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Instability Severity Index Score predicts recurrent shoulder instability after arthroscopic Bankart repair

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Abstract

Purpose: The Instability Severity Index (ISI) Score was developed to preoperatively assess the risk of recurrent shoulder instability after an arthroscopic Bankart repair. This study aims to validate the use of ISI Score for predicting the risk of recurrence after an arthroscopic Bankart repair in a heterogeneous population and proposes an appropriate cut-off point for treating patients with an arthroscopic Bankart repair or otherwise.

Methods: This study analysed 99 shoulders after a traumatic dislocation that underwent arthroscopic Bankart repair with at least 3 years follow-up. Patients were divided into subcategories based on their respective ISI Score. Recurrence includes either a postoperative dislocation or perceived instability.

Results: The overall recurrence rate was found to be 26.3%. A significant correlation was identified between ISI Score and the recurrence rate (odds ratio [OR]: 1.545, 95% confidence interval [CI]: 1.231–1.939, $p < 0.001$). Furthermore, ISI Score 4–6 (OR: 4.498, 95% CI: 1.866–10.842, $p < 0.001$) and ISI Score > 6 (OR: 7.076, 95% CI: 2.393–20.924, $p < 0.001$) both had a significantly higher risk of recurrence compared to ISI Score 0–3. In ISI Score subcategories 0–3, 4–6 and >6, the recurrence rate was, respectively, 15.4%, 40.7% and 71.4%.

Conclusion: ISI Score has predictive value in determining the recurrence risk of shoulder instability following an arthroscopic Bankart repair in a heterogeneous population. Based on the findings of this study, we recommend using arthroscopic Bankart repair in patients with ISI Score 0–3. Clinical and shared decision-making are essential in the group with ISI Score 4–6, since the recurrence rate is significantly higher than in patients with ISI Score 0–3. Arthroscopic Bankart repair is not suitable for patients with ISI Score > 6.

Level of Evidence: Level III.

KEYWORDS

arthroscopy, Bankart repair, instability, shoulder, surgery

Abbreviations: IQR, interquartile range; ISIS, Instability Severity Index Score; MRA, magnetic resonance arthrogram; SD, standard deviation.

INTRODUCTION

Opting for conservative treatment after a shoulder dislocation often results in recurrence (60%–96%) of traumatic anterior shoulder instability in a young and active population [3, 17, 20, 25, 28, 38]. Arthroscopic Bankart repair, considered the gold standard of treating anterior shoulder instability, is a quick procedure with low complication risks and a return to sports rate of 62.5%–97.5% [14, 18, 31, 33]. Nonetheless, recurrent instability after this type of surgery remains an issue, with rates ranging from 8.1% to 41.7% [1, 14, 15, 21, 27, 29, 33, 36, 39, 40]. In patients with severe bone loss, a boneblock procedure like the Latarjet can be a good option. However, reoperation rates of 7% and complication rates of up to 30% are described, including neurological deficits and nonunions [11, 12, 13, 26, 34].

The Instability Severity Index (ISI) Score was developed by Balg and Boileau (Table 1) to determine whether Bankart repair is a suitable treatment option [5]. Considering postoperative recurrent instability rates, the ISI Score gives the physician insight into the probability of successfully treating traumatic anterior instability. Balg and Boileau proposed a scoring system ranging from 0 to 10, consisting of these risk factors: age, shoulder hyperlaxity, patient participation in contact or overhead sports, patient participation in competitive sports and presence of a Hill–Sachs lesion or glenoid bone loss on X-ray. Their study identified a recurrence rate of 70% after an arthroscopic Bankart repair in patients with ISI Score > 6. They suggested that patients with such scores be treated with a Latarjet procedure. However, studies conducted in active military patients show that ISI Score is not accurate, making its use in clinical decision-making debatable [7, 8]. An ISI Score > 6 cut-off, as proposed by Balg and Boileau has been scrutinised in other studies that have observed high recurrence rates even in patients with ISI Score 4–6, therefore a lower cut-off point is proposed [23, 30].

The aim of this study is primarily to re-evaluate the predictive value of ISI Score in a heterogeneous population and secondarily to identify an appropriate ISI Score cut-off point for treatment with arthroscopic Bankart repair. The hypothesis is that the ISI Score, as proposed by Balg and Balg, can predict recurrent shoulder instability following arthroscopic Bankart repair in a heterogeneous population. However, we expect the current cut-off point of ISI Score > 6 may lead to an unacceptably high recurrence rate, suggesting the need for a lower, more appropriate cut-off point. This should aid clinicians in decision-making for patients with anterior shoulder instability.

TABLE 1 The Instability Shoulder Index Score as created by Balg and Boileau [5].

	Points
Age	
≤20	2
>20	0
Hyperlaxity	
No	0
Yes	1
Hill–Sachs on imaging	
No	0
Yes	2
Loss of glenoid contour on imaging	
No	0
Yes	2
Type of sport	
None or other	0
Contact or overhead	1
Sport intensity	
Recreational or none	0
Competitive	2

MATERIALS AND METHODS

The study was approved by the local institutional review board from the Medisch Spectrum Twente (MST-K20-23).

All patients undergoing stabilising shoulder surgery at Medical Spectrum Twente between 1 January 2014 and 15 August 2019 were retrospectively identified from the electronic patient records system.

All patients were seen at the outpatient clinic with an anterior–posterior (AP) radiograph. During this appointment, an orthopaedic surgeon assessed shoulder hyperlaxity, which is defined as external rotation >85° with the upperarm at the side or a positive Gagey test. After the first visit to the outpatient clinic, all patients underwent magnetic resonance arthrogram (MRA) to asses labral tears. When there was no sign of significant bone loss or engaging Hill–Sachs, an additional computed tomography (CT) scan was performed. Based on the findings by Burkhart and Beer, if glenoid bone loss exceeded 25.0%, measured on a sagittal plane with the best-fit circle method, a Latarjet was performed [6]. Furthermore, if the surgeon suspected the presence of engaging Hill–Sachs lesion, a CT scan was performed. In case of a wide Hill–Sachs lesion which was located relatively, medially on the humeral head and there was subcritical glenoid bone loss (15%–25%), a Latarjet procedure was conducted. If the MRA and X-ray showed a Bankart lesion without

evidence of massive bone loss (<25.0%), patients were planned for an arthroscopic Bankart repair.

Patients were selected based on the following inclusion criteria: (1) traumatic involuntary recurrent anterior instability of the shoulder with at least one full dislocation treated with an arthroscopic Bankart repair and (2) age 18 years or older at the time of surgery. Exclusion criteria were (1) previous shoulder surgery, (2) additional shoulder injury, (3) glenoid defect exceeding 25%, (4) bilateral surgery, (5) engaging Hill–Sachs lesion and (6) inability to complete questionnaires because of language or cognitive impairment. In total, 99 patients were included (Figure 1).

Surgical technique and follow-up

The operation was performed on a beach chair or in lateral decubitus position. The labrum is released and mobilised from the glenoid using a standard posterior viewing portal and two anterior working portals. Next, the glenoid is prepared with an arthroscopic shaver until bleeding of the glenoid rim is reached for improved soft-tissue healing. Nonresorbable sutures (FibreWires 2.0, Arthrex) were passed through the capsule and labrum to perform a capsular shift. The labrum was fixated to the glenoid rim using absorbable knotless anchors (Push Lock, Arthrex) starting from the inferior side and moving up to the superior end of the lesion. A total of 66 patients had lesions which were fixated with two anchors in the lower quadrant, while nine patients with smaller lesions required only one anchor, and 24 patients with larger lesions required three anchors for adequate fixation. Patients were discharged on the same day of surgery with an antirotation sling for the first 6 weeks. Patients were instructed to wear their sling, perform gentle pendulum exercises twice daily, and avoid external rotation passed neutral during these first 6 weeks. After 6 weeks, patients had to follow active therapy for 6 weeks under the supervision of a physiotherapist to achieve full range of motion. After 12 weeks, progressive strengthening was allowed. After 6 months, return to contact sports was allowed. All patients underwent a functional assessment by the surgeon 2 months and 1 year after surgery.

Outcome measures and data collection

A list of all stabilising shoulder procedures performed during the study period was provided by the orthopaedics department. The medical charts of all patients that met the inclusion criteria were reviewed, and the following variables were collected from the electronic patient medical records: patient demographics, date of surgery, type of lesion, recurrence or nonrecurrence, recurrence date, type of recurrence, revision surgery, radiological imaging and procedural characteristics.

A written questionnaire was sent to all patients, asking for demographic and ISI Score data. We also used the questionnaire to identify possible recurrences that were not entered into the patient records (treated elsewhere or spontaneous reduction). Patients that did not reply to the written questionnaire were reached by phone and presented with the same questions. Patients who did not provide a written or verbal response to the questionnaire were excluded because of missing data. Every patient that replied to the questionnaire provided an informed consent statement.

To determine the radiological parameters of ISI Score, an independent musculoskeletal radiologist judged all radiologic diagnostics. A senior radiologist assessed the X-rays for signs of glenoid bone loss and Hill–Sachs lesions. Only the AP radiographs in internal and external rotation were assessed to calculate ISI Score. MRAs or CTs were not used to calculate ISI

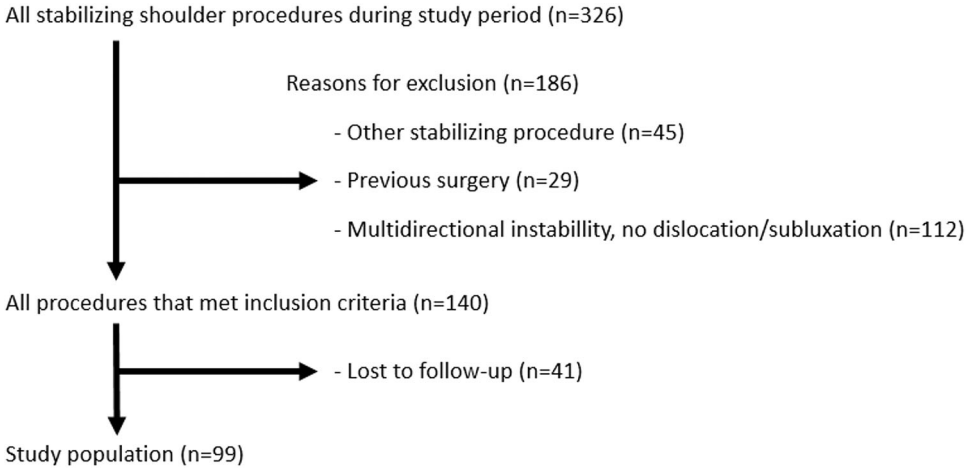

FIGURE 1 Flowchart of handling inclusion and exclusion criteria.

Score. By combining the electronic patient file search, the written questionnaire and the radiological findings of the senior radiologist, an accurate assessment of ISI Score could be performed for all included patients.

In the context of this study, recurrence was defined as a (partial) anterior glenohumeral dislocation that spontaneously reduced or required intervention at an emergency department. Additionally, we included subjective instability, denoting perceived instability without an actual dislocation event, which was recorded during routine follow-up or via the questionnaire.

Additionally, the relative risk of ISI Score > 6 was compared to ISI Score 0–6 (the cut-off point proposed by Balg and Balg) and ISI Score 0–6 was further subdivided into ISI Score 0–3 and ISI Score 4–6 to explore significant differences in recurrence risk.

Demographics

During the study period, an arthroscopic Bankart repair was performed on 99 patients, comprising 73 (73.7%) males and 26 (26.3%) females, with a mean age of 27 (standard deviation [SD]: 9.3) years and a mean follow-up period of 5.9 (SD: 1.5) years. At the time of surgery, 29 patients (29.3%) were ≤20 years of age and shoulder hyperlaxity was found in 19 (19.1%) patients. Twenty-seven (27.3%) Hill–Sachs lesions were identified and only five (5.1%) cases of glenoid bone loss were found. Fifty patients (50.5%) were known for participating in contact or overhead sports, and 43 (43.4%) patients competed in their sports. An overview of patient characteristics is presented in Table 2. In our population, the ISI Score ranged from 0 to 10, with a mean score of 2.5 (SD: 2.3). Figure 2 depicts the ISI Score distribution.

Statistical analysis

Data were analysed with Statistical Package for Social Sciences (SPSS Statistics, version 26.0). Continuous data are presented with mean and SD, when normally distributed, or median and range (IQR), when skewedly distributed. The Kolmogorov–Smirnov test was used to determine normal distribution. Categorical data are summarised by frequency and percentage within each cohort. The univariate associations between recurrence and demographic characteristics were assessed using Student's *t* test or Mann–Whitney *U* tests for continuous variables. Categorical variables were compared by Pearson's χ^2 test. Binary logistic regressions were performed to analyse the link between ISI Score and recurrence. We assessed the relative risk between predefined (ISI Score

TABLE 2 Demographic characteristics for all patients and subpopulations (with and without recurrence of shoulder instability).

Variable	All patients (99)	Patients with recurrence (26)	Patients without recurrence (73)	Risk estimate (%), 95% CI	*p* Value[a]
n (%)	99 (100)	26 (26.3)	73 (73.7)		
Follow-up, years, mean (SD)	5.9 (1.5)	5.9 (1.6)	5.8 (1.5)		
Sex, male, *n* (%)	73 (73.7)	19 (73.1)	54 (74.0)	0.874 (.429–1.779)	n.s.
Age, years, mean (SD)	27 (9.3)	22 (4.8)	28 (10.8)		<0.01
Dominant limb affected, *n* (%)	52 (52.5)	13 (50.0)	39 (53.4)	0.904 (.467–1.748)	n.s.
Multiple dislocations, *n* (%)	74 (74.5)	20 (76.9)	54 (74.0)	1.126 (.510–2.488)	n.s.
Age ≤ 20,[b] *n* (%)	29 (29.3)	12 (46.2)	17 (23.3)	2.070 (1.093–3.922)	0.04
Hyperlaxity, *n* (%)	19 (19.1)	10 (38.5)	9 (12.3)	2.632 (1.429–4.854)	0.01
Hill-Sachs on Xray-AP, *n* (%)	27 (27.3)	10 (38.5)	17 (23.3)	1.667 (0.866–3.205)	n.s.
Loss of glenoid on Xray-AP, *n* (%)	5 (5.1)	4 (15.3)	1 (1.4)	3.412 (1.931–6.061)	0.01
Participates in contact or overhead sports, *n* (%)	50 (50.5)	18 (69.2)	32 (43.8)	2.203 (1.058–4.587)	0.02
Participates in competitive sports, *n* (%)	43 (43.4)	18 (69.2)	25 (34.3)	2.933 (1.409–6.098)	<0.01
Anchors used median (IQR)	2 (2–3)	2 (2–3)	2 (2–2)		n.s.
ISI Score, mean (SD)	2.5 (2.3)	4.5 (2.6)	2.2 (2.0)		<0.01

Abbreviations: AP, anterior–posterior; CI, confidence interval; IQR, interquartile range; ISI, Instability Severity Index; *n*, number of patients; SD, standard deviation.

[a]*p* Value calculated between recurrence and nonrecurrence.

[b]Age presented as binary variable as described in ISI Score.

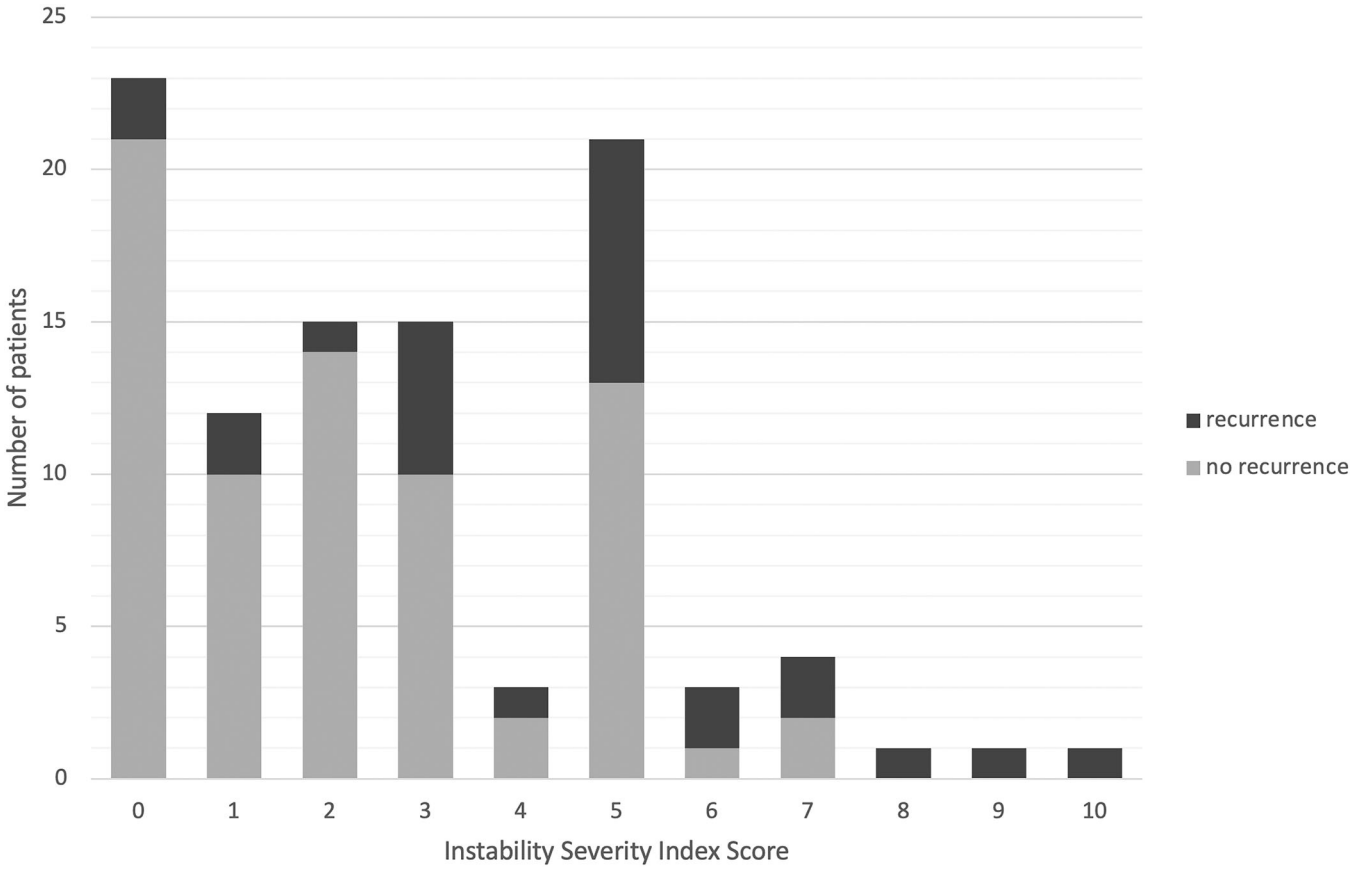

FIGURE 2 Distribution of the Instability Severity Index Score.

0–3, ISI Score 4–6, ISI Score 0–6 and ISI Score 7–10) subcategories of ISI Score and recurrence using a Cox regression to identify a cut-off point and performed a separate Kaplan–Meier curve to provide a visual overview of recurrence per ISI Score subcategory. A p value < 0.05 was considered statistically significant.

RESULTS

During the follow-up period, 26 (26.3%, measurement accuracy 18.3%–35.6%) cases of recurrent instability were recorded, of which 15 (57.7%) were complete dislocations and 11 (42.3%) subluxations. Four (26.6%) of the 15 full dislocations and one subluxation were due to trauma. Of the 26 cases, 14 (53.9%) underwent Latarjet revision surgery. Recurrence occurred at a mean time of 42.1 months (SD: 25.5) after surgery. ISI Score appeared to have a predictive value for recurrence with an OR of 1.545 (1.231–1.939), which was significant ($p < 0.01$) (Table 3).

Cut-off score

The recurrence for the predetermined subcategories, ISI Score 0–3 (15.4%), ISI Score 4–6 (40.7%) and ISI Score 7–10 (71.4%), was assessed to determine an adequate cut-off score. Through a Cox regression analysis we found that patients with ISI Score > 6 have a significantly higher risk of recurrent instability than ISI Score 0–6 (hazard ratio [HR]: 4.178, $p = 0.004$). There is already a significant increase in recurrence risk in ISI Score group 4–6 compared to ISI Score 0–3 (HR: 4.498, $p < 0.01$) (Table 4).

A separate Kaplan–Meier curve was performed to visually depict recurrent shoulder instability after

TABLE 3 Univariate regression analysis to determine the correlation between recurrence and ISI Score.

	Univariate analysis	
	Unadjusted OR (95% CI)	*p* Value
ISI Score	1.545 (1.231–1.939)	<0.01
Sex	0.955 (0.347–2.628)	n.s.
Age	0.904 (0.825–0.978)	0.01
Preoperative dislocations	1.173 (0.410–3.357)	n.s.
Dominant limb affected	0.872 (0.356–2.135)	n.s.
Anchors used	1.030 (0.458–2.319)	n.s.

Abbreviations: CI, confidence interval; ISI, Instability Severity Index; OR, odds ratio.

arthroscopic Bankart repair, categorised by ISI Score (Figure 3).

DISCUSSION

The most important finding of the present study was that the ISI Score significantly correlates with recurrent instability after the arthroscopic Bankart repair. This study showed a recurrence rate of 26.3% in 99 arthroscopic Bankart repairs in a heterogeneous population. The reported recurrence rate corresponds with rates reported in literature, which range from 8.1% to 41.7% [1, 14, 15, 21, 27, 29, 33, 39, 40]. Mean time to recurrence in this cohort was 2.1 (SD: 1.4) years, which was similar to the systematic review of Harris et al. [15]. with a mean time to recurrence of 2.2 years. Other studies identified a longer mean period to recurrence ranging from 2.7 to 3 years [24, 40]. This study did not identify any significant association or correlation between recurrence and gender, number of anchors used intraoperatively, type of lesion, whether the shoulder affected was on the dominant side, or number of preoperative dislocations in this population.

TABLE 4 Cox regression to identify an appropriate ISI Score cut-off point.

	Cox regression Unadjusted HR (95% CI)	*p* Value
ISI Score 4–6 (compared to ISI Score 0–3)	4.498 (1.866–10.842)	<0.01
ISI Score > 6 (compared to ISI Score 0–3)	7.076 (2.393–20.924)	<0.01
ISI Score > 6 (compared to ISI Score 0–6)	4.178 (1.561–11.178)	<0.01

Abbreviations: CI, confidence interval; HR, hazard ratio; ISI, Instability Severity Index.

Predictive value of ISI Score

There was a significant correlation between ISI Score and recurrences ($p < 0.01$) in this study, so a higher ISI Score indicates an increased risk of recurrence. Furthermore, age, type of sport and sports activity all correlated significantly with recurrence.

Dekker et al. [8] and Chan et al. [7] identified recurrence rates of 11.4% and 26%, respectively, but no correlation between recurrence and ISI Score. Those studies included patients who were active military personnel, a male-dominated population (>90% vs. 73.7% in our study), covering a minimum 2-year period (vs. minimum 3 years in our study). Both their populations participated in regular physical exercise and military training, which is not the case for our population. Because of this regular

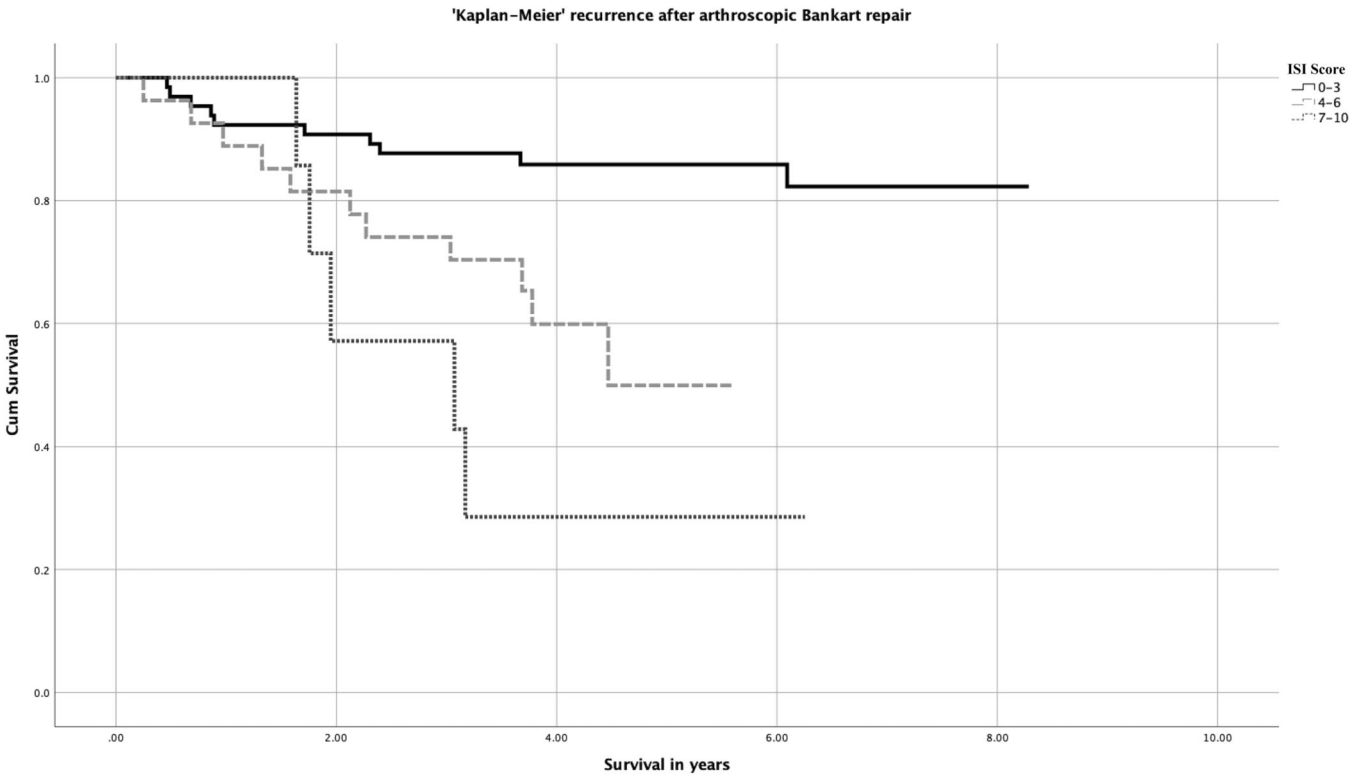

FIGURE 3 Kaplan–Meier survival curve for recurrent shoulder instability after arthroscopic Bankart repair categorised by Instability Severity Index (ISI) Score.

exercising, Chan et al. designated their entire population as participating in competitive sports, versus 50.7% for Dekker et al. and 43.3% in our study. Both studies recorded a higher mean ISI Score versus our 2.5 mean (Dekker 3.6, Chan 3.5). Dekker et al. solely performed arthroscopic Bankart repair in patients with ISI Score 1–6, Chan had an ISI Score upper limit of up to 8 and the range in our study was 0–10.

Research efforts have attempted to identify other risk factors predisposing to recurrence after arthroscopic Bankart repair [36, 37]. Some suggest replacing the bone loss parameters of ISI Score with on-/off-track lesions and have further specified the indication for arthroscopic Bankart repair with improved outcomes, thus not rejecting the ISI Score but altering it [10, 19, 22]. However, this on-/off-track principle or 'Glenoid Track Instability Management Score' is dependent on advanced imaging techniques, which are not widely adopted, thus making ISI Score the best and easiest alternative for predicting recurrence preoperatively.

Cut-off score

By assessing the cut-off point proposed by Balg and Balg of ISI Score > 6, a recurrence rate of 71.4% ($p = 0.004$). This finding concurs with other studies [20, 23, 30]. It is shown that patients with ISI Score ≤ 3 experience around 4%–6.3% recurrence, whereas an ISI Score < 6 has recurrence rate of around 10% [5, 23, 30]. In order to identify an appropriate cut-off score, we categorised ISI Score into different subgroups (0–3, 4–6 and 7–10). By performing a Cox regression analysis, we identified the HRs of ISI Score 4–6 and 7–10 compared to ISI Score 0–3 (shown in Table 4). Based on the results found, arthroscopic Bankart repair is recommended for patients with ISI Score 0–3. This concurs with findings presented by other ISI Score validation studies [30, 32, 35] which suggest that arthroscopic Bankart repair is safe in patients with ISI Score < 4, with recurrence rates ranging from 3.2% to 6.3%. In this group, patients with ISI Score 4–6 have a relative risk for recurrence (rate 40.7%) and should be consulted for other stabilising surgery such as a Latarjet or adding a remplissage. Based on our study, ISI Score is an effective tool in clinical decision-making to treat nonathletic patients with anterior shoulder instability to prevent recurrence.

Strengths and limitations

The cohort size and heterogeneity of the study population are one strength of this study. However, due to its retrospective nature, there is a selection bias. The number of patients that had an ISI Score > 6 is limited because this group could have been treated with a Latarjet primarily. Another reason for the higher recurrence might be the cut-off for an indication for Latarjet at 25% bone loss [4, 9]. Recent studies propose a 10%–24% cut-off measured on three-dimensional imaging [16, 26].

Another strength lies in the utilisation of the administered questionnaire, enabling a more precise representation of ISI Score and recurrences in the data set. The identification of recurrence after arthroscopic Bankart repair that occurred or were treated elsewhere was enabled by the questionnaire. Our follow-up was 36–99 months, during which recurrences could potentially have been overlooked, especially in cases with only 3 years of follow-up. However, Ahmed et al. [2] demonstrated that 55% of recurrences occur in the first year, steadily decreasing over 5 years. Therefore, the majority of recurrences would likely have been recorded within the follow-up period covered in this study.

CONCLUSION

ISI Score does have predictive value in determining the recurrence risk of shoulder instability following an arthroscopic Bankart repair in a general population. Based on the findings in this study, we recommend using arthroscopic Bankart repair in ISI Score 0–3 and performing a Latarjet in patients with an ISI Score > 6. Clinical and shared decision-making is essential in the ISI Score 4–6 group, since recurrence is significantly higher than in those with ISI Score 0–3.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection were performed by Matthijs Y. H. van Blommestein. Data analysis was performed by Matthijs Y. H. van Blommestein and Job van der Palen, Egbert Jan D. Veen, Lonneke H. M. Govaert and Wiebe C. Verra conceived and designed the study. The first draft of the manuscript was written by Matthijs Y. H. van Blommestein, and all authors assisted in drafting and editing the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, M. Y. H. v. B., upon reasonable request.

ETHICS STATEMENT

The study was approved by the local institutional review board (MST-K20-23). Informed consent was obtained from all patients included in this study.

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REFERENCES

1. Aboalata, M., Plath, J.E., Seppel, G., Juretzko, J., Vogt, S. & Imhoff, A.B. (2016) Results of arthroscopic Bankart repair for anterior-inferior shoulder instability at 13-year follow-up. *The American Journal of Sports Medicine*, 45(4), 782–787. Available from: https://doi.org/10.1177/0363546516675145
2. Ahmed, I., Ashton, F. & Robinson, C.M. (2012) Arthroscopic Bankart Repair and capsular shift for recurrent anterior shoulder instability. *Journal of Bone and Joint Surgery*, 94(14), 1308–1315. Available from: https://doi.org/10.2106/JBJS.J.01983
3. Arciero, R.A., Wheeler, J.H., Ryan, J.B. & McBride, J.T. (1994) Arthroscopic Bankart repair versus nonoperative treatment for acute, initial anterior shoulder dislocations. *The American Journal of Sports Medicine*, 22(5), 589–594. Available from: https://doi.org/10.1177/036354659402200504
4. Arner, J.W., Peebles, L.A., Bradley, J.P. & Provencher, M.T. (2020) Anterior shoulder instability management: indications, techniques, and outcomes. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 36(11), 2791–2793. Available from: https://doi.org/10.1016/j.arthro.2020.09.024
5. Balg, F. & Boileau, P. (2007) The instability severity index score. *The Journal of Bone and Joint Surgery. British Volume*, 89-B11, 1470–1477. Available from: https://doi.org/10.1302/0301-620X.89B11.18962
6. Burkhart, S.S. & De Beer, J.F. (2000) Traumatic glenohumeral bone defects and their relationship to failure of arthroscopic Bankart repairs. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 16(7), 677–694. Available from: https://doi.org/10.1053/jars.2000.17715
7. Chan, A.G., Kilcoyne, K.G., Chan, S., Dickens, J.F. & Waterman, B.R. (2019) Evaluation of the instability severity index score in predicting failure following arthroscopic Bankart surgery in an active military population. *Journal of Shoulder and Elbow Surgery*, 28(5), e156–e163. Available from: https://doi.org/10.1016/j.jse.2018.11.048
8. Dekker, T.J., Peebles, L.A., Bernhardson, A.S., Golijanin, P., Di Giacomo, G., Hackett, T.R. et al. (2021) Limited predictive value of the instability severity index score: evaluation of 217 consecutive cases of recurrent anterior shoulder instability. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 37(5), 1381–1391. Available from: https://doi.org/10.1016/j.arthro.2020.12.185
9. Di Giacomoa, G., Itoi, E. & Burkhart, S.S. (2014) Evolving concept of bipolar bone loss and the hill-sachs lesion: from “engaging/non-engaging” lesion to “on-track/off-track” lesion. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 30(1), 90–98. Available from: https://doi.org/10.1016/j.arthro.2013.10.004
10. Di Giacomob, G., Peebles, L.A., Pugliese, M., Dekker, T.J., Golijanin, P., Sanchez, A. et al. (2020) Glenoid track instability management score: radiographic modification of the instability severity index score. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 36(1), 56–67. Available from: https://doi.org/10.1016/j.arthro.2019.07.020
11. Domos, P., Lunini, E. & Walch, G. (2017) Contraindications and complications of the Latarjet procedure. *Shoulder & Elbow*, 10(1), 15–24. Available from: https://doi.org/10.1177/1758573217728716
12. Griesser, M.J., Harris, J.D., McCoy, B.W., Hussain, W.M., Jones, M.H., Bishop, J.Y. et al. (2013) Complications and re-operations after Bristow-Latarjet Shoulder Stabilization: a systematic review. *Journal of Shoulder and Elbow Surgery*, 22(2), 286–292. Available from: https://doi.org/10.1016/j.jse.2012.09.009
13. Gupta, A., Delaney, R., Petkin, K. & Lafosse, L. (2015) Complications of the Latarjet procedure. *Current Reviews in Musculoskeletal Medicine*, 8(1), 59–66. Available from: https://doi.org/10.1007/s12178-015-9258-y
14. Harada, Y., Iwahori, Y., Kajita, Y., Takahashi, R., Yokoya, S., Sumimoto, Y. et al. (2022) Return to sports after arthroscopic Bankart repair on the dominant shoulder in overhead athletes. *Journal of Orthopaedic Science*, 27(6), 1240–1245. Available from: https://doi.org/10.1016/j.jos.2021.07.014
15. Harris, J.D., Gupta, A.K., Mall, N.A., Abrams, G.D., McCormick, F.M., Cole, B.J. et al. (2013) Long-term outcomes after Bankart shoulder stabilization. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 29(5), 920–933. Available from: https://doi.org/10.1016/j.arthro.2012.11.010
16. Haskel, J.D., Colasanti, C.A., Hurley, E.T., Matache, B.A., Jazrawi, L.M. & Meislin, R.J. (2021) Arthroscopic Latarjet procedure: indications, techniques, and outcomes. *JBJS Reviews*, 9(3), e20.00071. Available from: https://doi.org/10.2106/JBJS.RVW.20.00071
17. Hovelius, L. (1978) Shoulder dislocation in Swedish ice hockey players. *The American Journal of Sports Medicine*, 6(6), 373–377. Available from: https://doi.org/10.1177/036354657800600611
18. Hurley, E.T., Manjunath, A.K., Bloom, D.A., Pauzenberger, L., Mullett, H., Alaia, M.J. et al. (2020) Arthroscopic Bankart repair versus conservative management for first-time traumatic anterior shoulder instability: a systematic review and meta-analysis. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 36(9), 2526–2532. Available from: https://doi.org/10.1016/j.arthro.2020.04.046
19. Itoi, E. (2017) ‘On-track’ and ‘off-track’ shoulder lesions. *EFORT Open Reviews*, 2(8), 343–351. Available from: https://doi.org/10.1302/2058-5241.2.170007
20. Kasik, C. & Saper, M.G. (2018) Variability of outcome reporting following arthroscopic Bankart repair in adolescent athletes: a systematic review. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 34(4), 1288–1294. Available from: https://doi.org/10.1016/j.arthro.2017.10.041
21. Kramer, J., Gajudo, G. & Pandya, N.K. (2019) Risk of recurrent instability after arthroscopic stabilization for shoulder instability in adolescent patients. *Orthopaedic Journal of Sports Medicine*, 7(9), 232596711986899. Available from: https://doi.org/10.1177/2325967119868995
22. Locher, J., Wilken, F., Beitzel, K., Buchmann, S., Longo, U.G., Denaro, V. et al. (2016) Hill-Sachs off-track lesions as risk factor for recurrence of instability after arthroscopic Bankart repair. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 32(10), 1993–1999. Available from: https://doi.org/10.1016/j.arthro.2016.03.005
23. Loppini, M., Delle Rose, G., Borroni, M., Morenghi, E., Pitino, D., Domínguez Zamora, C. et al. (2019) Is the instability severity index score a valid tool for predicting failure after primary arthroscopic stabilization for anterior glenohumeral instability? *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 35(2), 361–366. Available from: https://doi.org/10.1016/j.arthro.2018.09.027
24. Mahure, S.A., Mollon, B., Capogna, B.M., Zuckerman, J.D., Kwon, Y.W. & Rokito, A.S. (2018) Risk factors for recurrent instability or revision surgery following arthroscopic Bankart repair. *The Bone & Joint Journal*, 100-B(3), 324–330. Available from: https://doi.org/10.1302/0301-620X.100B3.BJJ-2017-0557.R1
25. McLaughlin, H.L. & MacLellan, D.I. (1967) Recurrent anterior dislocation of the Shoulder II. A comparative study. *The Journal of Trauma: Injury, Infection, and Critical Care*, 7(2), 191–201. Available from: https://doi.org/10.1097/00005373-196703000-00002

26. Min, K.S., Wake, J., Cruz, C., Miles, R., Chan, S., Shaha, J. et al. (2023) Surgical treatment of shoulder instability in active-duty service members with subcritical glenoid bone loss: Bankart vs. Latarjet. *Journal of Shoulder and Elbow Surgery*, 32(4), 771–775. Available from: https://doi.org/10.1016/j.jse.2022.10.011
27. Murphy, A.I., Hurley, E.T., Hurley, D.J., Pauzenberger, L. & Mullett, H. (2019) Long-term outcomes of the arthroscopic Bankart repair: a systematic review of studies at 10-year follow-up. *Journal of Shoulder and Elbow Surgery*, 28(11), 2084–2089. Available from: https://doi.org/10.1016/j.jse.2019.04.057
28. Novakofski, K.D., Melugin, H.P., Leland, D.P., Bernard, C.D., Krych, A.J. & Camp, C.L. (2022) Nonoperative management of anterior shoulder instability can result in high rates of recurrent instability and pain at long-term follow-up. *Journal of Shoulder and Elbow Surgery*, 31(2), 352–358. Available from: https://doi.org/10.1016/j.jse.2021.07.016
29. Panzram, B., Kentar, Y., Maier, M., Bruckner, T., Hetto, P. & Zeifang, F. (2020) Mid-term to long-term results of primary arthroscopic Bankart repair for traumatic anterior shoulder instability: a retrospective study. *BMC Musculoskeletal Disorders*, 21(1), 191. Available from: https://doi.org/10.1186/s12891-020-03223-3
30. Phadnis, J., Arnold, C., Elmorsy, A. & Flannery, M. (2015) Utility of the instability severity index score in predicting failure after arthroscopic anterior stabilization of the shoulder. *The American Journal of Sports Medicine*, 43(8), 1983–1988. Available from: https://doi.org/10.1177/0363546515587083
31. Rodriguez, K., Hurley, E.T., Park, C.N., Bulleit, C., Levin, J.M., Klifto, C.S. et al. (2024) Complications following arthroscopic Bankart repair: a systematic review. *Journal of Shoulder and Elbow Surgery*, 33(2), 435–440. Available from: https://doi.org/10.1016/j.jse.2023.08.013
32. Rosenberg, S.I., Padanilam, S.J., Pagni, B.A., Tjong, V.K. & Sheth, U. (2021) A lower instability severity index score threshold may better predict recurrent anterior shoulder instability after arthroscopic Bankart repair: a systematic review. *Journal of ISAKOS*, 6(5), 295–301. Available from: https://doi.org/10.1136/jisakos-2020-000584
33. Rossi, L.A., Pasqualini, I., Tanoira, I. & Ranalletta, M. (2022) Factors that influence the return to sport after Arthroscopic Bankart repair for Glenohumeral instability. *Open Access Journal of Sports Medicine*, 13, 35–40. Available from: https://doi.org/10.2147/OAJSM.S340699
34. Rutgers, C., Verweij, L.P.E., Priester-Vink, S., van Deurzen, D.F.P., Maas, M. & van den Bekerom, M.P.J. (2022) Recurrence in traumatic anterior shoulder dislocations increases the prevalence of Hill–Sachs and Bankart lesions: a systematic review and meta-analysis. *Knee Surgery, Sports Traumatology, Arthroscopy*, 30(6), 2130–2140. Available from: https://doi.org/10.1007/s00167-021-06847-7
35. Thomazeau, H., Courage, O., Barth, J., Pélégri, C., Charousset, C., Lespagnol, F. et al. (2010) Can we improve the indication for Bankart arthroscopic repair? a preliminary clinical study using the ISIS score. *Orthopaedics & Traumatology: Surgery & Research*, 96(8), S77–S83. Available from: https://doi.org/10.1016/j.otsr.2010.09.007
36. Vermeulen, A.E., Landman, E.B.M., Veen, E.J.D., Nienhuis, S. & Koorevaar, C.T. (2019) Long-term clinical outcome of arthroscopic Bankart repair with suture anchors. *Journal of Shoulder and Elbow Surgery*, 28(5), e137–e143. Available from: https://doi.org/10.1016/j.jse.2018.09.027
37. Verweij, L., van Spanning, S.H., Grillo, A., Kerkhoffs, G., Priester-Vink, S., van Deurzen, D. et al. (2021) Age, participation in competitive sports, bony lesions, ALPSA lesions, > 1 preoperative dislocations, surgical delay and ISIS score > 3 are risk factors for recurrence following arthroscopic Bankart repair: a systematic review and meta-analysis of 4584 shoulders. *Knee surgery, Sports Traumatology, Arthroscopy*, 29(12), 4004–4014. Available from: https://doi.org/10.1007/s00167-021-06704-7
38. Wheeler, J.H., Ryan, J.B., Arciero, R.A. & Molinari, R.N. (1989) Arthroscopic versus nonoperative treatment of acute shoulder dislocations in young athletes. *Arthroscopy: The Journal of Arthroscopic & Related Surgery*, 5(3), 213–217. Available from: https://doi.org/10.1016/0749-8063(89)90174-6
39. Xu, Y., Wu, K., Ma, Q., Zhang, L., Zhang, Y., Xu, W. et al. (2019) Comparison of clinical and patient-reported outcomes of three procedures for recurrent anterior shoulder instability: arthroscopic Bankart repair, capsular shift, and open Latarjet. *Journal of Orthopaedic Surgery and Research*, 14(1), 326. Available from: https://doi.org/10.1186/s13018-019-1340-5
40. Zimmermann, S.M., Scheyerer, M.J., Farshad, M., Catanzaro, S., Rahm, S. & Gerber, C. (2016) Long-term restoration of anterior shoulder stability: a retrospective analysis of arthroscopic Bankart repair versus open Latarjet procedure. *Journal of Bone and Joint Surgery*, 98(23), 1954–1961. Available from: https://doi.org/10.2106/JBJS.15.01398

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