studies, 1 retrospective study, 3 case series, 2 narrative reviews):

In first time anterior shoulder dislocation most surgeons would consider a soft tissue procedure. However, there are cultural differences from country to country and for different kind of sports. The limit for performing a bony procedure can be argued by glenoid bone loss and/or a threshold in the ISIS score. Even though the ISIS score is widely used to predict recurrence after arthroscopic surgery its reliability and cut off values are questionable. Oh et al. found no difference in ISIS score between groups with recurrence compared to groups with no recurrence in a series of retrospectively reviewed patients [243].

Hardy et al. compared the outcome after Latarjet procedure in patients operated after the first dislocation to patients operated with Latarjet after recurrent dislocations [120]. They concluded that the number of episodes of dislocation before surgery does not affect postoperative instability rates and reoperation rates after the Latarjet procedure. However, patients with first-time dislocations had more postoperative pain compared with patients with recurrent dislocations before surgery [120].

A glenoid defect of 13.5% has been recognised as a sub-critical glenoid defect for which an arthroscopic Bankart is contraindicated in collision/contact athlete or military personnel. If patients have a subcritical bone loss and a remaining large bony fragment Nakamura et al published low recurrence rates even in athletes [230].



Bipolar bone defects are smaller in shoulders with primary instability compared to recurrent instability. The post-operative recurrence rate has been proven to be low in first time instability regardless the size of the bipolar defect and the patient's age [232]. Post-operative recurrence is found to be influenced by the size of the pre and post operative size of bipolar bone defects [235]. (Level 3)

In rugby players the risk of recurrence and subsequent the need of reoperations is higher in patients operated with arthroscopic Bankart procedure compared to Latarjet even if the glenoid bone loss is limited $< 20\%$. Both the arthroscopic Bankart and the Latarjet can produce excellent functional outcomes and most athletes returning to sport at the same level they had before injury. In a follow up of 80 Bankart and 50 Latarjet patients after mean 40 months, Rossi et al. reported 20% of recurrence and 16% of reoperations in the Bankart group compared to 4% recurrence and 4% reoperations in the Latarjet group [286]. Return to sport was allowed when the patient was pain free, full shoulder ROM had been achieved, and shoulder strength was near the same as before the injury [286].

Yamamoto evaluated the effect of subcritical glenoid bone loss on clinical scores [356]. Patients with bone loss of more than 17% had significantly lower WOSI scores compared to patients with bone loss of $< 17\%$. This indicates that patients with higher percentage of bone loss will have inferior clinical scores even though they do not have recurrence of instability in form of new luxations or subluxations [356].

It is important to distinguish between hyperlax patients and voluntary dislocators. In the voluntary dislocators, Latarjet is contraindicated because laxity is difficult to correct by surgery. The results reported in this group are poor [342].

Contraindications to perform the Latarjet procedure is an issue in patients older than 20-40 years. In older patients we may observe poor quality of the bone and accelerated degenerative changes which are concerns to be addressed before Latarjet. After performing Latarjet in



older patients, situations of static anterior instability with subluxation and progressive osteonecrosis have been observed. Another complex situation in the same group are situations of irreducible inferior subluxation of the humeral head as a result of the non-elastic part of the subscapularis, which is pulled down by the transferred coracoid and the conjoined tendon and consequently allows permanent and irreducible humeral head subluxation [73]

Walch et al recommend primarily treating the instability in patients where the rotator cuff is not repairable. In this situation the Latarjet is contraindicated. A Trillat procedure might be tried to restore the stability. If this fails, the reversed shoulder arthroplasty remains the only option. (Level 4)

28.2.3 Older adults (Best evidence: 1 case series study):

Shin et al. describe one patient with an engaging Hill-Sachs lesion, and they performed a Latarjet procedure after the first time anterior shoulder dislocation [316].

Therefore, there is a lack of consensus regarding the indications/contraindications for the Latarjet procedure after first-time anterior shoulder dislocation in older patients. Probably in older patients with first-time shoulder dislocation with a huge Hill Sachs Lesion and a good subscapularis tendon, a Latarjet procedure could be considered.

29. What are the indications/contraindications for bone augmentation/Latarjet procedure after recurrent anterior shoulder dislocation?

29.1 Statement



A bone augmentation procedure is indicated in patients with traumatic recurrent anterior shoulder dislocation and a critical glenoid bone loss (>20) (Grade B).

It can also be an option in cases of subcritical (10-15%) glenoid bone loss, especially with a concomitant off-track Hill-Sachs lesion (Grade B). The practice of collision sports, younger age, hyperlaxity and failed previous soft tissue procedure can lower the threshold for a bone procedure even in patients with limited glenoid bone loss (Grade C).

Some surgeons would recommend systematically bony procedure and have no indications for soft-tissue procedure (Grade D).

Older adults

There is limited evidence on indications/contraindications for bone augmentation procedures after recurrent anterior shoulder dislocation in this age group. It is mainly performed in the setting of subcritical/critical glenoid defects. Osteoarthritis represent the main contraindication (Grade D).

Median (range): 9 (7-9)

29.2 Literature summary

Regarding bone augmentation:

29.2.1 Adolescents (Best evidence: 3 retrospective clinical studies, 1 systematic review):



The general indications for Latarjet procedure found in the current literature were: 3 or more episodes of dislocation, symptomatic recurrent traumatic instability with either soft tissue (Bankart lesion) or less than 10-15% of glenoid bone deficiency (bony Bankart, glenoid erosions) associated with any size Hill-Sachs lesions, Instability Severity Index Score (ISIS) equal to or greater than 5 or critical glenoid bone deficiency (>15-25%) [71,162,170,309]. When it comes to bone development, one study also took into consideration for this type of procedure skeletally immature patients. The same study also reported a high return-to-sport rate (the same level of sport) after surgery, suggesting that Latarjet procedure could play a role in some athletic young patients [162].

No information was found in the current literature about the contraindications of Latarjet procedure or about the indications/contraindications of any other bone augmentation procedure.

29.2.2 Young adults (Best evidence: 1 prospective randomized trial, 1 cohort study, 2 retrospective comparative studies and 1 systematic review):

The choice between soft tissue procedure, Latarjet procedure and bone augmentation techniques depends on several factors, including the size and location of the bone defect, the patient's age and activity level, the surgeon's experience and preference, and the presence of other shoulder pathology.

If the Latarjet procedure remains the gold standard for glenoid reconstruction in case of bone loss, the use of bone graft has recently gain in interest in the literature due to some issues as the relatively high rate of complications, the need to split the subscapularis muscle and to transfer the coracoid process. Rerouting the conjoint tendon, especially in case a previous failed Latarjet remains also a concern.



Glenoid reconstruction with bone augmentation with autograft or allograft is a technique which aims at anatomically augment bone defect reconstruction. The bone augmentation techniques present the advantage to preserve the subscapularis muscle and to ensure an appropriate graft sizing to perform an anatomical graft reconstruction.

Razaeian et al. evaluated open Latarjet procedure versus all arthroscopic autologous tricortical iliac crest bone grafting for anterior inferior glenohumeral instability with glenoid bone loss and found comparable clinical outcomes except for significantly better Rowe score, Rowe-range of motion, WOSI physical symptoms subdomain, and internal rotation capacity in the AICBG group at an average FU of 34.9 months [270].

Moroder et al. [225] performed a prospective randomized study on patients with anterior shoulder instability and glenoid bone loss who were randomized to either an open Latarjet or an open iliac crest bone graft transfer (J-bone graft) and found no difference in clinical and radiologic outcomes between the both techniques with a 24 months follow-up (except for significantly worse internal rotation in the Latarjet group and more frequent donor site morbidity in the ICBGT group).

Frank et al. evaluated the outcomes of Latarjet versus distal tibia allograft (DTA) for anterior shoulder instability repair in a matched cohort analysis and found similar clinical outcomes for the both procedure in patients with anterior glenoid bone loss $> 15\%$ of the glenoid area at 45 +/- 20 months after surgery [93]. In their study, DTA was recommended as opposed to Latarjet if bone loss was $> 25\%$, in case of failed prior Latarjet or if there was a significant cartilage component associated with the osseous defect. Patients undergoing either procedure experience a relatively low overall complication rate (10%) with an equal number of complication and reoperations in each cohort. The availability of DTA in some regions must nevertheless be considered has a potential limitation for this technique.

Cut-off for bone augmentation procedure:



Malahias et al. evaluated iliac crest bone grafting for the management of anterior shoulder instability in patients with glenoid bone loss in a systematic review of contemporary literature [212]. They demonstrated that this procedure was safe and effective in short-term (<4 years) for patients with substantial glenoid bone loss.

Iizawa et al. evaluated clinicals results of an arthroscopic Bankart repair with or without arthroscopic bone graft augmentation and demonstrated its beneficial effect in case of glenoid bone loss especially in recurrent instability in contact/collision athletes with bone loss > 20% after at least 2 years after the surgery [145].

As mentioned before, Frank et al. recommended the use of bone augmentation with distal tibia allograft in patients with a glenoid bone loss > 25% [93].

29.2.3 Older adults (Best evidence: 1 case series):

There is a lack of consensus regarding the indications/contraindications for bone augmentation procedure after recurrent anterior shoulder dislocation. A very interesting statement regarding the necessity of bone augmentation comes from Ro et al. [276]. The authors described in his series 24% of them had glenoid defect without significant glenoid bone loss (glenoid deficit <25%), and the mean number of dislocations of the group with glenoid defect was 31.7, thus demonstrating a significantly higher frequency of dislocation compared with the 13.6 times shown by the group without glenoid defect ($P = .003$). Nevertheless, glenoid defect had no significant effect on postoperative recurrence ($P = .458$). This statement is reported only for patients >40 years old [276].

Regarding Latarjet:



29.2.1 Adolescents (Best evidence: 1 comparative study, 1 case series, 2 narrative reviews):

For skeletally immature patients with anteroinferior capsulolabral or bony injuries, Doms et al. found that the open Latarjet procedure provides a low rate of recurrent instability, with acceptable radiographic results and low complication rates at a mean 6.6 years of follow up [71]. The same authors reported this procedure as an effective and safe treatment option for shoulder instability without any significant glenoid growth disturbance or deformity in adolescent patients [71]. Another indication for Latarjet procedure in this particular population was the presence of more than one episode of recurrence [162].

Regardless of the maturity of the skeleton, in the adolescent population with glenoid bone loss greater than 25%, the surgical treatment of choice was the Latarjet procedure [170,186].

29.2.2 Young adults (Best evidence: 5 systematic review 1 randomized controlled trial, 3 prospective case series, 12 retrospective case series):

Glenoid bone augmentation procedures, in particular the Latarjet procedure, have been extensively used since their development in the mid-twentieth century. They are very popular and there is no subset of patients with recurrent anterior shoulder instability in which good outcomes have not been reported with these procedures. Defining whether these procedures are indicated or not can only be done stratifying the studies according to different populations. The Latarjet procedure can be used in most patients with recurrent anterior dislocation. Studies in unselected patients comparing an isolated Bankart repair with an open Latarjet procedure at mid-term follow-up (6 years) have shown that the recurrence rate was half in the Latarjet group with improved Rowe scores. Younger age worsened the results in both groups but practice of competitive sports and shoulder hyperlaxity only worsened the outcomes in the



Bankart group [21]. A systematic review performed by Imam et al. focused in studies that compared patients treated with either Bankart repair or Latarjet [146]. They included 7 studies including more than 3000 patients. They found that the Latarjet procedure was clearly superior regarding recurrence but had an increased risk of infection. The effect was especially pronounced when long-term data (6-10 years) was analyzed [146].

In subjects participating in contact or high level sport the Latarjet procedure seems to work as well as in the general population with recurrence rates below 5% at 4 years follow-up [15]. Even when a bone defect is present the good outcomes seem to be maintained [18] and are clearly superior than those found with Bankart procedures that had a clearly increased rate of recurrence (19% vs.0%) that worsened with time. In contrast Latarjet procedures had way more complications (16% vs 2%) [263].

The degree of glenoid bone loss does not seem to affect dramatically the outcomes of arthroscopic Bankart repair. If no bone loss is present similar clinical outcomes to Bankart repair can be expected with less loss of external rotation [63]. When a large glenoid bone defect (>20%) there is good reason to use a bony procedure, in particular if contact sports are involved the Latarjet procedure has better recurrence rates [286]. It should be noted that there are many studies that compare the short term outcomes of different glenoid bone graft techniques vs. the traditional Latarjet procedure and they seem to obtain similar results. [46,93,225]. For subcritical glenoid bone loss (13.5%-20%) Bankart repair might provide better return to sport and subjective perception of the shoulder compared to Latarjet but that recurrence might be higher [27].

A large Hill-Sachs defect seems not to be by itself an indication for a Latarjet procedure as the outcomes of a Bankart repair plus remplissage seem comparable to an open Latarjet procedure with low and similar recurrence rates. However, loss of external rotation and residual pain seem to be significantly more common with the combined Bankart-remplissage



procedure [9]. Furthermore, the Latarjet procedure is associated with way more complications (14% vs 0%) [53].

If a combined bone defect is present, the Latarjet procedure is effective with subjects with smaller glenoid defects (<25%) obtaining similar outcomes as those with larger defects (>25%) [357]. Care should be taken to address patients with large combined glenoid-humerus bone loss that are still off-track after the Latarjet procedure as these seem to fair poorly [44].

To finish a specific subset of patients with glenoid bone defects are those with a bony Bankart. Classically the outcomes of these subjects after arthroscopic Bankart repair were considered to be worse than those obtained with a Latarjet procedure [101] but healing of the Bony Bankart after arthroscopic repair seems to improve greatly the outcomes [235] reducing the recurrence rate [230].

In patients with epilepsy the arthroscopic Latarjet procedure has similar outcomes as in subjects without epilepsy. Epilepsy did not worsen clinical outcomes or recurrence rates, irrespective of the initial glenoid bone loss or the recurrence of epilepsy [78].

There is controversy on whether the Latarjet procedure should be performed open or arthroscopically.

Two systematic reviews found limited differences. The arthroscopic technique yielded significantly superior results for the non-union rate of the graft, the total graft osteolysis/resorption, the mean Western Ontario Shoulder Instability Index score and the early postoperative pain [213] but more residual apprehension [137].

29.2.3 Older adults (Best evidence: 3 case series):

Ro et al. (2019) used the Latarjet procedure only in revision cases regardless of the initial glenoid defect during the first (Bankart) operation [276]. Domos et al. propose the Latarjet



procedure in patients >40 years old with either soft-tissue Bankart lesions or glenoid bony lesions. The study comes from France, where the surgeons perform approximately in all cases a Latarjet procedure [72]. Ernstbrunner et al. performed the Latarjet procedure in primary or revision cases [86]. However, the authors performed a pre-operative CT scan and measured glenoid bone loss with the PICO method. Their indication for primary Latarjet was the 15% glenoid bone loss (15-29%) or heavy labour and all revision cases (glenoid bone loss 4-17%). The shoulder arthropathy >4 Samilson Pietro was a contraindication for the Latarjet procedure. The mean number of recurrent anterior shoulder dislocations before the Latarjet was 17(2-90) [86]

Therefore, as we can see from the published literature, the Latarjet procedure remains the first choice for French surgeons regardless of the defect. However, for the rest of the world, the indication seems to be the same as for the younger population:

- The revision cases
- The Subcritical bone loss (15%)
- The type of the work (heavy labour).

The main contraindication is the presence of arthritic changes in the glenohumeral joint (mainly Samilson Pietro classification >4).

30. What type of immobilization is recommended after soft tissue procedures (position and timing)?

30.1 Statement

There are no high-level studies providing the answer. The consensus group recommends the use of a simple sling for a period of 3-4 weeks after soft tissue procedures. Exercises usually



start a few days after surgery. The range of motion should be limited to maximum shoulder height in forward flexion and abduction and 20 degrees of external rotation for the first 4 weeks after surgery. From 4 weeks on the range of motion increase as tolerated. Strengthening exercises are recommended from 8-12 weeks after surgery. (Grade D)

Median (range): 9 (7-9)

30.2 Literature summary

30.2.1 Adolescents (Best evidence: 1 prospective study, 1 retrospective comparative study, 2 systematic reviews):

There is considerable variation regarding reported postoperative guidelines [206]. Position and timing of immobilization after soft tissue procedures was not evaluated in a scientific manner measuring its effect and comparing different immobilization protocols. However, some examples are published as being used in the studies evaluating arthroscopic soft tissue stabilization procedures. Postoperative care usually consist of immobilization in a neutral rotation sling for 4 weeks [187]. One study reported immobilization in a sling with the arm in 15 deg of abduction and 15 deg of external rotation [187]. Systematic review of 17 studies evaluating postoperative management following arthroscopic soft tissue stabilization in adolescent and young adults reported most common duration of immobilization 4 weeks (47%) [167]. In the same systematic review, position of immobilization was specifically listed in only 5 studies and varied among them from position in adduction and neutral rotation to abduction pillow and shoulder immobilizer in 30 deg of external rotation. Additionally, specific guidelines for postoperative ROM restriction was described in the studies. Restrictions



varied from prohibiting all ROM, active assisted motion, active motion, passive motion, external rotation, abduction, and flexion/extension between 2 and 12 weeks, most commonly suggested 4 weeks. There was no consensus among the studies about the duration of restriction, type of motion restricted or plane of motion restricted. Initiation of muscle strengthening is suggested between 4 and 12 weeks, typically the rotator cuff, deltoid and periscapular muscles. Example of well described supervised protocol suggests sling to be worn all time except during exercises; passive ROM in scapular plane and pendulum exercises in the first week; active assisted ROM in external rotation and forward flexion in the third week; discontinuation of sling at 4 weeks; active ROM in all planes at the six weeks. Protocol is followed by gradual strengthening exercises after six weeks, proprioceptive exercises at 12 weeks and gradual recruitment into sports-specific programs at this point [250].

30.2.2 Young adults (Best evidence: 3 prospective randomized controlled trial, 1 prognostic case series, 2 retrospective comparative study, 1 prospective comparative study, 2 cohort study):

Most authors recommended a use of a simple sling for a mean period of 1 to 3 weeks, some with zero degrees of abduction, others using abduction slings. There are no studies comparing different times of immobilization and their impact on functional outcomes.

In a prospective randomized clinical study by Kim et al. [168], they found that early mobilization of the operated shoulder after arthroscopic Bankart repair, comparing with immobilization in an abduction sling, does not increase the recurrence rate. Although the final outcomes are approximately the same, the accelerated rehabilitation program promotes functional recovery and reduces postoperative pain, which allows patients an early return to desired activities.



In a study by Jakobsen et al. [153] comparing primary repair versus conservative treatment after arthroscopic Bankart. This study found significantly more redislocators after conservative treatment than after repair. Patients used a nonfixed sling for 1 week, after which both groups underwent an identical rehabilitation program consisting of passive movement immediately postoperatively.

In 2012, Aechetti et al. [6] performed a Randomized Clinical Trial comparing open versus arthroscopic Bankart repairs. In the first 7 postoperative days, a sling was used continuously. From the seventh day on, the patients were advised to maintain discontinuous immobilization for 3 more weeks. In the fourth week, immobilization was eliminated, and progressive range of movement was gained in all participants. Both open and arthroscopic techniques were effective.

In 2016 Cho et al. [52] performed a comparison study in collision athletes versus noncollision athletes that underwent arthroscopic stabilization. A high recurrence rate (17.2%) was observed among athletes. Compared with the noncollision group (6.7%), the collision group yielded a higher failure rate (28.6%). Immobilization was provided for 3 weeks after arthroscopic surgery in both groups.

A paper of Park et al. [259] evaluated the clinical outcomes and recurrence rates after arthroscopic Bankart in patients with a glenoid bone erosion. Even with more than 20% there were satisfactory clinical outcomes and recurrence rates, although these results were inferior to those of patients with glenoid erosions less than 20%. In both groups patients were immobilized postoperatively for 4 weeks with an abduction brace.

Uchiyama et al. [336] also compared open versus arthroscopic repairs in their RCT. Their data suggested that open repair leads to a lower rate of recurrent instability. However, those with arthroscopic Bankart had fewer ER and horizontal extension limitations. In both groups,



a shoulder sling/immobilizer was used for 4 weeks after surgery, during which time active use of the upper extremity below the elbow was encouraged.

Aydin et al. [7] compared the complication rates and clinical results of labral repair with two suture anchors and capsular plication, and labral repair with three suture anchors fixation in arthroscopic Bankart surgery. Two-anchor usage was associated with higher recurrence rates. In both groups the arm was maintained in a simple arm sling for three weeks on postoperative period.

Nakagawa et al. [231] evaluated the influence of bipolar bone defect size in postoperative recurrence after arthroscopic bankart repair in shoulders with primary instability compared with recurrent instability. The recurrence rate was consistently low in patients with primary instability and was significantly influenced by bipolar bone defect size and patient age in patients with recurrent instability. Patients wore a brace (allowing 90° of internal rotation and 0° of abduction) for 4 weeks postoperatively.

In 2021, Rossi et al. [287] compared the recurrence rates with arthroscopic Bankart repair versus Latarjet procedure in competitive rugby players with a glenoid bone loss <20%. Both arthroscopic Bankart and the Latarjet procedure produced excellent functional outcomes, with most athletes returning to sport at the same level. However, the Bankart procedure was associated with a significantly higher rate of recurrence and reoperation. In both groups, the arm was supported in a sling for 4 weeks.

30.2.3 Older adults (Best evidence: 4 case series studies, 2 comparative/cohort studies):

Ernstbrunner et al. used a sling for 4 weeks, and only pendulum exercises were allowed for the first 6 weeks [85]. Araghi et al. proposed using an arm sling for 3 weeks after open bankart repair. Then they started FF, ER, and IR — six weeks post-op isometric exercises and



then resistive exercises [5]. Delgrande et al. proposed using a sling for 4 weeks, then active assisted motion, and, at 6 weeks, active range of motion and strengthening [66]. Maier proposed using an arm sling for 3-4 weeks, but the passive range of motion and the self-assisted exercises began on the 3rd post-op day [209]. However, the technique of the surgical technique is not described at all.

Porcellini et al. reported that the postoperative management was similar for all patients with isolated labral or capsular lesions with or without lesions of the rotator cuff and with isolated cuff lesions [265]. The shoulder was maintained in an immobilizer (DonJoy Ultra Sling II; Smith & Nephew DonJoy, Carlsbad, CA) for 3 weeks. Patients then began assisted passive mobilization avoiding external rotation for 5 weeks. After 5 weeks, they began active exercises in a pool and passive mobilization in external rotation, and at 8 weeks, strengthening exercises with a rubber band. Activities of daily living were permitted after 10 weeks. Plain radiographs were taken in the immediate postoperative period and then at 12 and 24 months [265].

Sperling et al. reported 11 shoulders that underwent open (6 patients) and 5 arthroscopic repairs [326]. In some cases, the authors immediately started the passive range of motion. In other cases, the patients were immobilized for 3 or 6 weeks. It is unclear which patients followed different protocols and for what reason. Also, the type of immobilization is not clear [326].

From the published studies, most authors prefer to use only a simple arm sling for immobilization after a soft tissue procedure. The duration is between 3-4 weeks of usage. However, there is a lack of consensus regarding the start of passive ROM exercises. Some authors start immediately, while others wait for 3-4 weeks post-operatively.



31. What type of immobilization is recommended after bone augmentation/Latarjet procedure (position and timing)?

31.1 Statement

There are no high-level studies providing the answer. The consensus group recommends the use of a simple sling for a period of 2-4 weeks after bony procedures (Grade D). Exercises usually start a few days after surgery. The range of motion should be limited to maximum shoulder height in forward flexion/abduction and 20 degrees of external rotation for the first 4 weeks after surgery. From 4 weeks on the range of motion increase as tolerated. Strengthening exercises are recommended from 8-12 weeks after surgery. (Grade D)

Median (range): 8 (7-9)

31.2 Literature summary

31.2.1 Adolescents (Best evidence: 2 retrospective comparative study, 1 systematic review):

Postoperative rehabilitation following Latarjet and bone augmentation procedures was recommended to include minimum 2-6 weeks of sling immobilization (adduction and internal rotation), passive exercises until recovery of free range of motion [45,70,309]. Active-assisted range of motion was initiated 3 days following surgery, active range of motion was allowed 6 weeks postoperatively [70]. Strengthening was initiated 8 weeks postoperatively [70]. Progressive return to sporting activities and contact sports was allowed at minimum 3 months



postoperatively after clinical and radiological evaluation (confirms satisfactory healing of the bone graft) [45,70].

31.2.2 Young adults (Best evidence: Best evidence: 1 randomized controlled trial, 1 systematic review, 1 expert opinion):

There is a lack of well-conducted and dedicated studies to evaluate the position and timing of immobilization after bone augmentation or Latarjet procedures. Despite there are level-I studies being currently conducted [107], there is still inconclusive or not definitive evidence. Although immobilization has not been specifically studied in patients undergoing Latarjet procedure, there are several studies reporting on the outcomes of this technique that have applied and reported about immobilization [201]. Longo et al. conducted a systematic review to evaluate the clinical outcomes, recurrence rate, and complications of Latarjet, Bristow and Eden-Hybinette to treat recurrent anterior shoulder instability [201]. The authors evaluated 41 studies using Latarjet or Bristow procedures. While most of the studies did not report on the postoperative immobilization period, the following number of studies employed its corresponding immobilization period: no immobilization two studies, one week four studies, two weeks five studies, three weeks four studies, four weeks five studies, and six weeks one studies. In addition, Sharareh et al. published a 9-question survey among ASES and AOSSM surgeons study describing the variety between surgeons preferred rehabilitation after Latarjet [310]. Eighty-five percent of the surgeons recommended 3-6 weeks in a sling and 42 % of the surgeons advised their patients to wait 6 months before return to sport. Most surgeons would recommend a period of immobilization between 2 and 4 weeks after a bone augmentation or Latarjet procedure to allow adequate bone healing. There is no evidence to define whether the



immobilization should be implemented in external, neutral or internal rotation. The general recommendation would be an immobilization in internal rotation.

In conclusion, most studies apply an immobilization period between two and four weeks, without clear recommendations on the position of immobilization.

31.2.3 Older adults (Best evidence: 2 case series studies):

Domos et al. propose using a simple sling for 2 weeks while self-mobilization is started immediately [72]. Ernstbrunner et al. suggested using a sling for 4 weeks. As for the soft tissue procedures, the authors prefer using a simple arm sling [86]. The French school of shoulder surgeons is more aggressive, and they start immediate self-mobilization with short time sling use, and the Swiss surgeons keep the sling for 2 weeks more.

32. What type of rehabilitation and when is recommended after soft tissue procedure?

32.1 Statement

To date no universal or specific postoperative rehabilitation guideline exists with limited scientific evidence available for all age groups.

The consensus group recommends a period of motion limited to passive exercises only for 2 weeks, extendable to a maximum of 3-4 weeks in the youngest and hyperlax patients. During this period, passive shoulder external rotation up to neutral, and active non-resisted active elbow and hand/wrist exercises are encouraged. Afterwards, rehabilitation supervised by physical therapist is recommended to improve active range of motion (from weeks 2-4 to 8



postoperatively), gain general strength (from weeks 10 to 14 postoperatively), and perform sport-specific exercises (generally after week 16 postoperatively). (Grade D)

Median (range): 8 (7-9)

32.2 Literature summary

32.2.1 Adolescents (Best evidence: 1 prospective clinical study, 2 retrospective comparative study, 4 case series, 3 systematic reviews):

There is considerable variation with regards to reported rehabilitation guidelines after soft tissue stabilization procedures. Moreover, scientific evidence on comparison among different rehabilitation regimens is limited. One of the most comprehensive analysis of postoperative management following arthroscopic Bankart repair in adolescent and young adults is available in systematic review which includes 17 studies with total 675 patients and average age of 18,3 years [167]. Review reveals that no universal and specific postoperative rehabilitation guidelines exist.

Reported duration of immobilization is a mean of 4 weeks (range, 2-6 weeks) [167]. Internal rotation brace is mostly used [19,47,180,309,333]. Immobilization period is in one study combined by 2 weeks of immobilization and use of sling for additional 4 weeks when pendulum swings already begin [133].

Rehabilitation programs typically concentrate on range of motion until 3 months postoperatively, strengthening from months 3-6, and sport specific training from months 6-9 [180,234].



Above mentioned systematic review reports range of motion (ROM) restriction in 15/17 (88,2%) studies [167]. Restrictions varied between prohibiting all ROM, active-assisted motion, active motion, passive motion, external rotation, abduction, and flexion/extension between 2 and 12 weeks. Most commonly, passive, active-assisted and active movements are limited until 2-4 weeks [167]. Restriction of aggressive external rotation is mentioned in some studies and lasts until 6 weeks [167]. In a study with detailed description of restrictions in the postoperative period, external rotation and abduction and flexion to 45 deg is limited within 3 weeks after surgery; at 4 weeks abduction and flexion is allowed to 90 deg but external rotation is still limited to 0 deg; finally free active ROM is allowed 6 weeks after surgery [300].

Systematic review reports also on 13/17 (76,4%) studies, which emphasized strength exercise restriction [167]. Initiation of strengthening starts at 4-12 weeks after surgery and typically involves rotator cuff, deltoid and periscapular muscles [167].

Patients are advised to return to sport (RTS) after sport specific training is initiated and on the basis of their sport and activity demands [180]. Sport specific training is started at 3 months postoperatively [300]. In general, patients are not released to full activity or contact sports until after 5-6 months [19,133,161,300]; however some authors report accelerated rehabilitation program with graduated return to sports activities including return to contact sport after a minimum of 3 months [333]. Another systematic review of 11 studies reports the most commonly reported timetable for unrestricted participation 5 months after surgery [161]. The most common criterion used for determination of RTS is time from surgery and is set at 4-6 months [167]. Using subjective or objective criteria to determine safe RTS is rare [167]. Reports include restrictions based on return to normal strength, ROM and endurance, comparison to contralateral limb or after sport specific training and activity demands [167]. Only few articles report criteria to progress from one phase of rehabilitation to another. In this



regard 80% of motion is expected (usually 6-8 weeks postoperatively), before strength rehabilitation is begun with a focus on medial scapular stabilizers and the rotator cuff complex [133]. The goal is to achieve near normal strength and motion (80% of strength and 90% of motion) before return to full activity [47,133].

32.2.2 Young adults (Best evidence: 2 randomized control trials, 1 nonrandomized control trial, 1 practice guideline, 1 descriptive epidemiology study, 1 international survey, 2 systematic reviews, 1 case series):

In 2010 the American Society of Shoulder and Elbow Therapists' (ASSET) developed a consensus protocol [98] that is widely used and cited. Despite of this, there is large variability on the rehabilitation protocols used for patients undergoing soft tissue procedures [65]. This has been confirmed by a recent international Survey of Shoulder Surgeons [95].

A recent scoping review on the available protocols [218] identified numerous evidence gaps that have not been sufficiently addressed by appropriate research. The most important ones were unclear immobilization & ROM Initiation/Progression goals and lack of Strengthening Initiation/Exercise Type/Progression criteria.

Some considerations should be made about the type of soft tissue procedure performed. During open Bankart repair the subscapularis is incised and repaired, a step that is not required during arthroscopic Bankart repair. This has implications on the rehabilitation protocol [197] as the subscapularis repair has to be protected in the early stages and external rotation should be protected during the first 6 to 8 weeks at least.

Ismail et al. [148] in 2014 performed a randomized controlled trial in a small group of 34 adults with ages ranging between 18 and 35 years-old that underwent an arthroscopic Bankart repair. They compared a home based supervised and the same protocol performed in a



hospital-based setting (visits on every other day for the first 24 weeks) and found no differences between groups. Eren et al. [83] performed a similar prospective cohort study of 54 patients (with mean ages around 30 years) and found similar results. Thus, these studies strongly suggest that an appropriately supervised home-based protocol might be adequate in this group of patients.

Some other studies have investigated the possibility of using an accelerated rehabilitation protocol with limited sling use postoperatively. The most relevant one is the randomized controlled trial performed by Kim et al. [168] in which 62 non-athlete patients with traumatic recurrent anterior instability undergoing an arthroscopic Bankart repair using suture anchors were randomized to a protocol that allows for early mobilization or to sling use for three weeks postoperatively and found no differences at 31-months follow-up. This study has been corroborated by Gibson et al. [102] in a case series that included athletes.

32.2.3 Older adults (Best evidence: 1 systematic review 1 case series):

There are no specific recommendations available for patients in this group. The surgeons may highlight the risk of postoperative stiffness, which is increased in patients aged > 40 years that undergo surgery for labral pathology [84]. Therefore, faster recovery is recommended for these patients. A study proposes that immobilisation in a simple sling is required for four weeks. Then active assisted exercises should be initiated at four weeks, progressing to active range of motion, and strengthening at six weeks. Patients should be allowed to resume full activities without restriction at six months [66].



33. What type of rehabilitation and when is recommended after bone augmentation/Latarjet procedure?

33.1 Statement

There is lack of evidence about specific recommendations regarding rehabilitation after bone augmentation/Latarjet procedure. In general, the rehabilitation after a Latarjet procedure can be faster than after a soft tissue procedure without limitation of ER.

The consensus group recommends a period of motion limited to passive exercises only for 2 weeks. Active motion can be allowed after 2 weeks from surgery. In case of Latarjet procedure resisted elbow flexion and supination should be avoided for the first 6 weeks. After 2-4 weeks, rehabilitation supervised by physical therapist is recommended to improve active range of motion (from weeks 2-4 to 8 postoperatively), gain general strength (from weeks 10 to 14 postoperatively), and perform sport-specific exercises (generally after week 16 postoperatively). (Grade D)

Median (range): 8 (7-9)

33.2 Literature summary

33.2.1 Adolescents (Best evidence: 1 case series, 1 narrative review):



No decisive information was found in the given literature on what type of rehabilitation and when is recommended after bone augmentation/Latarjet procedure in the adolescent population.

Only two studies mentioned rehabilitation patterns after Latarjet procedure. Domos et al. started rehabilitation on day 3 (active-assisted flexion and external rotation) and continued with self-mobilization at 2 weeks and shoulder strengthening at 8 weeks [71]. On the other hand, Khan et al. suggested an unspecified type of rehabilitation that starts at 3-4 weeks after surgery and continues for 6-8 weeks [162].

33.2.2 Young adults (Best evidence: 1 prospective randomized trial, 3 cohort studies, 1 retrospective cohort study, 1 systematic review and meta-analysis and 1 narrative review):

For patients practicing sport activities, the main objective of the rehabilitation is the return sports, if possible, at the same level, which apply to restore structural stability. It seems logical to say that rehabilitation programs must be tailored to individual athletes taking account of underlying pathology and concomitant lesions, mode of management and sport [227].

The goals of the rehabilitation are to diminish pain, inflammation, and muscle guarding, to promote the healing of soft tissues, to prevent the negative effect of the immobilization, to reestablish baseline dynamic joint stability and to prevent further damage to the glenohumeral joint capsule.

Rehabilitation after bone augmentation or Latarjet procedure still currently remains a matter of surgeon preference rather than a scientific rationale and is therefore subject to high variability between centers. This explains the many different rehabilitation protocols used in



different studies. Only few studies evaluated the benefits and drawbacks of different rehabilitation programs [367].

Different rehabilitation protocol in several phases:

Standard rehabilitation after Latarjet procedure involves full postoperative immobilization using a sling for 3-6 weeks, passive rehabilitation with a physiotherapist for another 3-6 weeks and eventually strengthening exercises as necessary [15,367]. Baverel et al and Hardy et al used shorter time of immobilization [15,120].

Roulet et al. evaluated short-term outcomes of shoulders treated for anterior instability with the open Latarjet technique followed by immediate self-rehabilitation and demonstrated that this rehabilitation techniques enabled recovery of preoperative shoulder mobility at 3 months [289]. They found no increase in adverse events, including postoperative hematomas, coracoid graft union and recurrent dislocations or subluxation. They also found that patients who did not adhere to immediate self-rehabilitation experienced significantly more pain and a limited active forward elevation and internal rotation at 3-month follow-up.

In many studies, rehabilitation protocols are different and make difficult to describe uniform recommendations for the several phases of the rehabilitation and their duration. To the best of our knowledge there is no high-level study, which demonstrate the superiority of a specific protocol. Here are some examples:

Baverel et al. evaluated the outcomes of open Latarjet procedure for primary stabilization in competitive athlete who have a high functional demands and great risks of redislocation [15]. For the postoperative rehabilitation, the patient's arm was immobilized for 2 weeks using a sling and rehabilitation was restricted to pendulum exercises. After two weeks patients were able to perform exercises daily and active-assisted range of motion exercises without strengthening. They expected complete range of motion at 6 weeks and the strengthening program was permitted after 3 months after the surgery. The return to sport was allowed



between 3 to 4 months postoperatively. Over 106 patients, they reported 3 cases of recurrence of shoulder dislocation and a persistent apprehension test in 11,5% at a minimum 2 years follow-up and 100% of competitive athletes and 69.4% of recreational athletes resumed at least at the same level their previous sports practice than before their injury

Hardy et al. evaluated the outcomes after Latarjet procedure patients with first-time versus recurrent dislocations and used a different postoperative management [120]. All patients wore a sling for the first week postoperatively and started self-assisted rehabilitation at the beginning of the second week for a duration of 3 weeks. The patients were referred to a physical therapist to start active mobilization in elevation and external rotation after one month postoperatively. Delay for return to sport was not indicated. At a mean follow-up of 3,4 years +/-8 years the rates of recurrence and reoperation were not significantly different between group.

Zhu et al. [367] performed a prospective comparative study to compare clinical and computed tomographic outcomes between open and arthroscopic Latarjet procedure and used the same rehabilitation protocol for the both groups. Patients had to have a sling for 6 weeks after the surgery and passive range of motion exercises were started at 3 weeks postoperatively. Daily activities were allowed 6 weeks after the surgery. At 3 month postoperatively terminal stretching was allowed and contact or overhead sports were allowed at 1 year when full range of motion was restored with no apprehension detected. At more more than 2 years of clinical follow-up no difference was detected between the groups regarding clinical outcomes and no recurrent dislocation occurred in either group.

Comparison of rehabilitation between Latarjet and bone augmentation

Moroder et al. [225] performed a prospective randomized study on patients with anterior shoulder instability and glenoid bone loss who were randomized to either an open Latarjet or an open iliac crest bone graft transfer (J-bone graft) and found no difference in clinical and



radiologic outcomes between the both techniques (except for significantly worse internal rotation in the Latarjet group and more frequent donor site morbidity in the ICBGT group). They performed the same rehabilitation protocols for the both techniques as well as the postoperative period of sling immobilization.

The use of arthroscopic Latarjet procedure has been suggested to decrease stiffness and to allow a quicker rehabilitation despite the fact that this surgical techniques remain challenging [137].

33.2.3 Older adults (Best evidence: 1 case series study):

There are no specific recommendations for this group of patients. A study proposes that all patients should be placed in a sling postoperatively for two weeks. Active-assisted forward flexion and external rotation can be tolerated three days after surgery. The sling may be removed two weeks after surgery, followed by self-mobilization. Four weeks after surgery, patients can be allowed to resume conditioning of the lower extremities, and eight weeks after surgery, shoulder strengthening can be started [72].

34. What are the criteria to return to sports after surgical treatment of anterior shoulder instability (yes/no, timing and goal)?

34.1 Statement



No specific criteria are defined for return to sport (RTS) after surgical treatment of anterior shoulder instability. The RTS must be individualized based on the patient's demands and the type and level of sport practised (Grade C).

The patient should have a stable shoulder with negative apprehension test, be pain-free, have a full active range of motion, restored scapulothoracic rhythm and appropriate strength compared to the contralateral shoulder. In addition, the patient should meet their sport's specific functional, proprioceptive, and physical demands. Psychological readiness of the patient remains mandatory. Patients undergoing a soft tissue procedure will usually resume activities without restriction at six months. For patients undergoing a bony procedure, this usually happens at four months. However, these time intervals may be altered (increased or decreased) based on patient's progression. In individual cases return to sport might be allowed even with minor loss of external rotation or residual apprehension (Grade D).

Older adults

In this age group, if a rotator cuff repair has been performed, the rehabilitation program should follow the rules of such a repair (Grade C).

Median (range): 9 (8-9)

34.2 Literature summary

34.2.1 Adolescents (Best evidence: 1 prospective comparative study, 2 cohort study, 1 prognosis study, 3 systematic reviews, 3 case series)



The timing to return-to-sports (RTS) after surgical treatment of anterior shoulder instability ranges between 3 to 6 months postoperative, depending on the chosen technique [36,103,133,167,190]. Soft tissue reconstruction techniques usually allow a safe RTS when the patient's active range of motion and muscular endurance are compatible with the sports activity in question and this usually happens 4-6 months after surgery [47,161,180]. In a LOE IV systematic review a total of seven studies mentioned a specific timing from surgery for unrestricted RTS, with the average number of months reported being 5.3 months (range, 3–10 months) [160]. After open Latarjet procedure RTS is usually allowed once clinical and radiographic evaluation confirmed satisfactory healing of the coracoid graft, usually at 3 months after surgery [71].

34.2.2 Young adults (Best evidence: 2 non-randomized prospective study, 3 cohort study):

Uhring recommended time frames for return to sport: for non-operative treatment, return to sports (RTS) would be allowed after 2 months, and for operated patients (Bankart) RTP would be allowed after 3 months without contacts or overhead movements, and after 4 months with no restrictions [337].

In a comparison between arthroscopic Bankart and Latarjet in Rugby players, RTS was allowed when the patient was pain free, full shoulder ROM had been achieved, and shoulder strength was near the same as before the injury [286]. Running was authorized at 8 weeks.

Perret et al. did another comparison of Bankart and Latarjet in rugby players: 93.1% of capsulolabral patients and 96.9% of open Latarjet patients returned to professional contact sport [263]. The median RTS time was 6.8 months for the capsulolabral group and 7.3 months for the Latarjet group. There was no significant difference in RTS rates between the 2 groups ($P = .270$). Of those undergoing surgery early in the season, 75% of the capsulolabral and



71% of Latarjet group were able to RTS within the same season, at a mean time of 16.9 weeks and 18.8 weeks, respectively. There was a significant difference in instability recurrence, with 19% for the capsulolabral group and no recurrence in the Latarjet group ($P = 0.017$). There was no significant reduction in player on-field performance in either group ($P > 0.05$). It may therefore be reasonable to assume that in a professional sporting population, it may take 6 to 9 months for adequate external rotation to be achieved to enable players to perform overhead marks [263].

In a cohort study comparing open Latarjet in recreational athletes to competitive athletes, the competitive athletes had a significant higher return to sport rate [15]. Return to sports was allowed between 3 and 4 months postoperatively, depending on sports requirements, if the shoulder was pain-free and with complete range of motion, and if the fusion of the coracoid graft was achieved on the Bernageau glenoid view at 3 months [15].

In a follow up after more than six years there was a significant difference in return to sport between young athletes treated surgically compared to a similar group treated non-surgically [64]. Seventy percent of the patients treated surgically were able to return to sport at the pre-injury level versus 41 % in the non-operated group. The numbers who were able to return to sport activities at any level was 93% and 89%, respectively. The authors allowed for surgical patients to RTS at four months post-operatively for non-contact sports, and at 5 months post-operatively for contact sports, while those treated conservatively were allowed to RTS following a progressive three-month rehabilitation program.

34.2.3 Older adults (Best evidence: 2 case series):

There are no specific recommendations for this group of patients. Patients undergoing a soft tissue procedure can resume full activities without restriction at six months [66]. Patients



undergoing a bony procedure can return to sporting activities, including contact sports, once clinical and radiographic evaluation confirms satisfactory healing of the coracoid graft, usually three months after surgery [72].

E) Outcomes

35. Which measurement tools are validated for evaluating outcomes in the treatment of anterior shoulder instability?

35.1 Statement

The WOSI score, Walch&Duplay score and general shoulder outcome scores (Constant, ASES and DASH) are validated for patients with shoulder instability (Grade B).

There's a high variability in the outcome measurement tools used in the literature. Recurrence rate (redislocation, subluxation or residual apprehension) is the most used outcome evaluation tool. A combination of recurrence rate, a general shoulder score (Constant, ASES or DASH) and an instability-specific score (WOSI, numerical scale WOSI, Walch&Duplay score, ROWE) is recommended. (Grade D).

Older adults

If the patients have undergone rotator cuff repair the treatment outcomes are assessed accordingly (Grade B).



Median (range): 9 (8-9)

35.2 Literature summary

35.2 1 Adolescents (1 prospective comparative study, 4 systematic reviews, 6 case series):

There was a high variability in the literature regarding validated measurement tools for evaluating outcomes in the treatment of anterior shoulder instability, especially in patient reported outcomes measures (PROMs). This variability was observed even in studies that included the same surgical procedure. In arthroscopic repair, the most common PROMs used were: ASES (American Shoulder and Elbow Surgeons), Rowe, SANE (Single Assessment Numeric Evaluation), and L'Insalata [47,103,160,250,309]. For the young athletic population, WOSI (Western Ontario Shoulder Instability Index) and Kerlan-Jobe Orthopaedic Clinic Shoulder and Elbow Score proved to be more suited for evaluating stability [250]. No similarities in outcome measurement of Latarjet procedure in skeletally immature patients between studies was observed (used PROMs: Rowe, Constant-Murley Score, Walch-Duplay Score, French QuickDash, French 3S) [71,162]. The FISOR (Filling Index Score of Remplissage) proved to be a useful measurement tool for evaluating the structural outcome of the remplissage procedure [275].

Although recurrence rate was frequently used as a valid measurement tool for outcome, one systematic review reported a distinction in its definition. Thus, a common ground has to be reached in which recurrence rate refers to either both dislocation and subluxation or repeated episodes of shoulder dislocation that require manual reduction [161].

The most common and reliable measurement tool in evaluating outcomes after treatment, especially in athletic patients was the return-to-sports rate [71,126,160,161,250,309,364].



35.2.2 Young adults (Best evidence: 3 prospective diagnostic studies, 2 reviews, 1 systematic reviews):

The assessment of outcomes of treatments for anterior shoulder instability can be considered relatively easy, as the main outcome, recurrence, is relatively straightforward to measure. Despite for this initial consideration, there is a clear need to use outcomes that present the researcher with a more detailed view of the shoulder function. To do this instability specific and general shoulder outcome measures have been widely used. Probably using a combination of a general shoulder score (Constant, ASES or DASH) and an instability specific score (WOSI or Rowe) is the best option [251,352].

Instability specific tools:

The WOSI questionnaire, a patient reported outcome, was published and thoroughly validated in 1998 [171], has been translated and cross-culturally validated in many other languages, is widely used in research and appears to have the best supporting evidence with excellent reliability/responsiveness [288]. Its main disadvantage is that it takes some time to fulfill and that its assessment can be bothersome.

Goetti et al. [106] analyzed whether a shorter version of the WOSI, the numerical scale WOSI (in which the answer are given in discrete numeric form, not over a VAS line) was a good alternative to the traditional version and could be used telephonically or via email. They found that all these were valid, reliable, and timesaving alternatives to the original WOSI questionnaire.

The Rowe score [290] developed in 1978 specifically to assess patients with instability is also widely used. This extended implantation is its main advantage, but it has many limitations. It is not patient reported, baseline values are always low (as instability rates disproportionately



in the value), it was not designed to assess specific domains, and has not been properly assessed for validity.

General shoulder tools:

It is not the scope of this review to assess the specific merits of tools such as the Constant shoulder score, ASES or DASH. All have extended implantation, have been validated to be used in instability patients and have been shown to be reproducible. The only consideration is that, in young subjects with isolated instability (for example after an isolated episode of instability) initial values can be very high (they have a high floor effect) and cannot be very sensitive to clinically relevant changes.

35.2.3 Older adults (Best evidence: 23 case series, 2 reviews, 1 systematic review, 4 comparative/cohorts, 1 diagnostic case control, 1 descriptive epidemiology, 1 case report):

Clinical and functional outcomes were assessed using:

- Constant-Murley score (absolute and relative Constant scores) in 10/33 studies.
- Rowe score in 7/33 studies.
- Walch-Duplay score in 4/33 studies.
- American Shoulder and Elbow Surgeons (ASES) scores in 3/33 studies.
- Western Ontario Shoulder Instability Index (WOSII) in 2/33 studies.
- Subjective Shoulder Value in 3/33 studies.

Less frequently (1/33 studies), the authors used:

- Simple shoulder test
- Disabilities of the arm, shoulder, and hand (DASH) questionnaire
- Single Assessment Numeric Evaluation (SANE) score



- Penn Shoulder Score (PENN).

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