Arthroscopic Bankart Repair Versus Open Bristow-Latarjet for Shoulder Instability: A Matched-Pair Multicenter Study Focused on Return to Sport

Title: return to sport after surgery for recurrent anterior shoulder instability. Arthroscopic stabilization using anchors versus open Bristow-Latarjet: a pair-matched multicenter study.

Abstract

Background: Recurrent shoulder instability is a common shoulder pathology especially in athletes. Among the available techniques, the arthroscopic Bankart and open Bristow-Latarjet procedures have been most commonly used to treat recurrent instability.

Hypothesis/Purpose: The aim of this multicenter study was to compare in a case-control matched manner the two techniques with particular emphasis on the return to sport after surgery.

Study Design: retrospective study.

Methods: A study was conducted in two hospitals in patients with post traumatic recurrent anterior dislocations with a minimum follow-up of two years. Patients with glenoid bone loss were excluded. In one hospital, patients were treated with arthroscopic Bankart repair using anchors, while patients in the other had the Bristow-Latarjet procedure. The patients included in the study were matched according to age at surgery, type and level of sport (DOSIS score), and number of dislocations. The primary outcomes were: rate of recurrent instability, return to sport (SPORTS score), Oxford shoulder score for instability (OSSI), Subjective Shoulder Value (SSV), WOSI score and range of motion (ROM). The Student t-test and the Fisher test were used to compare parametric and not parametric results. A multiple regression analysis was also performed to search for factors affecting the ability to return to sport.

Results: The patients that underwent arthroscopic Bankart repair obtained better results in terms of return to sport (SPORTS score: 8 vs. 6, $p = 0.02$) and ROM in the throwing position (86° vs. 79°, $p = 0.01$). The subjective perception of the shoulder was also better in the Bankart group (SSV= 86% vs. 75%, $p = 0.02$). No differences were detectable using the OSSI and WOSI score. The rate of recurrent instability was not statistically different in the two groups (Bankart 11% vs. Bristow-Latarjet 0%, $p = 0.25$). The multiple

regression analysis showed that the independent variables statistically related to the return to a sport were: preoperative DOSIS score, type of surgery and recurrent dislocations after surgery.

Conclusion: In a cohort of patients representative of our population, the arthroscopic stabilization using anchors, provided better results compared to the open Bristow-Latarjet procedure.

Key Terms: recurrent shoulder instability, arthroscopic Bankart repair, open Bristow-Latarjet procedure, DOSIS score, return to sport.

What is known about this subject: Several techniques have been proposed for the treatment of anterior shoulder instability and the two most commonly used techniques are the Bristow-Latarjet technique and the Bankart arthroscopic stabilization. There are very few works comparing these two techniques: they are typically retrospective studies focused on a single technique rather than being based on direct comparison between the two techniques. In only one recent study the transfer of the coracoid was compared with the arthroscopic Bankart repair with slight better outcomes after coracoid transfer.

What this study adds to existing knowledge:While the literature commonly focuses on outcomes such as pain, range of motion and rate of recurrent instability, we put particular emphasis on the return to sport after surgery. In order to optimize the pair-matched process, a modified Tegner score for upper extremity, called the Degree of Shoulder Involvement in Sport (DOSIS), was developed. The arthroscopic stabilization seems to provide better return to sport, better external rotation in the throwing position, and better subjective perception of the affected shoulder compared to the open Bristow-Latarjet procedure.

Introduction

Anterior shoulder instability can be a disabling condition especially when it affects active patients. If conservative treatment fails and an active patient is not able to return to their sport, surgical treatment is usually indicated[6, 7, 18, 21].

Several techniques have been proposed for the treatment of anterior shoulder instability. Among the available techniques, the two most commonly used are the transposition of the coracoid (Bristow-Latarjet technique)[11] and the arthroscopic stabilization by tensioning of the capsule and repair of the labral lesion[8].

Evidence-based data exists supporting the efficacy of both of these procedures[2, 7, 9, 11, 15, 18, 23], and the surgeon's personal preference plays a significant role in the choice of one of these techniques over the other. Supporters of the transposition of the coracoid justify their choice based mainly on a lower recurrence rate and a better return to the patients' pre-injury sport activity levels especially if the patient participated in collision sports[2, 7, 11, 15, 18]. On the other hand, the arthroscopic stabilization strategy restores the anatomy of the shoulder, preserves the range of motion and, with modern instruments, is as effective as the transfer of the coracoid with respect to its recurrence rate[9, 23]. However, most of these opinions have been deduced from retrospective studies focused on a single technique rather than being based on direct comparison between the two techniques.

Very few studies have compared the open Bristow-Latarjet procedure to the arthroscopic stabilization procedure[15, 24]. Hovelius, *et al*, reported in their study including 185 shoulders that the Bristow-Latarjet procedure had a lower recurrence rate and better subjective-based outcomes compared to the open Bankart repair[15]. However, Petrera, *et al*, reported that modern arthroscopic stabilizations have led to better outcomes compared to open Bankart repair[19]. In only one recent study[2] the transfer of the coracoid was compared with the arthroscopic Bankart repair with slight better outcomes after coracoid transfer.

The relative paucity of studies directly comparing these two procedures can be attributed to several factors. Any single surgeon usually has more experience with the one technique that they tend to use for the majority of their cases. This can result in an unintended technical bias toward their favored technique.

Another significant challenge in conducting comparative studies is the extreme variability of patients undergoing surgery for shoulder instability. It is clear that a high-level rugby player cannot be compared with a sedentary patient in this context. This confounding factor could be controlled through a ranking of sports activity into groups with similar involvement of the upper extremity. The Tegner activity scale[22] is a score designed with this specific aim, however, it has been developed for ligamentous injuries of the knee. Unfortunately a similar score has not been developed for the shoulder.

Despite these difficulties, a comparison of the two techniques remains important for its potential benefit in the decision making process for the treatment of recurrent anterior shoulder instability.

The aim of our study was to compare, in a pair-matched manner, the return to sport after open Bristow-Latarjet versus arthroscopic shoulder stabilization. In order to optimize the pair-matched process, a modified Tegner score for upper extremity was developed. This score was called the Degree of Shoulder Involvement in Sport (DOSIS) score and was tested and then applied in the same cohort of patients.

Material and Methods

This study was organized in two phases. The first was a basic research phase to develop and test the DOSIS score. This part was essential for the second clinical phase that was a retrospective multicenter pair-matched study, designed to compare the arthroscopic shoulder stabilization procedure using suture anchors to the open Bristow-Latarjet procedure.

First phase: design of the Degree Of Shoulder Involvement In Sport score (DOSIS score)

The DOSIS score was developed by the SPORT committee of the SIGASCOT (Società Italiana di Ginocchio, Artroscopia, Sport, Cartilagine e Tecnologie Ortopediche) to score the sport activity based on three parameters: 1) *the type of sport* classified as: a) no/minimal demand, b) moderate demand, c) high demand; 2) *the frequency* the sport was played: a) occasionally, b) at least twice a week; 3) *the level* at which the sport was played: a) recreational, b) low level of competition, c) high level of competition (Table I, Figure 1). Using these parameters the DOSIS score is calculated by the researcher using an allocation table (Appendix 1).

During the construction of the DOSIS score it was clear that the parameter "*type of sport*" was the parameter more predisposed to disagreement. To reduce potential disagreement the ranking of the sports followed a 2-step process.

In the first step a questionnaire including a list of 20 common sports and specific positions/roles (e.g. goal keeper in soccer) was sent by email to 7 international experts on the shoulder and elbow (from USA, Italy, Germany, Switzerland, Belgium, Spain, and Turkey). This questionnaire included three questions for each sport that assessed three factors: a) whether or not the sport requires full or almost full range of motion (ROM), b) whether or not the sport is an overhead sport, c) the amount of stress and contact forces to the upper extremity while playing that sport.

Two of the experts suggested that some sports required a significantly different involvement between the dominant and the non-dominant arm. In a second step, based on their suggestions, a new questionnaire that

separated the dominant and non-dominant arms for some specific sports or positions/roles were made. In addition, a question regarding the degree of expertise in the sport of the respondent was added.

This questionnaire was sent by email to the members of the SIGASCOT. This society includes members with different backgrounds but with a comparable expertise in sport related trauma. Using the answers to the questionnaire, the sports were initially classified into either 3 categories (no/minimal demand, moderate demand, high demand, Table II) or 5 categories (no/minimal demand, low demand, moderate demand, high demand, extremely high demand). The classification of a sport into a category was done by measuring the amount of points given for each characteristic (see Appendix 2). In summary, the category of "high demand sport" was defined as a sport that required full range of motion, that included an overhead gesture, and that involved a high stress or contact force on the upper extremity (e.g., water polo, baseball pitcher). The decision to use a 3-group or 5-group classification was made after measuring the inter-observer reliability.

Using the classification of sports table (Table II), the frequency the sport was played and the level at which the sport was played, the DOSIS score was then calculated using the allocation table.

In a subsequent phase the intraobserver reliability of the DOSIS score was tested in a subgroup of 41 patients during their follow up examination after Bristow-Latarjet procedure. These patients belonged to the cohort used for the clinical study. Three weeks before the scheduled appointment an envelope was sent to them containing the DOSIS score questionnaire (Table I). The patients were instructed to answer the questions for the DOSIS score, the same day or the day after they had received the envelope. Two weeks before the planned visit they were re-contacted by phone in order to be sure that they had received the questionnaire and completed it. During the subsequent appointment in the outpatient clinic, the patients were then interviewed and asked to complete again the DOSIS score questionnaire. The answers to the DOSIS score questionnaire were used to calculate the DOSIS score and to measure reliability.

Statistical analysis

The interobserver reliability of the classification of the sports into three categories and into five categories was assessed by calculating the Fleiss' kappa[12] - a statistical measure for assessing the reliability of agreement between a fixed number of raters. A limit of agreement of 0.7 for the experts was predetermined

as the limit to accept the classification. If both the classifications had reached the level of 0.7 of agreement, the 5-group classification would have been used.

The intraobserver reliability of the DOSIS score completed at home was compared to the scores completed in the clinic. The data were analyzed using Bland and Altman analysis[3].

Second phase (pair-matched retrospective study)

The second phase was a retrospective multicenter study conducted in two university hospitals. The two hospitals are located in the same region and, during the period of the study, each hospital had one shoulder unit staffed by two expert surgeons and one or two surgeons in training. The principal investigator (initials) was a member of the shoulder unit that used the Bristow-Latarjet procedure in the majority of the cases. However, he participated in the data analysis only and not the data collection. The follow up was performed by two researchers not involved in the care of the patients.

This study was made possible by the fact that the two shoulder units have had similar surgical indications for recurrent anterior shoulder instability but different approaches with respect to the techniques used (Figure 2).

The inclusion criteria were: 1) post traumatic recurrent anterior dislocation with a minimum of two episodes of documented dislocations, 2) minimum follow-up of two years, 3) patients older than 18 years old.

Cases for which both shoulder units would use the same treatment were excluded. These included: a) patients treated with a coracoid transfer for revision surgery or in cases of 20% or greater glenoid surface bone loss and b) patients treated with arthroscopic shoulder stabilization for recurrent anterior shoulder instability in patients younger than 25 year old not involved in collision sport with less than 5 episodes of dislocations. Patients with other concomitant pathologies (cuff tear, SLAP lesion) were also excluded.

A review of the data of the patients that underwent surgery from April 2004 to December 2010 was performed. The selected patients were then contacted by phone and asked to participate in this study. If they agreed an appointment was scheduled.

During the follow up examination the patients were evaluated using the following scores: the SPORTS score questionnaire[4, 5], the Oxford Instability Shoulder Score (OISS)[10], the Subjective Shoulder Value (SSV)[13], the Western Ontario Shoulders Instability Index (WOSI) score[17] and the DOSIS score.

The SPORTS score was the primary outcome of this study. This is a score designed to address the ability to resume the pre-injury sport level. The available scores range from 0 points (unable to resume the same sport) to 10 points (able perform/resume the same sport at the same level of effort and performance as before onset of impairment without pain). Patients who did not resume their sport for reasons other than the shoulder were asked to answer considering the best level reached before leaving their sport.

The patients were also asked to report any episode of recurrent shoulder dislocation or subluxation. Moreover the active ROM in external rotation with elbow at the side (ER1) and at 90° of abduction (ER2) was measured with a handheld goniometer.

Surgical techniques and post-operative rehabilitation

The arthroscopic stabilization including Bankart repair and re-tensioning of the anterior capsule was performed in lateral decubitus using the classic three portals[8]. Different anchors were used over the course of the study period. The type, number of anchors, length of surgery and perioperative complications were recorded. Postoperatively the patients were placed in a standard sling for 4 weeks. From 5 to 8 weeks patients were allowed to perform passive and active motion up to 0° of external rotation and 90° of abduction. Starting from 9 weeks post-op, full ROM was allowed. Non-collision sports were allowed starting from 3 to 5 months post-op. Collision sports were permitted after 6 months.

The Bristow-Latarjet procedure was performed similarly to the technique described by Walch G.[11] Unlike the original technique, a single 4.5mm malleolar screw without washer was used in all the cases to fix the coracoid to the glenoid. A drain was always kept in place for approximately 24 hours. The length of surgery and perioperative complications were recorded for comparison with the arthroscopic stabilization. After surgery, the patients were placed in a standard sling for 3 weeks. After 3 weeks the sling was removed and

the patients were allowed progressive full range of motion. Non-collision sports were allowed starting from 2 months post-op. Collision sports were permitted after 6 months postoperatively.

Statistical analysis

Patients that underwent arthroscopic repair and Bristow-Latarjet procedure were pair-matched according to age (≤ 22 and >22 year old), the number of episodes of anterior shoulder dislocations before surgery (≤10, > 10 episodes), and the level of sport activity before the onset of shoulder instability (DOSIS ± 0).

The differences between continuous and non-continuous variables were tested using independent samples Student t-Test and the Fisher test for the unmatched cohort of patients. The differences between pair-matched patients were tested using paired Student t-Test and the McNemar test for continuous and non-continuous variables respectively.

A multiple regression analysis was performed to measure correlation between return to sport and recurrent instability after surgery and the following independent variables: age at surgery, involvement of the dominant arm, number of dislocations before surgery, DOSIS score, and recurrent dislocation. The number of anchors was not analyzed since in all but a few cases three anchors were consistently used. P-values of ≤0.05 were considered to be significant for all analyses.

Results

A total of 131 surgeries were performed during the study period (62 arthroscopic stabilizations and 60 Bristow-Latarjet procedures). Of these 131 patients, 36 were met one or more of the exclusion criteria and were not included in the study: 10 patients had a multidirectional instability, 9 a common indication for arthroscopic procedure, 3 had a concomitant SLAP lesion and 3 had surgery after a primary dislocation. An additional 11 cases of coracoid transfer were excluded because they were performed in patients with glenoid bone loss of greater than 20%, or because they were performed as a revision surgeries. This left 95 patients for inclusion. Of these, 90 were traceable and 85 consented to participate in the study and had a follow-up examination. The 5 patients that declined to participate reported no recurrent shoulder instability. Their data, however, were not included in this study. The demographic data and clinical results of the unmatched cohort of patients are reported in Tables III and IV.

DOSIS score

One hundred and twenty five members of SIGASCOT replied to the online questionnaire. However, 15 questionnaires were incomplete and were excluded from the analysis. The remaining 110 questionnaires were filled by the SIGASCOT members including 57 whom considered themselves to be experts in shoulder pathology. The classification of the sports into five categories had a moderate inter-rater reliability among the shoulder pathology experts ($k = 0.51$) and non-experts ($k = 0.45$). The classification of the sports into three subgroups increased the reliability of the classification for both experts ($k = 0.71$) and non-expert raters ($k = 0.63$). Therefore, the classification of the sports into three subgroups was adopted in the definitive version of the DOSIS score and use for the analysis of intra-observer reliability and for the clinical part of this study.

The DOSIS score had excellent intra-observer reliability. The systematic error between the first and the second assessment of the DOSIS score was 0 points with a 95% upper limit of agreement of 0.88 points. Of the 41 patients, 5 changed their answers when they completed the DOSIS score for the second time. Of these,

1 patient changed the frequency he practiced the sport, 1 patient changed the type of sport, 1 patient changed from “no sports” to “occasional jogging” and 2 patients changed their level of competition.

Open Bristow-Latarjet vs. Arthroscopic Stabilization

In the un-matched cohort of patients (average follow-up of ≈ 5 ½ years) the recurrence rate was higher in the patients that underwent arthroscopic stabilization (4 dislocations in the arthroscopic stabilization group (9%) vs. 0 dislocations in the Bristow-Latarjet group) but the difference was not statistically significantly ($p = 0.12$, Table IV). Of the 4 patients that had recurrent dislocation 2 had revision surgeries: 1 with a coracoid transfer and 1 with an arthroscopic stabilization. None of the patients reported subluxation after surgery.

Despite the higher recurrence rate seen with the arthroscopic stabilization patients, this group had a better return to sport (SPORT score 8 versus 6, $p = 0.09$) and a better subjective opinion of their operated shoulder (SSV = 84% vs. 74%, $p = 0.004$). No differences were found in the active external rotation.

No acute complications were reported in the arthroscopic group while one patient in the Bristow-Latarjet group experienced a postoperative hematoma that resolved spontaneously. An average of 3 bio-absorbable anchors were used in the patients that underwent an arthroscopic stabilization (range 2 to 4). All the anchors were loaded with high-strength sutures (Orthocord®, Fiberwire®, Tigerwire®, Tigertail®). Three types of bio-absorbable sutures were used: LUPINE™ (DePuy-Synthes Raynham, Massachusetts, USA), Bio-SutureTak™ (Arhtrex, Naples, Florida, USA), Bio-FASTak® (Arhtrex, Naples, Florida, USA).

Pair-matched analysis

Fifty-six patients were successfully pair-matched. The demographic data and results are reported in Table III and IV. Age, number of preoperative anterior dislocations and DOSIS scores were similar in the two groups confirming the efficacy of the matching process. The average length of surgery was 96 minutes (range 35 to 210 minutes) in the arthroscopic stabilization group and 71 minutes (range 50-120 minutes) in the Bristow-Latarjet group ($p = 0.001$).

The pair-matched analysis confirmed the better clinical results seen with arthroscopic stabilization with respect to the return to sport and SSV. The external rotation in abduction was also better after arthroscopic treatment (Table IV). Three patients in the arthroscopic stabilization group (11%) experienced a recurrent dislocation. Three anchors were used in the patients that had recurrent dislocations. The patients with recurrent instability had significantly more preoperative dislocations (average dislocation 44 vs. 11, p = 0.02). Among the patients that underwent arthroscopic stabilization, the patients with recurrent dislocations, had significantly worse SPORTS scores (5 vs. 9, p= 0.06), SSVs (67 vs. 88, p= 0.003) and WOSI scores (64% vs. 86%, p= 0.03).

Two patients in each pair-matched group (7%) had a SPORTS score of 10 points even though they did not play the same sport at the same level at the time of the follow-up. They were interviewed to investigate the reason of these inconsistent results. It was determined that they quit their sport or changed level (from competitive to recreational) for reasons not associate with their shoulder. Five patients in the Bristow-Latarjet group (18%) and three patients in the arthroscopic stabilization group (11%) were not able to return to sport (SPORTS score 0) (p = 0.7).

The multiple regression analysis showed that the independent variables statistically related to the return to a sport were: preoperative DOSIS score, type of surgery and recurrent dislocations after surgery. Although external rotation at 90° was not statistically related to the return to sport, its p-value approached significance (p < 0.08) (Table V). Figure 3 illustrates the relationship between the degree of shoulder involvement in sport (DOSIS) and the ability to the return to sport after surgery. It seems that the higher the shoulder involvement was in the sport before surgery the lower the ability was to resume it (Figure 3B). The type of surgery was the only independent variable related to recurrent instability after surgery (Bristow-Latarjet, correlation coefficient = -0,13, t = -2.016, p = 0.047).

Discussion

This pair-matched retrospective study has been designed to compare two of the most prevalent techniques for the treatment of recurrent posttraumatic anterior shoulder instability. The principal outcome that we used was the return to sport. The return to sport is usually the first goal of patients seeking treatment for shoulder instability. Warth *et al* in a study of 313 shoulders treated by an arthroscopic procedure, found that the most important expectation was to continue participation in sporting activities[25]. Interestingly, the patients that sought treatment for shoulder instability valued their continued participation in sports more than stopping their shoulder from dislocating.

With respect to the SPORTS score, the patients that underwent arthroscopic stabilization showed a better return to sport compared to those with the open Bristow-Latarjet procedure even though both the techniques provided an high rate of return to sport. More than 80% of the patients returned to their sport for both repair techniques. However, the level at which they returned to sport was significantly in favor of arthroscopic stabilization. Interestingly, the difference in SPORTS score was higher in the middle range of the DOSIS scores and tended to disappear for sports with a high degree of shoulder involvement.

Patients that played sports with high upper extremity involvement (e.g. swimming, rugby, martial arts) at competitive level (DOSIS score 9 or 10) have a lower level of return to sport with both repair techniques (Figure 3). The ability to resume a sport after arthroscopic stabilization seemed, in our series, to be more dependent on the type of sport rather than the use of the Bristow-Latarjet technique. A study by Kim, *et al.* showed a similar correlation between Bankart repair, level of activity/demand and return to previous activity level[16].

In contrast to our findings, the return to sport after coracoid transfer was better in studies focused on competitive rugby and soccer players[7, 18] in comparison to our results. The reasons for this could be a technical issue or the fact that our population was more heterogeneous, including different sports practiced at a recreational level. It is conceivable that recreational athletes had invested less time and effort into their post-operative rehabilitation and had also less motivation to resume their sport compared to professional athletes.

297 Return to sports after surgery for shoulder instability depends on several factors, including perceived
298 shoulder stability while the sport is being played. Other factors, however, such as the recovery of ROM,
299 proprioception, and the type of sport, are equally important. Some studies have already demonstrated that
300 after open and arthroscopic repair the joint position sense improved significantly, to the level of a normal,
301 healthy shoulder [20, 27].

302 Regarding ROM, we found a significant loss of external rotation in the throwing position in patients after
303 coracoid transfer. This finding could contribute to the difference in SPORTS score between the surgical
304 techniques in our study. The multivariate regression analysis seemed to support this hypothesis. A recent
305 systematic review paper has describes similar results regarding external rotation after the Bristow-Latarjet
306 procedure[14].

307 The different levels of return to sport between arthroscopic stabilization and open Bristow-Latarjet procedure
308 is not corroborated by previously published studies in the literature. For this reason our outcome has to be
309 considered with great caution. There is only one study available in the literature that compared arthroscopic
310 Bankart repair and coracoid transfer with similar return to sport results[2]. One possible reason for this
311 discrepancy between our return to sport findings and those previously reported in other studies is that the
312 other studies did not use a dedicated score to measure the return to sport.

313 In our study a new score (DOSIS score) has been used to reach this outcome while other well-known scores
314 such as the Oxford score for instability and the WOSI score did not show significant differences. However,
315 in support of the better return to sport for the arthroscopic technique, we also found a better subjective
316 perception of the operated shoulder compared to a normal shoulder. The SSV in fact was 86% in the
317 arthroscopic group and 75% in the Bristow-Latarjet group ($p = 0.02$). A combination of the limitation in
318 external rotation, different return to sport outcome, as well as cosmetic reasons could have contributed to the
319 difference in SSVs.

320 Similar limitations in the use of specific scores for shoulder instability have been already reported in the
321 recent literature. Netto, *et al.*[1], comparing arthroscopic and open techniques for the treatment of Bankart
322 lesions found no differences when using established scores for instability (ROWE and UCLA scores).

Remarkably, they found differences in scores when using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire -- a score not specifically designed for shoulder instability. A recent study by Stein, *et al.*[21], has been focused on shoulder sport-specific impairments after arthroscopic Bankart repair. They concluded sport-specific impairments are not detectable by established clinical score systems. In this scenario, therefore, it seems reasonable to search for new tools for a more complete assessment of outcomes after surgery for shoulder instability.

The DOSIS score was developed with the specific aim to match the patients according to the level of sport before shoulder impairment. Without this tool, in an unmatched population, the differences between arthroscopic stabilization and coracoid transfer were not significant and similar to the outcomes reported by Bessier, *et al.*[2].

In this study, both repair techniques were able to restore stability in the majority of the patients. The rate of recurrent instability after surgery was 9% in the arthroscopic group and 0% in the Bristow-Latarjet group. Similar rates were reported in the literature[1, 7, 16]. However, the rate of 0% in the Bristow-Latarjet group deserves some further discussion. The patients with glenoid loss higher than 20% were excluded from this study as well as patients with prior surgery. Moreover the average age of patients was 33 years old and adolescent athletes were absent. This could easily explain this low rate of recurrent instability and the low rate of complications[26].

Even if the different in rate of recurrent instability between arthroscopic stabilization and Bristow-Latarjet procedure was not statistically significant, there was a tendency toward a better rate of recurrent instability in the Bristow-Latarjet group. The failure to achieve statistical significance is likely due to the small numbers of patients included with the consequent under-powering of the study. This trend was confirmed by the regression analysis that showed a correlation between technique and rate of recurrent instability after surgery.

Overall we observed a mismatch between subjective clinical outcomes that was in favor of the arthroscopic procedure and rate of recurrent instability that favored the Bristow-Latarjet procedure. Although a definite explanation for this is not available, it is possible that having only 3 patients with recurrent instability,

resulted in a sample size that was too small to negatively affect the overall outcomes after the arthroscopic stabilization.

This study has some limitations. It is a retrospective study based on new score. This score, however, was designed carefully and tested in the same cohort of patients where it showed good psychometric features. Not all the psychometric features of the DOSIS score were analyzed and other studies are needed to further investigate this.

Another limitation is the minimum follow up of 2 years. More dislocations could be observed with longer follow-up. This study, however, was focused on the return to sport that generally does not require a lengthy follow-up to be assessed. Moreover, Griesser, *et al.*, has reported that more than 70% of dislocations occur within one year of the Bristow-Latarjet procedure[14]. Another limitation is that we did not assess the presence and extent of Hill-Sachs lesions. This data was not reported in a reliable way in the documentation of most of the patients treated before 2007.

The strength of this study is that it is a matched-pair study where the patients were carefully matched according to age, degree of shoulder involvement in sport and number of prior shoulder dislocations.

Conclusions

In a cohort of patients representative of our population, without significant glenoid erosion, the arthroscopic stabilization using anchors, provided better return to sport, better external rotation in the throwing position, and better subjective perception of the affected shoulder compared to the open Bristow-Latarjet procedure. The difference in return to sport disappeared when the patients practiced sports with high involvement of the shoulder and at competitive level. If the patient is greatly concerned about recurrent dislocation the open Bristow-Latarjet procedure is preferred.

Table legends

Table I: DOSIS score

*: For seasonal sports considered the frequency during the season

The DOSIS score can be completed either with respect to the sport performed during the month before the questionnaire is filled out, or with respect to the sport performed during the period before the onset of the shoulder disease. In this study we used the DOSIS to investigate the status before the onset of the shoulder instability.

Table II: classification of sports

The list of sports included in each group has to be considered an open list. Other sports not listed here can be added using the instructions in the appendix.

Table III: demographic data

Demographic data of the un-matched and matched patients.

Table IV: outcomes

Bold values are statistically significant ($p<0.05$). ER1: external rotation with the elbow at the side. ER2: external rotation in the throwing position (90° of abduction).

Table V: Multiple regression analyses for return to sport

Bold values are statistically significant ($p < 0.05$).

Figure legends

Figure 1: design of the DOSIS score

The DOSIS score was developed by the SPORT committee of the SIGASCOT to score the sport activity based on three parameters: 1) *the type of sport* (in blue) classified as: a) no/minimal demand, b) moderate demand, c) high demand; 2) *the frequency* the sport was played (in orange) : a) occasionally, b) at least twice a week; 3) *the level* at which the sport was played (in yellow): a) recreational, b) low level of competition, c) high level of competition.

The classification of sports in groups with similar involvement of the upper extremity was done taking into account whether or not the sport requires full or almost full range of motion (ROM), b) whether or not the sport is an overhead sport, c) the amount of stress and contact forces to the upper extremity while playing that sport. To address this issue an online questionnaire was sent to the members of the SIGASCOT.

Figure 2: inclusion and exclusion criteria

Figure 3A&B: relationship between DOSIS score and SPORT score.

The difference in SPORTS scores tends to disappear for higher DOSIS scores.

Appendix legends

Appendix 1: Allocation table

Using this table the researcher scores patient according to type of sport, frequency in which the sport is played, and level of the sport. For example an occasional tennis player (high demand sport-Table II), with involvement of the dominant arm, is assigned a DOSIS score of 6 (in gray).

Appendix 2: Classification of sports based on the online questionnaire

According to the three characteristics of each sport (ROM, overhead gesture, amount of stress and contact forces) the sports were ranked into three groups. This is an open list. New sports can be added and ranked in one of three groups. The ranking will be defined by the total points given for each characteristic. For example if a researcher wants to add windsurfing he/she has to define a)the ROM needed to perform windsurfing (not full = 0 points), b) if windsurfing can be considered an overhead sport (no = 0 points), amount of stress and contact forces (high = 2 points). The total points for windsurfing would therefore be 2 points = moderate demand. The researcher has to decide if the involvement of the shoulder is significantly different between dominant and non-dominant arms. For windsurfing the involvement is approximately the same, hence the distinction between dominant and non-dominant arms is not necessary.

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Table I

1) What sports did you play before the onset of your shoulder problem? List the sports below and indicate which was the most important/predominant for you:		
List of sports	**Most important/predominant**	
1)	yes	no
2)	yes	no
3)	yes	no
…	yes	no
2) How frequently did you participate in sports?*		
Occasionally		
≥ 2 times a week, most of the weeks of the year		
3) What level of sport did you play?		
Recreational		
Low level of competition (regional, local)		
High level of competition (national or international or professional)		
4) Which was your dominant arm during your sports activities?		

Table II

No-minimal involvement of the upper extremity	Moderate involvement of the upper extremity	High involvement of the upper extremity
Jogging	Soccer	Swimming
Street cycling	Bowling (dominant arm)	Martial art
Horseback riding	Nordic ski	Gymnastic
Bowling (non-dominant arm)	Rowing	Volleyball (dominant arm)
Mountain bike	Motocross	Tennis/squash (dominant arm)
Alpine ski	Golf	Baseball pitcher
Nordic Walking	Track and field (running and jumping)	Baseball (dominant arm)
Hiking	Track and field (throwing) (non-dominant arm)	American football quarterback
	Kayak	American football
	Dance	Rugby
	Basketball	Water polo
	Volleyball (non-dominant arm)	Track and field (throwing) (dominant arm)
	Tennis/squash (non-dominant arm)	Soccer, Goal keeper
	Baseball (non-dominant arm)	Rock Climbing

Table III

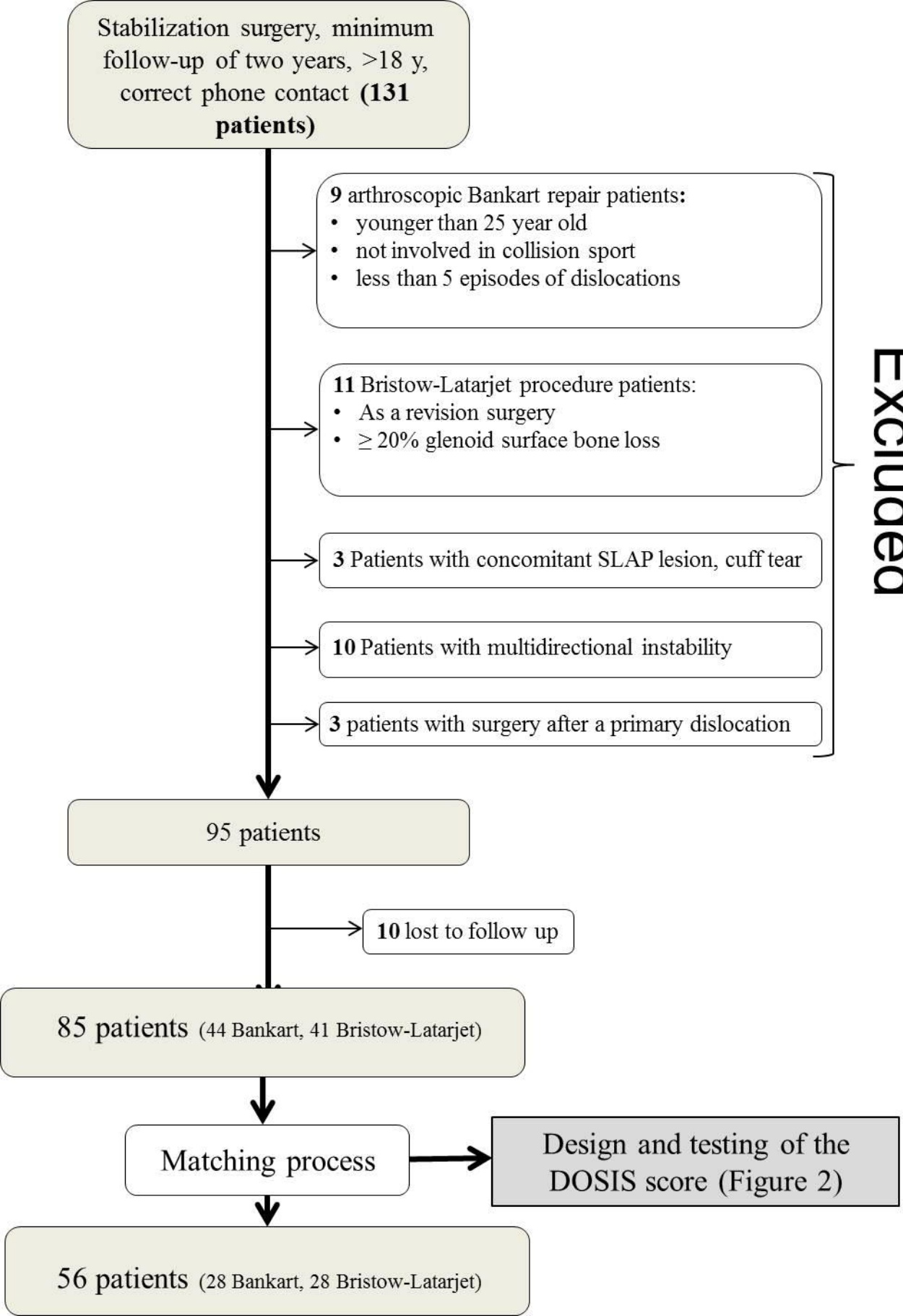
		N	Age	Sex (Male)	DOSIS	N of shoulder dislocations before surgery	Surgery on dominant shoulder	Collision Sport	Follow up (years)
Unmached patients	**Bankart**	44	34 (20 to 53)	39 (89%)	6 (2 to10)	14 (2 to >50)	25 (57%)	20 (45%)	5.4 (2.9 to 9.8)
	Bristow-Latarjet	41	33 (19 to 63)	36 (88%)	5 (2 to10)	20 (2 to >50)	23 (56%)	22 (54%)	5.1 (2 to 8.7)
	p		0.72	1	0.37	0.26	1	0.5	0.5
Matched population	**Bankart**	28	31.5 (20 to 53)	24 (86%)	6 (2 to10)	15 (2 to >50)	17 (61%)	17 (61%)	5.3 (2.9 to 9)
	Bristow-Latarjet	28	31.5 (19 to 45)	24 (86%)	6 (2 to10)	19 (2 to >50)	18 (64%)	15 (54%)	5.3(2 to8.7)
	p		0.96	1	1	0.44	1	0.79	0.89

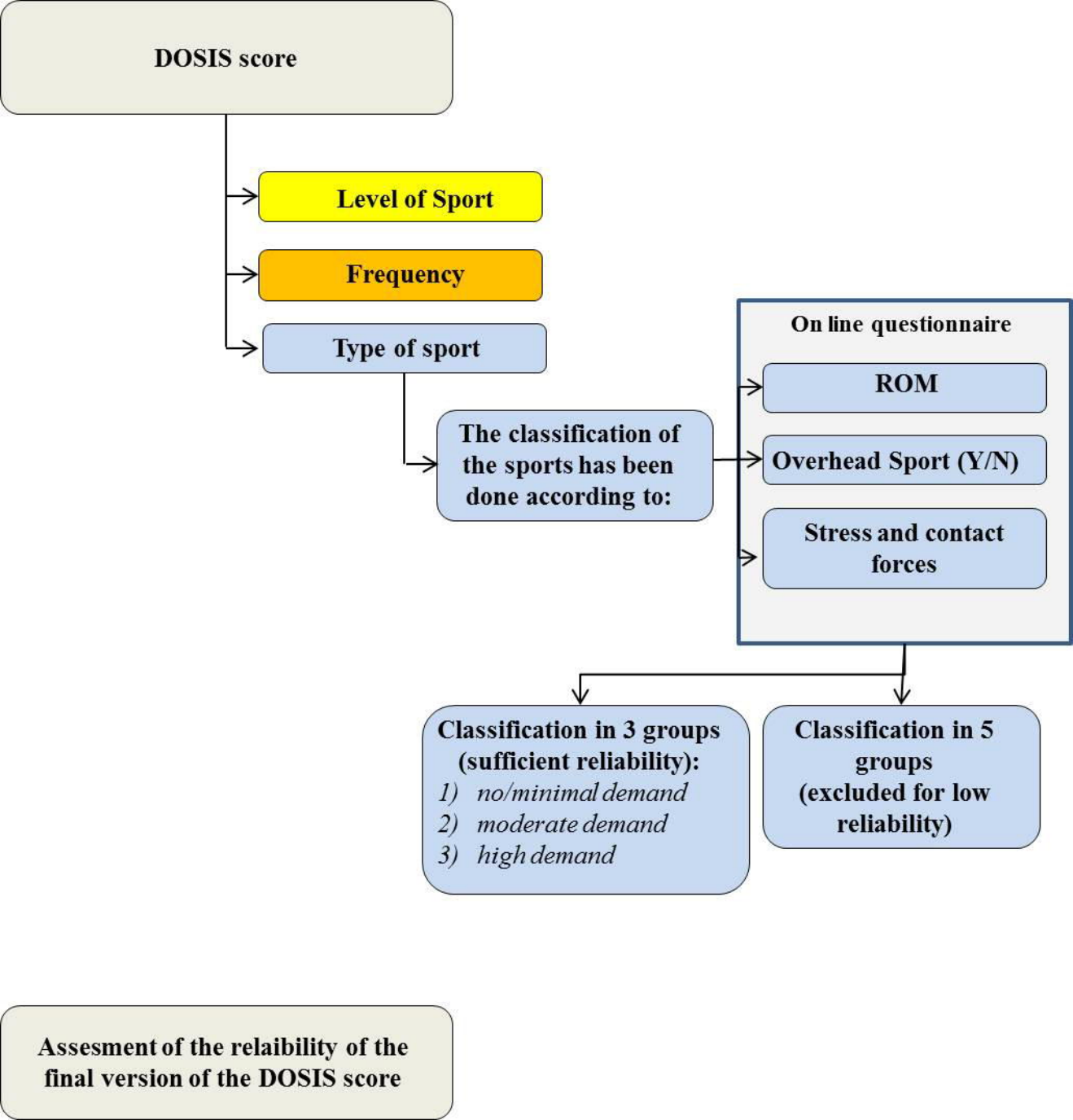
Table IV

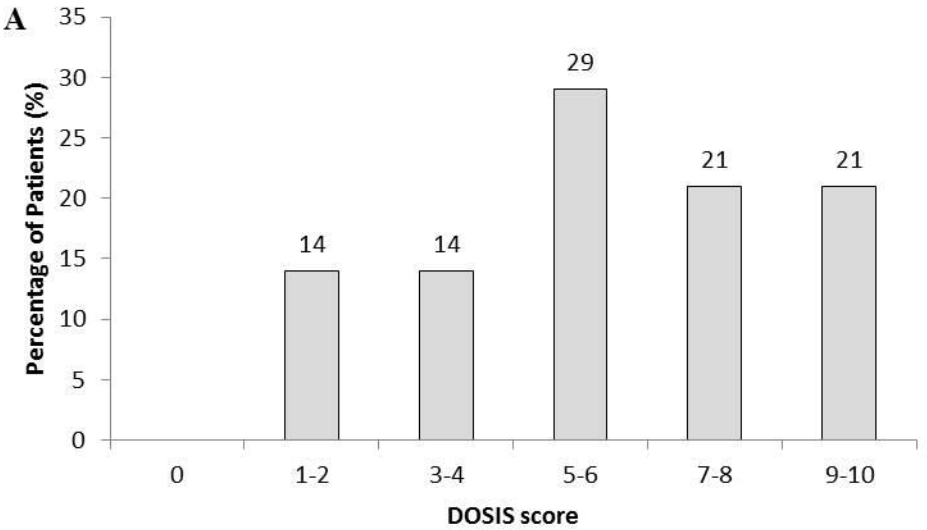
		Oxford	SPORTS Score	WOSI					SSV	ER1 (°)	ER2 (°)	Recurrent disclocation	Revision surgery
				A	B	C	D	%					
Un-matched patients	Bankart N= 44	42	8	118 (0-480)	58 (0-290)	62 (0-240)	53 (0-270)	84% (44-100%)	84	57° (10°-75°)	84° (60°-105°)	4 (9%)	2 (5%)
	Bristow-Latarjet N= 41	40	6	166 (0-540)	73 (0-290)	80 (0-359)	49 (0-300)	82% (37-99%)	74	54 (30°-75°)	80° (30°-100°)	0 (0%)	0
	p	0.24	0.09	0.13	0.35	0.29	0.75	0.77	**0.004**	0.35	0.24	0.12	0.1
Matched patients	Bankart N= 28	41	8	107 (0-480)	51 (0-290)	51 (0-210)	41 (0-190)	84 (46-100%)	86	57° (10°-75°)	86° (70°-105°)	3 (11%)	2
	Bristow-Latarjet N= 28	40	6	169 (0-540)	83 (0-290)	85 (0-285)	50 (0-260)	82 (37-99%)	75	56° (30°-70°)	79° (50°-100°)	0 (0%)	0
	p	0.36	**0.02**	0.13	0.101	0.07	0.63	0.588	**0.02**	0.76	**0.01**	0.25	0.5

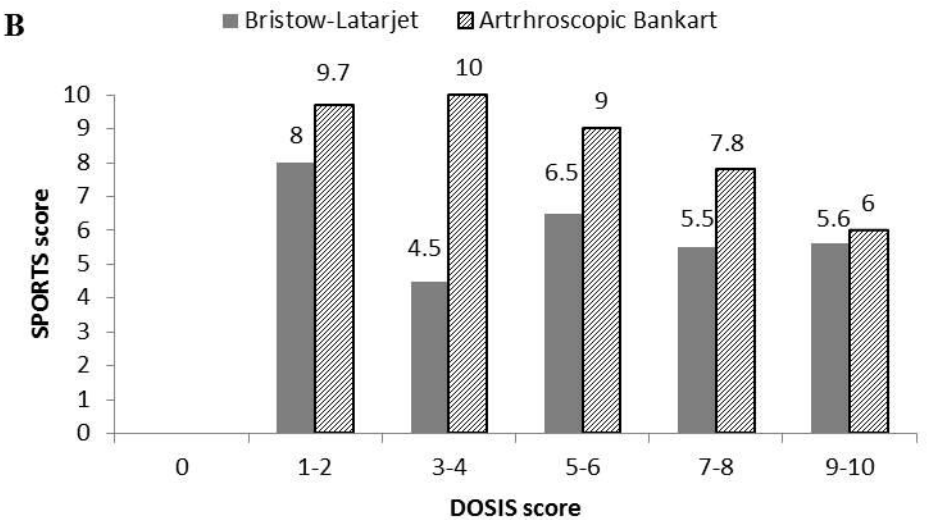
Table V

Independent variables for **return to SPORT**	Coefficient	Std. Error	t	P
Bristow-Latarjet	**-2.74**	**0.82**	**-3.36**	**0.0012**
DOSIS score	**-0.44**	**0.15**	**-2.95**	**0.0042**
Recurrent dislocations	**-3.75**	**1.37**	**-2.73**	**0.008**
ER2	0.06	0.03	1.80	0.08
Age	-0.07	0.05	-1.51	0.13
ER1	-0.04	0.04	-1.0	0.28
Dominant Arm	-0.74	0.81	-0.91	0.36
Number of preoperative dislocations	0.005	0.02	0.24	0.8


Stabilization surgery, minimum follow-up of two years, >18 y, correct phone contact (131 patients)
9 arthroscopic Bankart repair patients:
• younger than 25 year old
• not involved in collision sport
• less than 5 episodes of dislocations
11 Bristow-Latarjet procedure patients:
• As a revision surgery
• ≥ 20% glenoid surface bone loss
3 Patients with concomitant SLAP lesion, cuff tear
10 Patients with multidirectional instability
3 patients with surgery after a primary dislocation
Excluded
95 patients
10 lost to follow up
85 patients (44 Bankart, 41 Bristow-Latarjet)
Matching process
Design and testing of the DOSIS score (Figure 2)
56 patients (28 Bankart, 28 Bristow-Latarjet)


DOSIS score
Level of Sport
Frequency
Type of sport
The classification of the sports has been done according to:
On line questionnaire
ROM
Overhead Sport (Y/N)
Stress and contact forces
Classification in 3 groups (sufficient reliability):
1) no/minimal demand
2) moderate demand
3) high demand
Classification in 5 groups (excluded for low reliability)
Assesment of the relaibility of the final version of the DOSIS score


A
Percentage of Patients (%)
35
30
25
20
15
10
5
0
14
14
29
21
21
0
1-2
3-4
5-6
7-8
9-10
DOSIS score


B
Bristow-Latarjet
Artrhroscopic Bankart
SPORTS score
10
9
8
7
6
5
4
3
2
1
0
8
9.7
4.5
10
6.5
9
5.5
7.8
5.6
6
0
1-2
3-4
5-6
7-8
9-10
DOSIS score

Appendix 1

		Type of SPORT			Frequency of playing the sport *		Level of SPORT		
DOSIS score	**No sport**	**No/Minimal Demand**	**Moderate Demand**	**High Demand**	**Occasionally**	**≥ 2 times per week**	**Recreational**	**Lower level of competition: Local/Regional divisions**	**Higher level of competition: National or International level or Professional athletes**
10				*					*
9				*				*	
8				*		*	*		
8			*						*
7			*					*	
6				*	*		*		
6		*							*
5		*						*	
4			*			*	*		
3			*		*		*		
2		*				*	*		
1		*			*		*		
0	*								

Appendix 2

	ROM Full/almost full		Overhead		Stress/Contact					
SPORTS	Yes (1)	No (0)	Yes (1)	No (0)	No-minimal (0)	Moderate (1)	High (2)	Extremely high (3)	Total	**Classifications**
Jogging		*		*	*					**No-Minimal Demand**
Road cycling		*		*	*					
Horseback riding		*		*	*					
Bowling (non-dominant arm)		*		*	*					
Mountain bike		*		*		*				
Alpine ski		*		*		*				
Nordic Walking		*		*		*				
Hiking		*		*		*				
Soccer		*		*			*			**Moderate Demand**
Bowling (dominant arm)		*		*			*			
Nordic ski	*			*		*				
Rowing		*		*			*			
Motocross		*		*			*			
Golf	*			*		*				
Track and field (running and jumping)	*			*		*				
Track and field (throwing), (non-dominat arm)	*			*		*				
Kayak	*			*			*			
Dance	*			*			*			
Basketball	*			*			*			
Volleyball (non-dominant arm)	*		*			*				
Tennis/squash (non-dominant arm)	*		*			*				
Baseball (non-dominant arm)	*		*			*				
Swimming	*		*				*			**High Demand**
Rugby	*			*				*		
American football (non-dominant arm)	*			*				*		
Martial art	*			*				*		
Gymnastic	*			*				*		
Volleyball (dominant arm)	*		*				*			
Tennis/squash (dominant arm)	*		*				*			
Water polo (non-dominant arm)	*		*				*			
Baseball pitcher (non-dominant arm)	*		*				*			
American football quarterback (non-dominant arm)	*		*				*			
Soccer, goal keeper	*			*				*		
Rock Climbing	*			*				*		
Baseball (dominant arm)	*		*					*		
Water polo(dominant arm)	*		*					*		
Baseball pitcher (dominant arm)	*		*					*		
American football quarterback (dominant arm)	*		*					*		
Track and field (throwing), (dominant arm)	*		*					*		