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Arthroscopic shoulder instability surgery in patients under 25 years of age: the key role of soft tissue with both anterior and posterior axillary hammock tensioning

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Abstract

Background The arthroscopic treatment of shoulder instability is widely debated in the literature and includes very different surgical techniques. Imaging techniques do not allow an accurate assessment of soft tissue quality. The aim of the study is to demonstrate that correct patient selection and a surgical technique involving anterior and posterior capsular ligament repair with axillary retention may be the most crucial factors for successful arthroscopic treatment.

Methods Patients with recurrent shoulder instability who underwent arthroscopic stabilization between 2014 and 2015 and aged between 15 and 25 years, were included. The minimum follow-up was 5 years. Specific exclusion criteria were critical bone loss and patients with genetic connective tissue disorders. Demographics, instability characteristics, surgical procedures, recurrences, both dislocations and subluxations, and surgical revisions were evaluated. The surgical procedure, always performed by the same surgeon, involved the use of a minimum of 3 double-suture fixation devices and repair/tensioning of the axillary hammock. Statistical analysis was based on the non-parametric Kendall statistical model and proportions test, with $p < 0.05$.

Results The study population consisted of 44 patients. The first dislocation occurred in 61.4% of cases between the ages of 15 and 19. The number of dislocations prior to surgery was < 3 in 29.5%, between 3 and 9 episodes in 25%, and 10 or more episodes in 45.5%. Defined by patients who had no recurrent dislocations and those whose symptom of instability or subluxation did not require surgical revision, the surgical success rate was 90.9%. During the follow-up period, 4.5% of patients required surgical revision. Patients who required none or one reduction maneuver or had less than three dislocation episodes were statistically correlated with no recurrences after surgery. After the first dislocation, the 88.6% of patients had recurrency. Furthermore, if treated after only one episode, 75% of patients were affected by an isolated capsulolabral injury. Prompt stabilization surgery allows a simpler procedure, due to a reduced bone damage and associated injuries.

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Conclusions Even in a high-risk age group under 25 years, when the bone defect is subcritical, performing a standardised surgical technique including antero-posterior capsulolabral repair with axillary hammock retensioning demonstrates high success rates. Patients who correlate with the highest chance of success are those who have had less than three dislocation episodes and who have not undergone reduction manoeuvres, confirming the importance of soft tissue quality and thus of early treatment.

Trial registration Retrospectively registred.

Keywords Shoulder instability, Arthroscopic stabilization, Capsulolabroplasty, Bankart repair, Axillary hammock, Instability, Arthroscopy

Background

The surgical treatment of recurrent shoulder instability is still widely debated in the literature.

In particular, the arthroscopic treatment of shoulder instability is based on procedures that, under their names, include very different surgical techniques: labral repair, capsuloplasty, bankart repair. In all treatments of instability, the results vary widely, but this is especially the case with the arthroscopic technique. Leroux et al. demonstrated that with careful patient selection and appropriate surgical technique, the failure rate can fall from 17.8 to 7.9% [1], even in a 'critical' population such as contact sports athletes.

As described by Di Giacomo G. et al., the population of patients with a sub-critical bone defect (glenoid bone defect < 25%, with on/off track Hill-Sachs lesions) [2], should be the candidate for arthroscopic stabilisation surgery. This is also because, despite the increasing popularity of Latarjet stabilisation, it has been shown that in patients with a small glenoid bone defect < 15% or no relevant bone defect the lack of mechano-transduction leads to partial reabsorption of the coracoid bone graft [3].

Despite numerous studies and proposals to accurately assess bone loss, Saliken's review, based on 41 studies, shows that there is still no certain consensus as well as no standardised method [4]. Furthermore, Weber points out that 3D CT is definitely superior to MRI in detecting bone deficiency [5]. This is not always applicable but, especially in cases where the bone deficit is not clearly defined, the other key factor to be assessed is the quality of the soft tissue. Shrestha-Taylor and Kim explain how ultrasound techniques could assess capsular thickness but this varies greatly depending on arm abduction [6, 7]. Several studies, including those of Park and Lee, focus on cases of multidirectional instability by proposing methods to measure capsular volume and elongation of the inferior capsule [8, 9]. The proposed evaluations also allow the exclusion of possible injuries but still do not permit an assessment of tissue quality. There are numerous studies in the literature that discuss the impossibility of correctly defining the characteristics of capsular tissue, with poor agreement between operators, underestimating lesions or due to errors/differences between techniques [10–13]. Vaswani demonstrates that it is not the capsular volume that correlates with the success of arthroscopic stabilisation but the morphology of the labrum in pre-operative arthro-MRI does [14]. He also shows, as Aboalata and Mahure do, that the number of episodes correlates with the risk of recurrence and proposes early surgery as a solution [15, 16]. Park and Kim also correlate a scarcity of capsulolabral tissue with the number of recurrences and study post-operative bump height and thickness as predictors of surgical outcome [17, 18]. Likewise, Lee shows that labrum height at the inferior anchor correlates with a reduction in post-operative appresion and dislocation recurrence, as well as a reduction in capsular volume [19]. Smeets demonstrates how the inferior glenohumeral ligament (IGHL) is exactly comparable in biomechanical and histological properties to the anterolateral ligament of the knee, which is extremely relevant for successful knee instability surgery today [20]. Previously, Ticker demonstrated the importance of the IGHL in shoulder instability, describing different characteristics in its three regions and correlating the injury mechanisms of the capsulolabral complex [21]. These considerations highlight the importance of the lower part of the whole capsulolabral complex, the axillary one, reinforcing Park and Kim's conclusions [17, 18].

The authors believe that it is necessary to study arthroscopic shoulder stabilisation techniques according to the latest principles and devices, considering proper patient selection and standardised surgical techniques, which must mandatorily involve the entire axillary hammock. Furthermore, as imaging techniques do not allow an accurate assessment of soft tissue quality, it is essential to demonstrate which factors can help us select the correct patients.

In a population younger than 25 years, without a critical bone deficit, the main objective of the study is to identify patients who are candidates for arthroscopic stabilisation with a low risk of recurrence.

Furthermore, in this study, the authors describe and validate their surgical technique, attempting to establish some key points for the standardisation of arthroscopic treatment of shoulder instability.

Methods

We performed a retrospective study of patients with recurrent shoulder instability who underwent arthroscopic stabilisation in the years 2014–2015. Patients who had performed the surgery between the ages of 15 and 25 years were included.

Exclusion criteria for this surgery were the presence of glenoid fracture and glenoid bone loss of more than 20% or bipolar bone loss type 3 or 4 (types with a glenoid bone defect > 25%). Patients with genetic connective tissue diseases were also excluded.

Pre-operative evaluation

Humeral and glenoid bone loss was assessed pre-operatively by CT examination in all patients and measured by the PICO method [22] and bipolar bone loss concept of on/off track Hill-Sachs lesion [2]. MRI study was also performed. Glenoid and humeral bone deficits were studied and confirmed intra-operatively.

Of each patient, the following data were evaluated: sex, dominant limb, age of patient at first episode, injury mechanism, number of dislocation/subluxation episodes, execution of reductive manoeuvres in the emergency room, time elapsed between dislocation and reduction, time elapsed between first episode and eventual recurrence, age at surgery, duration of surgery and type of instability. Specifically, the type of instability was subdivided into anteroinferior (AI) traumatic (I0), AI without major trauma (I1), multidirectional or in a hyperlax patient (Beighton Score equal to 5 or higher) [23] and recurrence following arthroscopic stabilisation surgery (I2).

Were also recorded type of lesions and repair performed. It was briefly indicated as "simple" (capsulo-labral repair, capsuloplasty, Bankart repair) or "Complex" (bony Bankart repair, remplissage, revision surgery, SLAP (superior labrum anterior and posterior) repair, HAGL (humeral avulsion glenohumeral ligament) repair, augment with porcine derma allograft).

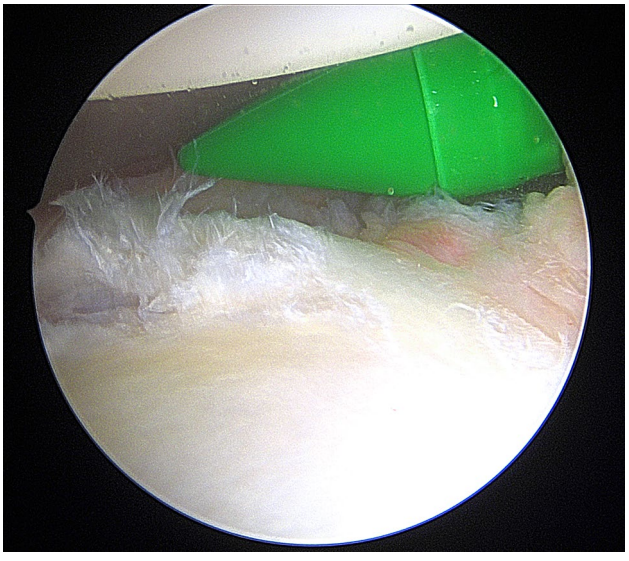

Fig. 1 The capsulolabral lesion reaches the postero-inferior region

Surgical procedure

All surgical procedures are performed under blended anaesthesia: general anaesthesia combined with interscalene block. Patients are positioned in lateral decubitus with 20° supination and upper limb in double traction: one longitudinal along the long axis, one perpendicular to it. A rigid roll is also prepared for selective distraction of the axilla, facilitating the passage of instruments. The arthroscope used is 45° angled. Using a standard posterolateral arthroscopic approach, the diagnostic phase is performed. Then, the anterior "mid-glenoid" and the "antero-superior" portals are created. Two cannulas (diameter 8.25 mm and 6 mm) are placed in these anterior portals. By moving the camera into the antero-superior portal, it is assessed whether the suture devices can be correctly implanted from the posterolateral portal and the instruments can be easily used in the posterolateral area and the axilla.

If the portal orientation is not optimal, the first one is abandoned and another one is created, usually more lateral. Then, a cannula with a diameter of 8.25 mm is inserted into it.

If necessary, to position a suture device at 7 o'clock, a further 'latero-inferior' (non-cannulated) accessory portal can be created. Therefore, three are the standard portals, with the variability just described; only three are maintained by cannulas.

The extent of the capsulolabral lesion and any associated injuries are assessed (Fig. 1).

When an off-track Hill Sachs lesion is present, the first surgical step is the remplissage [24]. The sutures will be passed through the infraspinatus tendon and capsule, parked free out the skin. They are knotted as the last step of the entire surgery. Knotting the sutures at this time would interfere with the surgery progression. Then, two millimetres of the cartilage are shaved off from the glenoid margin, exposing bone (Figs. 2, 3 and 4).

Then, the capsulolabral complex is detached from the glenoid neck to make it mobile, alternating shaver (4 mm blade) and periosteal elevator (Fig. 5).

Crucial is the axillary hammock mobilisation, extended beyond the 6 o'clock toward the posterior side (Fig. 6). This step is fundamental to reduce the axillary capsular volume while, at the same time, tensioning the posterior stretched capsule by the repair.

The repair and retensioning starts from the postero-inferior region. Only "all-suture" devices are implanted. The first one is placed at 7 o'clock (Fig. 7).

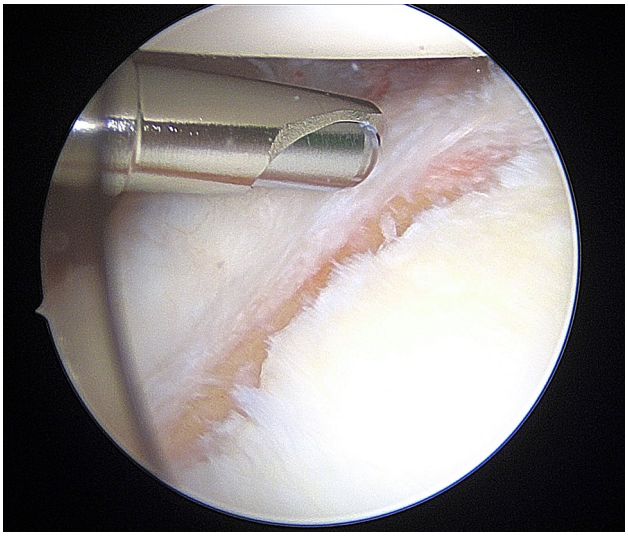

Fig. 2 The preparation of the glenoid margin extends beyond the 6 o'clock position

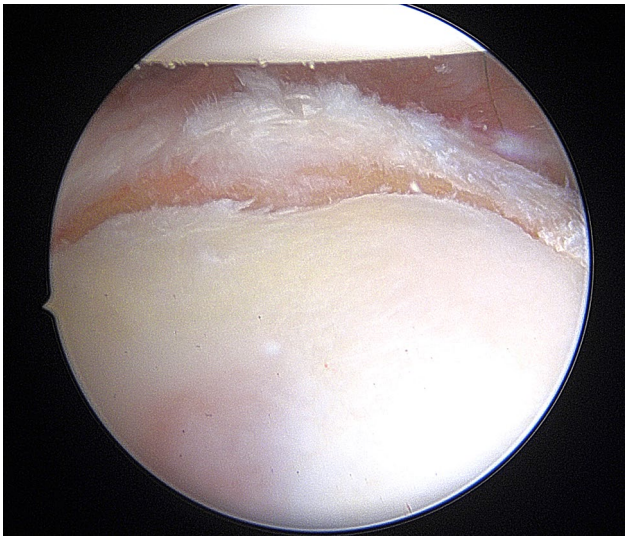

Fig. 3 The preparation of the glenoid margin extends beyond the 6 o'clock position

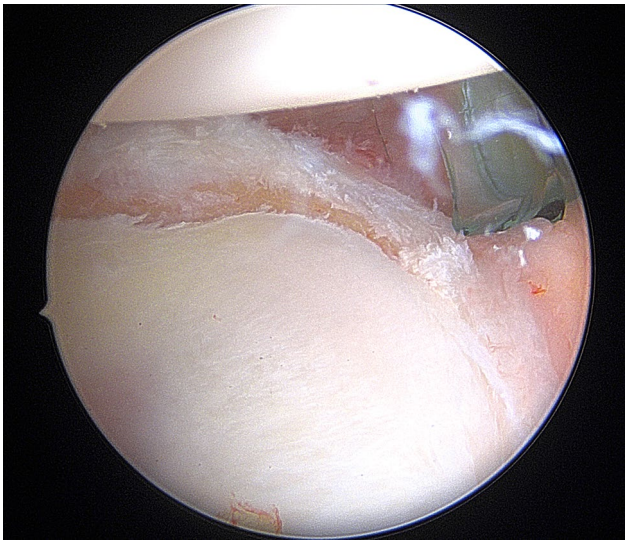

Fig. 4 The preparation of the glenoid margin extends beyond the 6 o'clock position

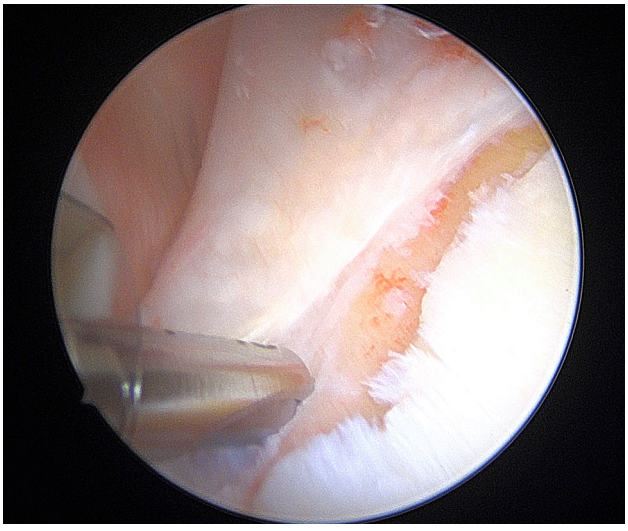

Fig. 5 The capsulolabral complex is detached from the glenoid neck

The suture shuttle hook (Linvatec Spectrum) is introduced through the posterior cannula. One limb of the same suture is passed twice through the capsule, commonly referred to as the "italian loop", while the second limb is passed once. The suture limbs are then knotted without using sliding knots, keeping the knots away from the articular surface while pushing the bump up and towards the joint (Figs. 8 and 9).

The repair, which began at 7 o'clock, continues with the anchor at 5 o'clock to complete the repair and retensioning of the axilla (Fig. 10). The procedure generally ends at 2 or 3 o'clock in the right shoulder (Figs. 11 and 12).

The procedure involves the use of a minimum of 3 double suture fixation devices and allows for the repair of the capsulolabral complex with re-tensioning of the axilla and creation of a voluminous bump (Figs. 13 and 14).

When the capsular tissue is scarce in quality and quantity, and there is instability in more than one direction, an augmentation procedure can be chosen as described by Gervasi et al. [25]. When the capsular tissue is insufficient, a grasp of some muscle fibres of the subscapularis are included the repair. This can be done with an intra-articular passage through the medial part of the capsule and the fibers of the subscapularis. The passage through the subscapularis can be performed proximally by passing the hook anteriorly through the rotator interval. This is indicated in shoulders with a subscapularis that is lengthened, with a medial insertion on the neck of the

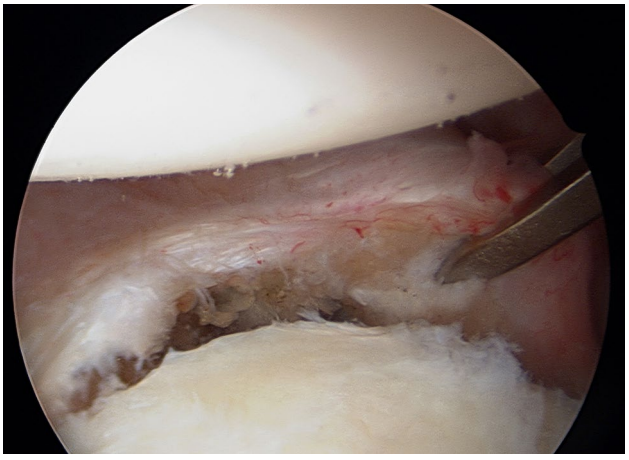

Fig.6 Axillary hammock mobilization

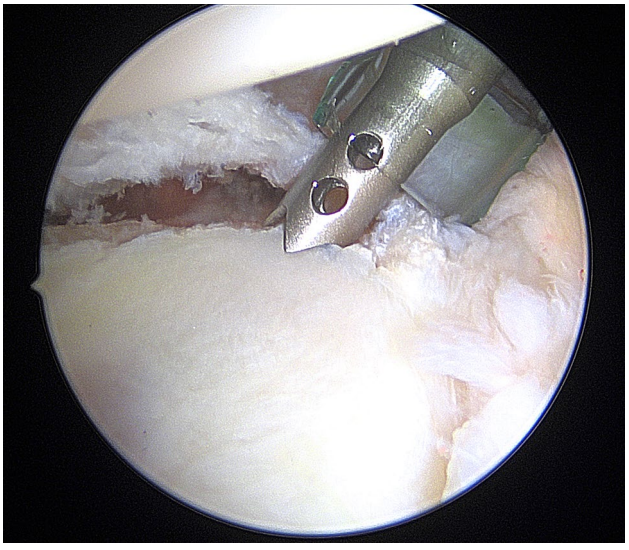

Fig. 7 The first anchor is placed at 7 o'clock, so the repair and retensioning of the capsulolabral complex starts from the posterior aspect of the axilla

scapula or stripped from it. If needed, associated injuries and SLAP-type lesions are treated.

All surgeries were performed by the same surgeon (E.G.).

After surgery, the patient wears a sling with 15° abduction for 25 days before starting rehabilitation. The rehabilitation protocol must include sport-specific exercises before the patient can return to contact sports 4 months after surgery.

Follow-up

The minimum follow-up for the entire population was 5 years.

The evaluation of patients was based on recurrence, surgical revision for instability and scores. Specifically, recurrences were divided into: recurrent dislocation due to high-energy trauma (Failure type 1 - F1), recurrent dislocation with minor trauma or in the absence of trauma (Failure type 2 - F2), perception of instability or subluxation (Failure type 3 - F3).

The recurrences were grouped into failures as follows: Type A failures (FA) as F2 + F3 and Type B failures (FB) as surgical revisions of the FA group. In addition, the time elapsed between surgery and recurrence was evaluated (in months).

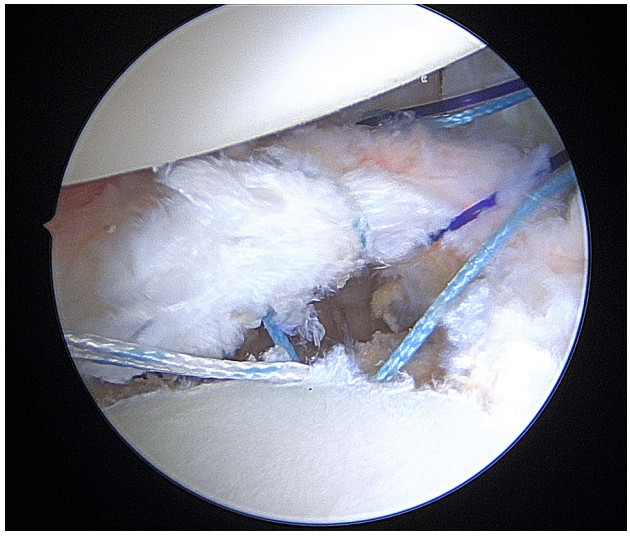

Fig. 8 The 'Italian loop' method of suture passage keeps the knot away from the joint surface and creates a capsulo-labral bump. As can be appreciated in this image, the bump is positioned close to the articular surface and raised above it. Moreover, due to the suture-passing technique, the bump is not loose and mobile but rigid and mechanically effective

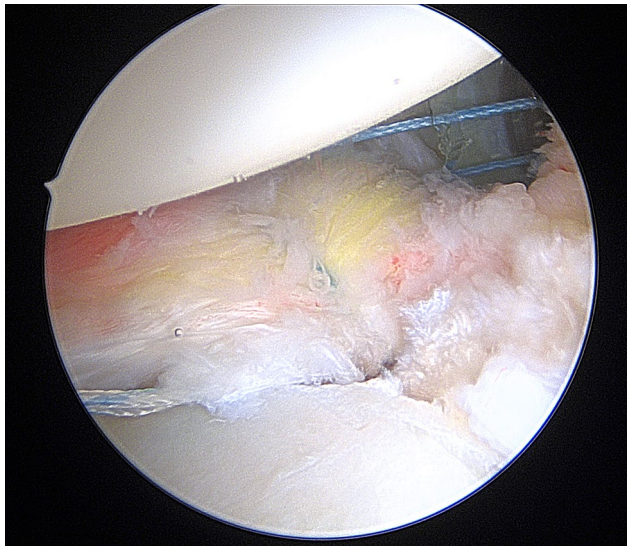

Fig. 9 The 'Italian loop' method of suture passage keeps the knot away from the joint surface and creates a capsulo-labral bump. As can be appreciated in this image, the bump is positioned close to the articular surface and raised above it. Moreover, due to the suture-passing technique, the bump is not loose and mobile but rigid and mechanically effective

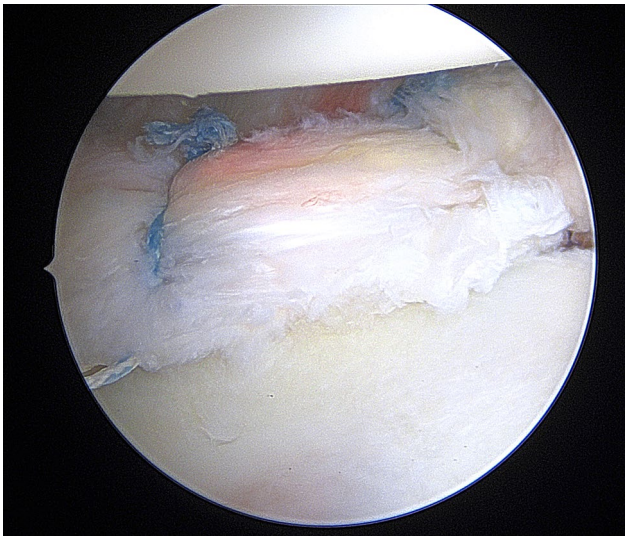

Fig. 10 After the anchor at 7 o'clock, the procedure continues with repair and retensioning of the anteroinferior axillary hammock with an anchor at 5 o'clock

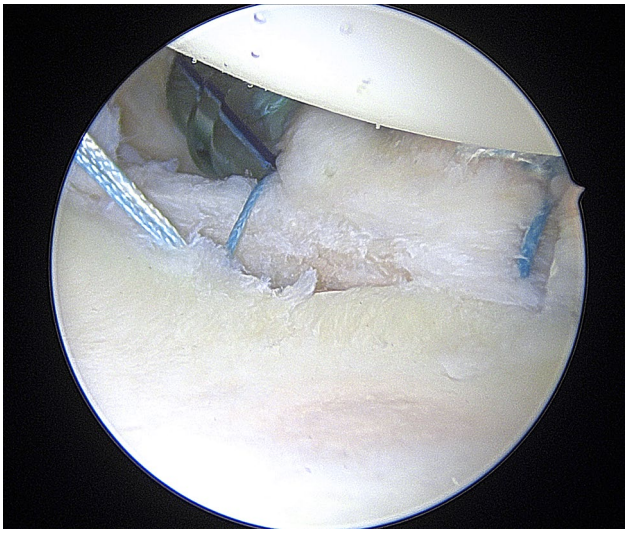

Fig. 11 The repair of the anteroinferior and anterior region is performed with the anchor positioned at 3 o'clock

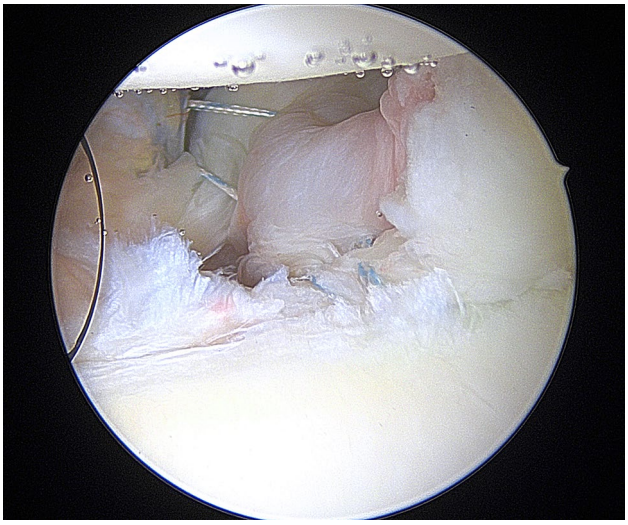

Fig. 12 The repair of the anteroinferior and anterior region is performed with the anchor positioned at 3 o'clock

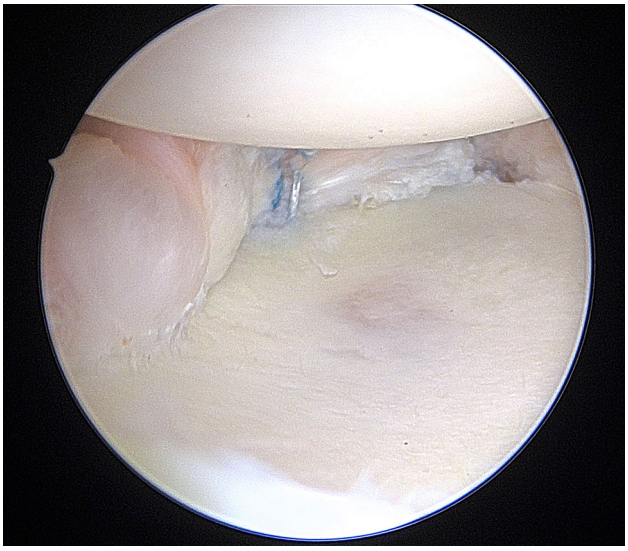

Fig. 13 Final view of the surgical procedure where one can appreciate the voluminous bump and the repair extending from postero-inferior to anterior

Lastly, the scores evaluated were the Subjective Shoulder Value and ROWE Score with a division of the results into: Excellent 90–100, Good 75–89, Fair 52–74, Poor < 52.

Statistical analysis

Statistical analysis was based on the non-parametric Kendall statistical model and proportions test. A p-value < 0.05 was considered statistically significant.

Results

The total population of the study consisted of 44 patients, 34 males (77.3%) and 10 females (22.7%). In 54.5% of patients, the affected upper limb with glenohumeral instability was the dominant one. The first episode of dislocation occurred at a mean age of 16.3 years. Specifically, 22.7% of patients experienced the first episode before the age of 15, 61.4% between 15 and 19 years, and the remaining 15.9% at 20 years or older. The number of instability episodes prior to the surgery was less than 3 in 13 patients (29.5%), between 3 and 9 episodes in 11 patients (25%), and 10 or more episodes in 20 patients (45.5%). Glenohumeral dislocation required reduction

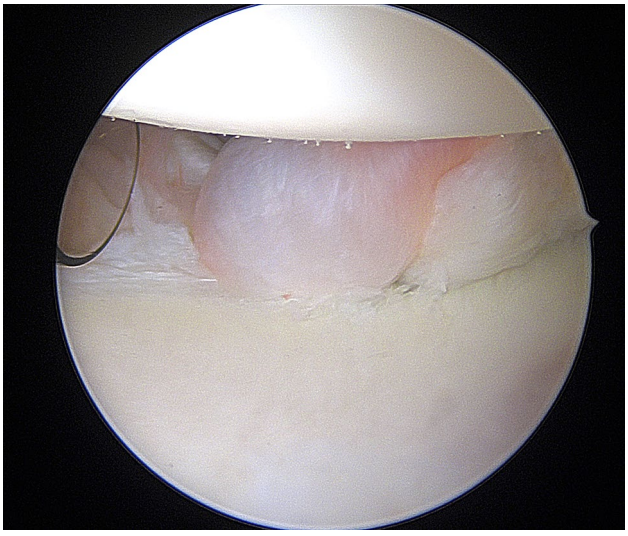

Fig. 14 Final view of the surgical procedure where one can appreciate the voluminous bump and the repair extending from postero-inferior to anterior

maneuvers in the emergency department only once in 13 patients (29.5%) and multiple times in 11 patients (25%). However, 45.5% of patients did not undergo reduction maneuvers. Among the patients who reported multiple instability episodes, there were 39 cases. In this population, the time interval between the first episode of instability and recurrence occurred within 3 months in 38.5% of patients and between 3 months and 1 year in 25.6% of patients. In the remaining 35.9% of patients, instability recurrence occurred more than one year after the initial event. The analysis of instability types showed that 54.5% of patients had post-traumatic anterior-inferior instability (I0). 11.4% of patients had anterior-inferior instability without a significant traumatic cause (I1). The remaining 34.1% of patients are lax patients, including those with multidirectional instability, or patients who had already undergone arthroscopic stabilization surgery (I2).

Regarding the surgical procedure, patients were operated on at a mean age of 20.3 years. The surgery had an average duration of 74 min, and at least three or more double sutures were used. The evaluation of surgical procedures showed that 75% of patients underwent a simple procedure, while the remaining 25% underwent complex procedures.

There were 4 cases of recurrent dislocation due to major trauma (F1), which are not considered surgical failures. The percentage of patients in the FB group is 9.1%. Therefore, the success rate of the surgery is 90.9%. The FA group accounts for 15.9% of cases. However, during the follow-up period, 4.5% of patients required surgical revision. The average time to recurrence after surgery was 19.33 months (min 4, max 48) for F2 and 21.86 months for F2-F3.

The analysis of scores showed good or excellent results in 68.2% of cases for the Subjective Shoulder Value (SSV) and in 75% of cases for the ROWE score. Poor results, considered unacceptable, were found in 2.3% of the SSV and 6.8% of the ROWE score.

Of the 4 FB cases, 50% were attributed to traumatic anterior-inferior instability (I0), and the other 50% to I2. Similarly, 50% underwent a simple repair, and the other half underwent a complex repair. The same results were observed for the two cases that required surgical revision. None of the FB or revision surgery patients had a diagnosis of non-traumatic anterior-inferior instability (I1).

Statistical analysis using Kendall's correlation (Appendix 1) demonstrated a statistically significant correlation in the overall population between: gender and age at first episode; gender and age at treatment; gender and type of lesion/repair; age at treatment and age at first episode; dominant side and need for surgical revision; recurrence and reduction maneuvers in the emergency department; recurrence and need for surgical revision; recurrence and ROWE score. In the FA population, Kendall's correlation showed a statistically significant correlation between: dominant side and number of preoperative episodes; type of instability and type of lesion/repair. On the other hand, no statistically significant correlation was found in the FB population.

The proportional test analysis of statistically significant correlations yielded the results shown in the tables in Appendix 2.

Specifically, in the age group of 15–19 years, male subjects (85.2%) statistically had a higher number of dislocations compared to females (14.8%). Simple repairs/lesions were correlated with male gender, and male subjects statistically had more simple repairs/lesions. Patients who experienced only one episode of dislocation were statistically correlated with not having recurrences. The group of patients who did not experience recurrences was statistically correlated with the group who never underwent reduction maneuvers, particularly when compared to those who required multiple reduction maneuvers. From the analysis of the FA population, it was found that I0 and I1 statistically correlated with a simple repair/lesion. A simple repair/lesion correlated with I0, while a complex repair/lesion correlated with I2.

Discussion

This study shows that in patients with a non-critical bone deficit, even in a population considered to be at high risk, arthroscopic treatment of shoulder instability is a procedure with a very high success rate. Furthermore, at the time of the study, arthroscopic stabilisation surgery, performed as described, had a re-intervention rate of 4.5%.

The results of this study changed the authors' indication for surgery, allowing more selective surgical indications.

Today, following the fundamental principles of the surgical technique described, it is possible to guarantee a very high probability of success in patients treated after the first episode or within three episodes of dislocation and who preferably have not undergone reduction manoeuvres. For this reason, it is necessary for the patient and healthcare personnel to be well informed about the possibility of recurrence and the damage associated with multiple episodes.

In the population examined in this study, instability is more frequent in males, mainly in the dominant limb, and the age of the first episode is predominantly between 15 and 19 years. Considering that patients with these characteristics have a second episode of dislocation in 88.6% of cases, surgical treatment may be mandatory already after the first episode, especially in such a young population. Moreover, in this study, many patients were already treated after the first episode, so this evidence shows even greater clinical relevance.

In the literature, in the population between 18 and 40 years old the recurrence rate after the first episode is 19.1% with conservative treatment in an abduction and external rotation sling and 2.3% after arthroscopic stabilization, as demonstrated by Minkus et al. [26]. Moreover, the recurrence of instability within the first two years can vary between 19% and 88% and reaches 92% in the specific population of patients under 30 years of age [26]. Moreover, in our study, in the majority of cases, the second episode of dislocation occurs within three months of the first. Therefore, especially in this young population, the early indication for surgery becomes even more important.

In this study, excluding new dislocations caused by major trauma (e.g., car accidents, falls during extreme sports), the patients who experienced recurrence or did not perceive their shoulder as perfectly normal (9.1%) are considered failures. These results are consistent with some studies on arthroscopic stabilization [27–29], but not with many others [30, 31]. We believe that the technique described in this study differs from those techniques that, although described by the same name, are limited to performing only a labrum repair. For arthroscopic stabilisation to be effective, it is essential that the surgical technique involves the capsule, especially the entire axillary region, including posteriorly, and that more than 3 double suture anchors are used. Our study shows that the success rate of this technique exceeds 90%. Furthermore, if failures are defined as patients requiring revision surgery, the failure rate is 4.5%. Therefore, the success rate is 95.5%. In the literature, these results are comparable to those of the Latarjet procedure in populations with a similar degree of bone loss [32, 33].

Analyzing the types of failures, causes of revision as well as unsuccessful cases, it seems that failures are associated with multiple episodes of traumatic anterior-inferior instabilities or complex instabilities (multidirectional, revision surgeries, hyper laxity). Multidirectional instabilities, hyper-laxity patients, and revisions of previous stabilizations represent high-risk categories for failure of any stabilization technique. The glenoid 'track' concept has placed even more emphasis on patient selection to minimise failure. This study encourages consideration of the key role of soft tissue quality and also shows that there is still a broad indication for arthroscopic stabilisation in patients younger than 25 years.

The statistical analysis highlights further aspects that make early treatment a relevant factor. Males in the 15–19 age group are more prone to simple lesions. Therefore, it becomes crucial to avoid recurrences in order to limit the severity or extent of injuries. Another critical factor is the number of episodes and reduction manoeuvres. The present study shows that patients operated after only one episode and those with less than three dislocations are statistically correlated with no recurrences when treated. Furthermore, in the analysis of the FA subgroup, it was found that complex injuries/repairs are correlated with multidirectional instability, lax patients or revisions of previous operations. Therefore, timely treatment and careful patient selection are crucial factors for successful outcomes.

Today, preoperative diagnostic examinations focus on bone deficit and do not allow an assessment of soft tissue quality. However, despite numerous proposed methods, there is still no consensus on the assessment of bone deficit or a defined critical cut-off [34]. Furthermore, for this assessment, CT would be the preferred technique, but the authors, given the age of the patients, almost always prefer to rely on MRI. The classifications proposed by Di Giacomo et al. represent for the authors the most correct way to estimate the bone deficit [2]. However, the assessment is sometimes too complex or approximate and therefore often relies on the surgeon's experience without a standardized approach [34]. These measurements only take the bony part into account, so it is essential to consider ligamentous laxity, pathological capsule elongation or capsule deficit that may lead to dislocation despite the measurement of the bone defect identifying it as on-track.

This study changed our approach in those patients where the imaging assessment was inconclusive, or inaccurate due to the technique used, and left room for interpretation. Patient selection is now also based on the number of episodes and the need for reduction manoeuvres. Ultrasound studies that aim to study the capsular tissue focus on evaluating the increase in capsule thickness, not its decrease. Furthermore, as these are dynamic

studies, they draw attention to how much the patient's position can affect a correct assessment of this tissue. Several authors, such as Vaswani, Park and Lee, evaluated the capsular tissue on the basis of its volume and did not identify a clear correlation with the success of arthroscopic stabilization [8, 9, 14]. The authors do not consider the assessment of capsular volume to be decisive, but capsular volumes far above normal can help in identifying those patients with increased tissue laxity. Furthermore, the literature points out that ultrasound has countless critical issues, such as the amount and pressure of the contrast medium, the injection mode and the position of the patient's arm during the examination [11]. As described by Aboalata, Mahure and Park, the authors believe that the number of episodes correlates directly with the quality of the tissue, as well as the extent of the lesions, and thus with the success or failure of surgery [15–17]. The height of the labrum after repair and thus the quality and quantity of capsulolabral tissue available for repair during surgery is one of the key concepts of this surgical technique. Therefore, this study is in agreement with other authors who have evaluated and correlated the number of episodes and the height and thickness of the glenoid capsulo-labral complex after repair with the success of this type of surgery. Another key aspect of the surgical technique used in this study is that it always involves the repair and tensioning of the axillary pouch. The authors believe that this action is fundamental to achieve not only a reduction in capsular volume but above all to repair the axillary capsulolabral tissue and thus the IGHL. Furthermore, the inferior capsuloplasty aims to reduce the space for the humeral head tracking, thus reducing its energy of action. Contrary to those who find no advantages [35], the authors believe that the lateral decubitus position, the use of double traction and a roller for selective axillary distraction are essential to facilitate the treatment of the axillary pouch. As also described by Smeets, the IGHL is as crucial in its stabilising function in the shoulder as the anterolateral ligament in the knee [20]. This, together with Ticker's anatomical and histological demonstrations [21], confirms and strengthens the results of Park, Lee and Kim's studies on the key role of the more inferior anchor [17–19]. In these studies, the antero-inferior anchor is often placed at 5 o'clock. The Authors consider it essential to use an anchor at 7 o'clock, even before the placement of anterior or antero-inferior anchors, that usually are placed at 5 and 3 o'clock. In any case, arthroscopic soft tissue stabilisation of the shoulder must, according to the authors, include treatment of the axillary pouch. This represents a further key point for the standardisation of this surgical technique in order to maximise the success of the procedure. The techniques described in the literature for the treatment of anterior instability involve retensioning the antero-inferior capsule with anterior anchors, rarely but sometimes also distally, or repairing the labrum alone. All devices, hence the repairs, are only anterior, whereas the authors consider it necessary to place a posterior anchor that allows the posterior capsule to be retensioned as well. This neutralises the rotational component of the instability that is co-responsible for recurrences. The analogy is with the jerk-test in knee instability. Having fixed only the anterior part, the humeral head rotates by pivoting on the anterior-inferior point, like a spinning.

The choice of the years 2014 and 2015 for the recruitment of patients in the study is motivated not only by the length of the follow-up but also by two technical reasons. The first is because in 2014 all-suture devices were available in our country. The other reason is the diffusion of the "remplissage" technique, introduced by Eugene M. Wolf in 2004 [24] and implemented in practice in the following years. In fact, compared to the recent past, there is now a clear improvement in surgical techniques, both in terms of execution and variability. In particular, the use of remplissage, which emerged after procedures that were considered the "gold standard" of stabilization in arthroscopy in the past, has yielded significant results [1, 19].

Other important developments have been made in materials and devices that are now much more effective, reliable and resistant. Both metallic and polylactic acid resorbable devices have been abandoned after disastrous failures. Compared to when it was not yet possible to establish superiority between metal anchors and resorbable anchors [36], today the authors believe that the availability on the market of all-suture devices with high-strength single or double sutures has marked another milestone.

Another new concept that makes arthroscopic surgery more reliable is the inclusion of the subscapularis in the repair. When necessary, it can be used to augment constitutionally poor tissues or those weakened by recurrent dislocation. In the past, these situations could surprise the surgeon during arthroscopy. At that time, in these conditions, the Latarjet procedure was undoubtedly the most effective procedure. Therefore, the authors believe that the perception of failures in arthroscopic shoulder stabilization, as reported in the literature, is based on outdated cases. Today, thanks to new techniques and arthroscopic surgical devices, it is possible to treat previously unrecognised or untreatable injuries.

This study therefore also has relevant implications for both radiological and surgical diagnostics. Even if the clinical suspicion is that of an antero-inferior dislocation, it becomes essential to also observe the postero-inferior part of the capsulolabral complex on MRI. Radiologists and other operators often look for the classic signs of antero-inferior dislocation as diagnostic confirmation

and bone involvement, but this study allows us to emphasise the need to observe the posterior part of the axilla as well, especially when studying a case of recurrent instability. A way to assess tissue quality has yet to be found but the increasingly common use of arthro-MRI can help specialists. Arthro-MRI examination must become the standard to assess the volume of the posterior recess of the axilla, Kim-type labral lesions, the apparently 'minor' lesions of the posterior humeral insertion of the inferior glenohumeral ligament, the medialisation of the capsule insertion compared to the posterior labrum, and the flattening of the posterior labrum.

The implication on the surgical side is that surgeons have the tools to search, identify and treat the postero-inferior part of the capsule as well. Similar to the search for RAMP or meniscal root lesions in knee instabilities, the surgeon must also examine the extent of the capsular-labral lesion on the inferior and postero-inferior side and treat it.

This study shows that, with the tools and knowledge available today, there is room for arthroscopic stabilisation of the shoulder. Therefore, with correct patient selection and a standardised surgical technique, the authors suggest that the Latarjet procedure, especially in a young population, should not always be the first choice.

In fact, in the examined population, over half of the patients have post-traumatic anterior-inferior instability and, especially considering prompt treatment, 75% of patients require only isolated capsulolabral repair. Therefore, early intervention prevents or limits bone damage and associated injuries, allowing the surgeon to choose arthroscopic stabilization, which the authors think should be mandatory after the first episode in this population of patients. In addition to the excellent results shown in this study, arthroscopic stabilization is an anatomical procedure that does not limit subsequent procedures and has a very low rate of complications [37]. It is also essential to remember that in patients undergoing the Latarjet procedure, the development or progression of glenohumeral arthritis is observed in 25.8% of cases at 5 years [38–40]. One review found no significant difference in arthrosis between bone block and arthroscopic procedures [41]. However, that study is now 10 years old and obviously included earlier studies. At that time, in the vast majority of cases, arthroscopic fixation devices were metal or resorbable anchors. The authors believe that one of the main reasons for these results is the arthrogenic effect given by the metal anchors, both by their pull-out and their emergence from the cartilage surface. Finally, it must be considered that nowdays arthroscopic stabilization also allows to repair all other associated injuries. The Latarjet procedure alone does not include this aspect. This could be a reason for those shoulders with residual pain even though stabilized after a Latarjet procedure [42]. The arthroscopic Latarjet procedure could address this issue but, even when performed by experienced surgeons, still shows a high complication rate [43].

The main limitation of this study is the sample size, which limits the statistical power of the analysis. Another limitation is the difficulty of comparing this study with the literature. Regrettably, the term "arthroscopic shoulder stabilization" encompasses various techniques that are not directly comparable. This perhaps represents a barrier to understanding and proving the real results of arthroscopic stabilization procedures. Furthermore, the heterogeneity of the study group can be considered a limitation. However, even if the population is not perfectly homogeneous, the presence of revision cases can, according to the authors, also be a strength of the study. A similar consideration can be made for cases of hyperlax patients and patients with multidirectional instability. In the latter, the literature indicates that arthroscopic treatment is the best surgical solution after rehabilitation failure [44]. However, due to the large number of cases, it is not possible to provide conclusive results to verify the surgical technique proposed in this study. Another critical issue, the relevance of which should be left to the subjectivity of the reader, is the exclusion from failures of cases with recurrence after high-energy trauma.

Conclusion

Arthroscopic treatment of shoulder instability in patients under 25 years of age with subcritical bone loss is associated with very high success rates. The study standardises the surgical technique that must involve both anterior and posterior capsular-labral repair with retensioning of the axillary hammock. This study provides selection criteria for choosing the most suitable patients for arthroscopic stabilisation performed according to the described technique. Emphasising the importance of early treatment, the patients who correlate with the greatest chance of success, and therefore the lowest risk of recurrence, are those who have had less than three dislocation episodes and who have not undergone reduction manoeuvres.

Abbreviations

CT	Computed Tomography
MRI	Magnetic Resonance Imaging
IGHL	Inferior Glenohumeral Ligament
PICO	Population, Intervention, Comparison, and Outcome
AI	Anteroinferior Instability
I0	Anteroinferior Traumatic Instability
I1	Anteroinferior Instability Without Major Trauma
I2	Recurrence Following Arthroscopic Stabilisation Surgery
SLAP	superior labrum anterior and posterior
HAGL	Humeral Avulsion Glenohumeral Ligament
F1	Failure type 1 - Recurrent dislocation due to high-energy trauma
F2	Failure type 2 - Recurrent dislocation with minor trauma or in the absence of trauma
F3	Failure type 3 - Perception of instability or subluxation
FA	Type A failures

FB Type B failures

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Informed consent was obtained from all patient involved in the study.

Institutional review board statement
This study was approved by the Scientific Committee of the Casa di Cura Giovanni XXIII (#02/2023), and the protocols used in the study comply with EU and Ministry of Health regulations.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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