A lower Instability Severity Index score threshold may better predict recurrent anterior shoulder instability after arthroscopic Bankart repair: a systematic review

Samuel I Rosenberg, 1 Simon J Padanilam, 1 Brandon Alec Pagni, 1 Vehniah K Tjong, 2 Ujash Sheth 3

ABSTRACT
Importance The Instability Severity Index (ISI) score was developed to evaluate a patient’s risk of recurrent shoulder instability following arthroscopic Bankart repair. While patients with an ISI score of >6 were originally recommended to undergo an open procedure (ie, Latarjet) to minimise the risk of recurrence, recent literature has called into question the utility of the ISI score.

Objective The purpose of this systematic review was to evaluate the efficacy of the ISI score as a tool to predict postoperative recurrence among patients undergoing arthroscopic Bankart procedures.

Evidence review Articles were included if study participants underwent arthroscopic Bankart repair for anterior shoulder instability and reported postoperative recurrence by ISI score at a minimum of 2 years of follow-up. Methodological study quality was assessed using the Methodological Index for Non-Randomized Studies criteria. Pearson’s $\chi^2$ test was used to compare recurrence rates among patients above and below an ISI score of 4. Sensitivity, specificity, mean ISI scores and predictive value of individual factors of the ISI score were qualitatively reviewed.

Findings Four studies concluded the ISI score was effective in predicting postoperative recurrence following arthroscopic Bankart repair; however, these studies found threshold values lower than the previously proposed score of >6 may be more predictive of recurrent instability. A pooled analysis of these studies found patients with an ISI score <4 to experience significantly lower recurrence rates when compared with patients with a score $\geq$4 (6.3% vs 26.0%, p<0.0001). The mean ISI score among patients who experienced recurrent instability was also significantly higher than those who did not.

Conclusions and relevance The ISI score as constructed by Balg and Boileau may have clinical utility to help predict recurrent anterior shoulder instability following arthroscopic Bankart repair. However, this review found the threshold values published in their seminal article to be insufficient predictors of recurrent instability. Instead, a lower score threshold may provide as a better predictor of failure. The paucity of level I and II investigations limits the strength of these conclusions, suggesting a need for further large, prospective studies evaluating the predictive ability of the ISI score.

Level of evidence IV.

What is already known
- The Instability Severity Index (ISI) score was developed by Balg and Boileau to predict recurrent shoulder instability among patients undergoing arthroscopic Bankart repair.
- There have been conflicting results regarding the clinical utility of the ISI score in predicting recurrent instability.

What are the new findings
- Based on the current literature, the ISI score may be a useful clinical tool to help surgeons predict recurrent instability following an arthroscopic Bankart procedure.
- Evidence from level III and IV studies suggests a lower ISI score threshold may improve the ability to predict recurrent anterior shoulder instability following an arthroscopic Bankart repair.

INTRODUCTION
The glenohumeral joint’s wide range of motion, poor osseous congruency and capsular laxity result in frequent instability, making it the most commonly dislocated joint in the body. 1, 2 First-time shoulder dislocation incidence ranges from 8.0 to 8.2 per 100 000 people per year and has a prevalence of about 2%. 3 A large number of patients experience pathological changes after initial anterior dislocation or subluxation which predispose the patient to recurrent instability, including avulsion of the anteroinferior labrum (Bankart tear) and potential bone loss of the glenoid and posterosuperior humeral head (Hill-Sachs lesion). 4 These changes may increase the patient’s risk of recurrent instability, with recurrence rate as high as 92% following non-operative management in young athletes. 5

To stabilise the glenohumeral joint and prevent recurrence in the form of dislocation or subluxation, several operative techniques have been developed, including the arthroscopic Bankart repair and the Latarjet procedure. Bankart repair, the most commonly used technique for patients with recurrent anterior instability, is performed arthroscopically by reattaching the torn anteroinferior labrum to the respective portion of the glenoid cavity using multiple suture anchors. While many patients...
experience excellent postoperative long-term outcomes,6 recurrence rates of 6%–50% have been reported.1–3,7–12 Alternatively, the Latarjet procedure involves open stabilisation by transferring the coracoid bone and its conjoined tendon to the glenoid in order to provide bony augmentation and increased static stabilisation. This more invasive procedure reports a much lower recurrence rate of only 5.8%, but has a complication rate as high as 30%, including nerve injury, non-union and early-onset osteoarthritis.13

In order to help determine which patients may require a Latarjet procedure over arthroscopic Bankart repair, Balg and Boileau7 created the Instability Severity Index (ISI) score in 2007. Several preoperative risk factors were found to predict recurrence of instability after Bankart repair and were incorporated into the weighted score, including age, degree and type of sports participation, shoulder hyperlaxity, and the presence of a Hill-Sachs lesion or glenoid loss on anteroposterior radiograph, as shown in the online supplementary appendix. When a patient’s ISI score and risk of recurrence following a Bankart repair are high, the more invasive Latarjet procedure is recommended. Balg and Boileau7 found their study population with repair are high, the more invasive Latarjet procedure is recommended. Balg and Boileau7 found their study population with

Figure 1  PRISMA flow diagram of the inclusion process for selected articles.14 ISIS, Instability Severity Index score; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

METHODS

Literature search and study selection

A review of the literature was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.14 MEDLINE, CINAHL and EMBASE databases were used to identify published articles until 24 June 2020 using a combination of the following search terms: ‘instability severity index score’, ‘ISIS’, ‘ISI’, ‘shoulder’ and ‘glenohumeral’. Details of the search strategy for one database are shown in the online supplementary appendix. Two investigators independently reviewed the identified articles to assess for inclusion in the qualitative analysis. Inclusion criteria consisted of (1) study participants undergoing arthroscopic Bankart repair for anterior shoulder instability, (2) median follow-up greater than 2 years and (3) postoperative outcomes stratified by ISI score. Exclusion criteria included additional surgical procedures outside of standard of care for operative treatment of primary recurrent anterior shoulder instability such as remplissage and rotator cuff repair, inclusion of patients undergoing revision shoulder surgery, lack of available full text and published in non-English language. All references from selected studies were further reviewed to ensure all relevant articles were included in the analysis.

Data collection and evaluation

After final selection of included studies, data regarding patients’ ISI score, recurrence rates, and ISI score sensitivity and specificity were extracted and organised in a custom spreadsheet. Additional details from each study were also recorded, including patient demographics, study design and surgical procedure. The Methodological Index for Non-Randomized Studies (MINORS) scoring was used to assess the methodological quality of all included studies.15 Studies were evaluated on a number of methodological criteria, each with a score of 0–2. A maximum of 16 points or 24 points was possible depending on whether the study design was comparative or non-comparative, respectively.

Statistical analysis

When available, sensitivity and specificity data were used to calculate recurrence rates based on individual ISI scores. For statistical comparison of the average ISI scores between patients who experienced recurrent instability and patients who did not, a two-tailed independent t-test was used (JMP 15 SAS, Cary, North Carolina). Pearson’s χ² test was used to compare the recurrence rates of patients with ISI score less than 4 with patients with scores greater than or equal to 4. A p value less than 0.05 was deemed significant.

RESULTS

Study characteristics

An initial search yielded 127 studies after duplicates were removed. A total of eight studies met the inclusion criteria for this systematic review (figure 1). Of the included studies, the level of evidence was level II in one study,15 level III in four10,29–31 and level IV in three.1,13 Three studies were prospective in nature.10 The mean follow-up of included studies was 4.7 years, with a mean reported follow-up rate of 95%. A total of 1563 patients (84% male) were collectively evaluated in this systematic review, with a mean age of 26.8 years. An arthroscopic Bankart repair was the primary procedure, with all studies reporting a mean or median number of suture anchors of 2 or greater. Additional surgical techniques included postero-inferior capsule plication,9 rotator interval closure,9 superior labrum anterior and posterior (SLAP) repair,11 anterior capsular repositioning10 and thermal...
anteroinferior capsular shrinkage. Four studies defined surgical failure as recurrence of dislocation or subluxation, while three additionally included subjective instability as surgical failure, and the final study included both surgical failure and functional failure (failure to return to preinjury activity). The mean MINORS score of the included studies was 69% (range 44%-81%); individual study scores and their components are shown in table 1 and the online supplementary appendix, respectively. A summary of study characteristics is shown in table 1.

**Sensitivity and specificity analysis**
In three studies, the receiver operating characteristics (ROCs) curves were used to evaluate the specificity and sensitivity of the ISI score in predicting recurrence of shoulder instability after arthroscopic Bankart repair. The investigations by Chen et al and Phadnis et al found an ISI score of 4 to be an optimal and effective cut-off for predicting recurrent instability after arthroscopic Bankart repair. Chen et al and Phadnis et al noted that a score of 4 or greater yielded sensitivities of 0.742 and 0.737 and specificities of 0.733 and 0.951, respectively. Chen et al reported an area under the curve (AUC) of 0.792, while Phadnis et al did not report an AUC. Chan and colleagues observed the opposite effect, with a calculated AUC of 0.526, indicating the ISI score was an insufficient predictor of recurrence.

**Predictability of individual prognostic factors comprising the ISI score**
Six of the eight included studies evaluated the ability of the individual prognostic factors that make up the ISI score in predicting recurrence after arthroscopic Bankart repair. Balg and Boileau developed the ISI score using univariable analysis; which contact or forced overhead sports were assigned 1 point. Bouliane and colleagues also found that an ISI score of 4 or greater was a strong predictor of recurrent instability following arthroscopic Bankart repair. Similar to Chen and colleagues, an ROC was used and demonstrated a cut-off of 4 to be ideal in maximising both sensitivity and specificity. Loppini et al did not perform a sensitivity and specificity analysis, but also proposed a cut-off of 4 and suggested that patients with scores between 4 and 6 had significantly greater failure rates compared with those with scores less than 4 (HR=2.43, p=0.002). More recently, Thomazeau et al used an ISI score less than or equal to 4 as inclusion criteria for arthroscopic Bankart repair and found that an ISI score of 2 or less was predictive of decreased risk of recurrent instability. The risk of recurrence after 9 years was 36% in patients with a score of 3 or 4, compared with only 10% in patients with a score of 0-2. Furthermore, no patients with a score of 2 or less had a recurrence after 4 years, while those in the higher score group still had recurrences 9 years following arthroscopic Bankart repair.

The pooled analysis of the current study (table 4) highlights the potential for an ISI threshold of 4 to provide as a more sufficient threshold than the previously proposed threshold of 7. In the analysis of four studies, a statistically significant difference was found between the recurrence rates of patients with ISI scores <4 when compared with patients with scores ≥4 (6.3% vs 26.0%, p<0.0001). These results support the use of more invasive stabilising procedures in order to prevent excessive instability recurrence. However, only studies that stratified recurrence rates by individual ISI scores or ISI scores <4 and ≥4 could be included in this analysis. This excluded two of the studies which found the previously proposed ISI cut-off of 7 to be insufficient, which may bias the results.

Balg and Boileau developed the ISI score using univariate analysis and only included risk factors that were found to be statistically significant in their score. The only risk factor included in the ISI score that was not found to be statistically significant by Balg and Boileau was the type of sport, in which contact or forced overhead sports were assigned 1 point.

**DISCUSSION**
There has been significant debate surrounding the clinical utility of the ISI score following its original description by Balg and Boileau in 2007. The current systematic review aimed to summarise the evidence for its use as a tool for predicting recurrent instability following arthroscopic Bankart repair and found conflicting evidence on the efficacy of the ISI score as a predictive tool. Although Balg and Boileau originally reported a score of 7 or greater to be significantly associated with recurrent instability, four of the studies included in this review found a lower threshold to be associated with recurrence following arthroscopic Bankart repair. Conversely, two of the included studies did not find the ISI score to be an accurate predictor of recurrent instability, while one study was inconclusive.

Recent investigations have called into question the ISI score cut-off of 7 proposed by Balg and Boileau, suggesting that it may be too conservative, contributing to higher rates of recurrent instability seen with arthroscopic Bankart repair. For instance, Bouliane and colleagues did not find an ISI score ≥7 to be a significant predictor of recurrence following arthroscopic stabilisation. Chan et al also found that the ISI score failed to predict recurrent instability and that none of the individual ISI factors independently predicted failure. Using ROC, Chen and colleagues found a cut-off of 4 to be optimal, with a decrease in sensitivity occurring at cut-offs higher than 4 and only a minor increase in specificity when increasing the cut-off to 5. Phadnis et al also found that an ISI score of 4 or greater was a strong predictor of recurrent instability following arthroscopic Bankart repair. Similar to Chen and colleagues, an ROC was used and demonstrated a cut-off of 4 to be ideal in maximising both sensitivity and specificity. Loppini et al did not perform a sensitivity and specificity analysis, but also proposed a cut-off of 4 and suggested that patients with scores between 4 and 6 had significantly greater failure rates compared with those with scores less than 4 (HR=2.43, p=0.002). More recently, Thomazeau et al used an ISI score less than or equal to 4 as inclusion criteria for arthroscopic Bankart repair and found that an ISI score of 2 or less was predictive of decreased risk of recurrent instability. The risk of recurrence after 9 years was 36% in patients with a score of 3 or 4, compared with only 10% in patients with a score of 0-2. Furthermore, no patients with a score of 2 or less had a recurrence after 4 years, while those in the higher score group still had recurrences 9 years following arthroscopic Bankart repair.

The pooled analysis of the current study (table 4) highlights the potential for an ISI threshold of 4 to provide as a more sufficient threshold than the previously proposed threshold of 7. In the analysis of four studies, a statistically significant difference was found between the recurrence rates of patients with ISI scores <4 when compared with patients with scores ≥4 (6.3% vs 26.0%, p<0.0001). These results support the use of more invasive stabilising procedures in order to prevent excessive instability recurrence. However, only studies that stratified recurrence rates by individual ISI scores or ISI scores <4 and ≥4 could be included in this analysis. This excluded two of the studies which found the previously proposed ISI cut-off of 7 to be insufficient, which may bias the results.

Balg and Boileau developed the ISI score using univariate analysis and only included risk factors that were found to be statistically significant in their score. The only risk factor included in the ISI score that was not found to be statistically significant by Balg and Boileau was the type of sport, in which contact or forced overhead sports were assigned 1 point.

**Comparison of mean ISI scores of patients with and without recurrence**
The average ISI score of patients with and without recurrence was available in five studies. A summary of these data is presented in table 5.
Table 1  Summary of characteristics and conclusions of the included studies

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Country of study</th>
<th>Study design (LOE)</th>
<th>MINORS score (% of 12)</th>
<th>Sample size</th>
<th>Male (%)</th>
<th>Mean age (range)</th>
<th>Mean follow-up (months)</th>
<th>Suture anchors used</th>
<th>Conclusion regarding ISI score efficacy</th>
<th>Definition of recurrent instability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balg and Boileau (2007) 8</td>
<td>France</td>
<td>Prospective case series (III)</td>
<td>75</td>
<td>131</td>
<td>79</td>
<td>27.3 (14–62)</td>
<td>31.2</td>
<td>Mean: 4.37 Range: 2–8</td>
<td>Arthroscopic Bankart repair is contraindicated in patients with ISI score ≥7.</td>
<td>Dislocation or subjective complaint of subluxation.</td>
</tr>
<tr>
<td>Bouliane et al (2014) 9</td>
<td>Canada</td>
<td>Prospective case series (IV)</td>
<td>81</td>
<td>100</td>
<td>79</td>
<td>25.2 (16–61)</td>
<td>24</td>
<td>Median: 4 IQR: 2–5</td>
<td>ISI score is not predictive of surgical failure after arthroscopic Bankart repair.</td>
<td>Dislocation or significant subluxation requiring medical treatment or failure to return to preinjury activity.</td>
</tr>
<tr>
<td>Chen et al (2020) 11</td>
<td>Taiwan</td>
<td>Retrospective case series (III)</td>
<td>81</td>
<td>222</td>
<td>88</td>
<td>25* (14–57)</td>
<td>50</td>
<td>3 (for all patients)</td>
<td>Arthroscopic Bankart repair is contraindicated in patients with ISI score ≥4.</td>
<td>Dislocation or subluxation.</td>
</tr>
<tr>
<td>Loppini et al (2019) 12</td>
<td>Italy</td>
<td>Case–control study (III)</td>
<td>69</td>
<td>670</td>
<td>85</td>
<td>27 (18–39)</td>
<td>100.8*</td>
<td>Mean: 2.4 Range: 2–4</td>
<td>Arthroscopic Bankart repair is contraindicated in patients with ISI score ≥4.</td>
<td>Dislocation, subluxation or feeling of instability.</td>
</tr>
<tr>
<td>Phadnis et al (2015) 13</td>
<td>UK</td>
<td>Retrospective case–control (II)</td>
<td>75</td>
<td>141</td>
<td>78</td>
<td>27.2 (NR)</td>
<td>47</td>
<td>Mean: 3.9 SD: 0.68</td>
<td>Arthroscopic Bankart repair is contraindicated in patients with ISI score ≥4.</td>
<td>Dislocation, subluxation or feeling of instability.</td>
</tr>
<tr>
<td>Thomazeau et al (2019) 14</td>
<td>France</td>
<td>Prospective cohort study (II)</td>
<td>69</td>
<td>125</td>
<td>NR</td>
<td>30.2 (16.5–59.6)</td>
<td>108*</td>
<td>Minimum: 3</td>
<td>ISI score ≤2 is associated with a decreased long-term recurrence rate compared with ISI score 3–4 after arthroscopic Bankart repair.</td>
<td>Dislocation or subluxation.</td>
</tr>
<tr>
<td>Tordjin et al (2016) 15</td>
<td>France</td>
<td>Retrospective case series (IV)</td>
<td>56</td>
<td>31</td>
<td>57</td>
<td>24.3 (NR)</td>
<td>61.2</td>
<td>Mean: 2.3 SD: 0.6 Range: 2–4</td>
<td>No suggestion was made.</td>
<td>Dislocation or subluxation.</td>
</tr>
</tbody>
</table>

*Denotes median instead of mean.
ISI, Instability Severity Index; LOE, level of evidence; MINORS, Methodological Index for Non-Randomized Studies; NR, not reported.
However, previous research had shown this factor was a significant predictor of recurrence, so it was included in the final ISI score.16–20 Subsequent research, although limited, has validated this particular criterion to be a significant predictor of recurrence.10,11 Similarly, Loppini et al10 found each component of the ISI score to be independently predictive of risk of recurrence. In the investigation by Phadnis et al,11 each of the risk factors included in the ISI score was found to independently increase the risk of recurrent dislocation, with the exception of shoulder hyperlaxity. However, Chen and colleagues9 found shoulder hyperlaxity to be independently predictive of recurrence, along with degree of sports participation and Hill-Sachs lesion. Other ISI score components were not found to be independently predictive, most notably age and glenoid bone loss, which is in contrast to previous reports.17,18,21–23 Meanwhile, Thomazeau and coworkers12 reported age as the only predictive factor of recurrent instability. Lastly, Chan et al1 found that none of the ISI score risk factors was an independent predictor of recurrent instability.

The glenoid track theory, developed by Yamamoto and Itoi,24 has received increasing attention as a means of predicting recurrent instability. Off-track lesions have been clinically validated as a predictor of recurrent instability following arthroscopic Bankart repair, with on-track lesions having a negative predictive value of 92%.25,26 The evaluation of these lesions requires the use of CT or MRI, as opposed to plain radiograph in the ISI score, increasing the risk of radiation to patients who undergo CT scan. Recently, the development of the Glenoid Track Instability Management Score (GTIMS) proposed by Di Giacomo et al27 provides a modification of the ISI score. The GTIMS proposes different scoring criteria with an emphasis on the more recently validated glenoid track theory, as it assigns 4 points for ‘off-track’ lesions. The use of GTIMS when compared with the ISI score showed promising results, with fewer Latarjet procedures performed and similar postoperative patient-reported outcomes and recurrence rates.28,29 However, validation of the GTIMS score is still necessary.29 Another alteration that may be considered in evaluating the ISI score is the greater weight attributed to glenoid bone loss.13 Leroux et al30 showed that the use of arthroscopic Bankart repair could yield far lower recurrence rates in athletes when glenoid bone loss is minimal. Nakagawa et al31 also demonstrated that glenoid bony defects are a significant factor in predicting recurrence in athletes. However, like the evaluation for the glenoid track, accurate measurement of glenoid bone loss also requires the use of CT or MRI. Patients with glenoid bone loss and large Hill-Sachs lesions can also undergo the remplissage procedure,31 rotator interval closure,3 rotator cuff repair,11 anterior capsular retensioning10 and thermal capsular shrinkage on the overall

### Table 2
Comparison of the predictability of individual prognostic factors within the ISI score across eligible studies

<table>
<thead>
<tr>
<th>Prognostic factor</th>
<th>Balg and Boileau1</th>
<th>Chan et al9</th>
<th>Chen et al3</th>
<th>Loppini et al10</th>
<th>Phadnis et al11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≤20</td>
<td>P=0.001</td>
<td>OR=2.63 (CI 0.11 to 1.35), p=0.134</td>
<td>OR=1.120 (CI 0.7 to 1.7), p=ns</td>
<td>HR=0.55 (CI 0.36 to 0.83)*, p=0.005</td>
<td>Risk of failure: 30%, P&lt;0.001</td>
</tr>
<tr>
<td>Degree of sport participation</td>
<td>P=0.031</td>
<td>OR=1.81 (CI 0.01 to 23.29), p=0.756</td>
<td>OR=1.956 (CI 1.2 to 2.9), p&lt;0.01</td>
<td>HR=4.27 (CI 1.88 to 9.71), p&lt;0.001</td>
<td>Risk of failure: 60%, P&lt;0.001</td>
</tr>
<tr>
<td>Type of sport participation</td>
<td>P=0.31</td>
<td>OR=0.45 (CI 0.98 to 4.89), p=0.056</td>
<td>OR=0.844 (CI 0.4 to 1.9), p=ns</td>
<td>HR=2.67 (CI 1.84 to 3.87), p&lt;0.001</td>
<td>Risk of failure: 23%, p=0.03</td>
</tr>
<tr>
<td>Shoulder hyperlaxity</td>
<td>P=0.036</td>
<td>OR=1.39 (CI 0.25 to 2.08), p=0.546</td>
<td>OR=6.523 (CI 2.9 to 14.9), p&lt;0.01</td>
<td>HR=2.01 (CI 1.29 to 3.13), p=0.002</td>
<td>Risk of failure: NR, p=0.24</td>
</tr>
<tr>
<td>Presence of Hill-Sachs on AP radiograph</td>
<td>P=0.002</td>
<td>OR=0.82 (CI 0.44 to 3.33), p=0.709</td>
<td>OR=2.901 (CI 1.7 to 5.0), p&lt;0.01</td>
<td>HR=1.95 (CI 1.21 to 3.13), p=0.006</td>
<td>Risk of failure: 41%, p&lt;0.001</td>
</tr>
<tr>
<td>Presence of glenoid loss of contour on AP radiograph</td>
<td>P=0.011</td>
<td>OR=0.33 (CI 0.36 to 24.63), p=0.314</td>
<td>OR=1.425 (CI 0.8 to 2.3), p=ns</td>
<td>HR=3.38 (CI 2.30 to 4.98), p&lt;0.001</td>
<td>Risk of failure: 70%, p&lt;0.001</td>
</tr>
</tbody>
</table>

Bold text means a significant difference was observed.
*Signifies the HR was calculated for age >20, not ≤20.
AP, anteroposterior; ISI, Instability Severity Index; NR, not reported.

### Table 3
Recurrence rate by ISI score

<table>
<thead>
<tr>
<th>ISI score</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>≥7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balg and Boileau1</td>
<td>5% (NR)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>70% (NR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bouliane et al8</td>
<td>10% (NR)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Chen et al9</td>
<td>6% (95)</td>
<td>0% (4)</td>
<td>13% (24)</td>
<td>8% (65)</td>
<td>28% (18)</td>
<td>21% (38)</td>
<td>75% (8)</td>
<td>40% (10)</td>
</tr>
<tr>
<td>Loppini et al10</td>
<td>7% (22)</td>
<td>0% (14)</td>
<td>0% (45)</td>
<td>16% (37)</td>
<td>11% (3)</td>
<td>50% (10)</td>
<td>0% (1)</td>
<td>100% (7)</td>
</tr>
<tr>
<td>Phadnis et al11</td>
<td>0% (30)</td>
<td>0% (33)</td>
<td>20% (3)</td>
<td>15% (34)</td>
<td>11% (3)</td>
<td>50% (10)</td>
<td>0% (1)</td>
<td>100% (7)</td>
</tr>
<tr>
<td>Thomazeau et al12</td>
<td>10% (80)</td>
<td>36% (45)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>Tordjman et al13</td>
<td>0% (4)</td>
<td>14% (7)</td>
<td>50% (2)</td>
<td>25% (8)</td>
<td>44% (9)</td>
<td>0% (1)</td>
<td>100% (7)</td>
<td></td>
</tr>
</tbody>
</table>

The transition from green to yellow to red represents low to moderate to high recurrence rate (dark green: 0%–9.9%; light green: 10%–19.9%; yellow: 20%–29.9%; orange: 30%–39.9%; light red: 40%–49.9%; dark red: 50%–100%).
ISI, Instability Severity Index; NR, not reported.
outcomes is unclear. Furthermore, the number of suture anchors used in arthroscopic Bankart repair remains a controversial topic. Several investigations indicate that the use of less than three sutures may be associated with increased risk of recurrent instability,\textsuperscript{35–37} while other reports have suggested that the number of anchors may not be clinically significant.\textsuperscript{18} The number of suture anchors reported in each study of this review was variable. However, 62.5% of the included studies used, on average, at least three suture anchors for procedures.\textsuperscript{1,7,9,11,12} The number of suture anchors used during arthroscopic Bankart repair may represent a confounder that is unaccounted for in the ISI score as currently constructed and may need to be amended if a more accurate understanding of predictive factors of recurrent instability is to be obtained. Further expanding on study heterogeneity, attention must be given to the geographical variability of the included investigations. The ISI score was originally developed in France;\textsuperscript{7} thus, a majority of the included studies were performed in Europe. However, two of the studies were performed in North America,\textsuperscript{1,8} and both of these studies found the original ISI score to be an insufficient predictor of instability recurrence after arthroscopic Bankart repair. It is possible the variable findings may reflect current practices based on geographical location, which should be considered when evaluating these findings.

**Limitations**

This study has a number of limitations, including the level of evidence of eligible studies, with the majority comprising level III and IV studies. Across studies, there was significant heterogeneity with respect to operative technique and threshold values for the ISI score. The heterogeneity of the stratification of data reporting also limited the analyses that could be performed across studies to evaluate various ISI score thresholds. Additionally, only three of the included studies calculated ROCs, which are essential in determining both the predictive ability of the ISI score as well as the optimal cut-off to use in clinical practice. Furthermore, the retrospective nature of the studies may have resulted in selection bias. Finally, while the purpose of this study was to evaluate the efficacy of the ISI score in predicting failure after arthroscopic Bankart repair for anterior shoulder instability, surgical outcomes after Latarjet or other interventions (eg, remplissage) were not evaluated and compared with the arthroscopic Bankart repair outcomes.

**CONCLUSION**

Based on the available evidence, the ISI score as constructed by Balg and Boileau\textsuperscript{7} may have clinical utility as a tool to help clinicians predict recurrent anterior shoulder instability following arthroscopic Bankart repair. However, this review found the original threshold values published in their seminal article to be insufficient predictors of recurrent instability. Instead, a lower ISI score threshold may provide as a better predictor of failure with an arthroscopic Bankart procedure. However, the paucity of level I and II investigations limits the strength of these conclusions. As such there is a need for further large, well-designed, prospective studies evaluating the predictive ability of the ISI score.

**Contributors** SIR, SJP and BAP performed the systematic review and data analysis of the included studies and were also involved in manuscript drafting. VKT and US oversaw the review process and contributed clinical insight to the manuscript.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** Formal ethical approval by an institutional review board or ethics committee was not required for this study because primary data were not collected.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** All data relevant to the study are included in the article or uploaded as supplementary information.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

**ORCID ID**

Samuel I Rosenberg http://orcid.org/0000-0001-8570-8267

**REFERENCES**


