

Pittsburgh Instability Tool Risk Assessment Score Evaluates Failure Risk in On-Track Shoulders Undergoing Primary Arthroscopic Anterior Stabilization with or without Remplissage

Shaquille JC Charles, Stephanie Boden, Ehab Munier Nazzal¹, Matthew Como, Romano Sebastiani, Jonathan D Hughes², Mark W Rodosky³, Adam Popchak, Volker Musahl⁴, Bryson Patrick Lesniak⁵, Dharmesh Vyas, Albert Lin⁶

¹University of Pittsburgh Medical Center, ²UPMC Freddie Fu Sports Medicine Center, ³University of Pittsburgh Sports Medicine, ⁴UPMC Center for Sports Medicine, ⁵UPMC Center For Sports Medicine, ⁶Freddie Fu UPMC Sports Medicine Center

INTRODUCTION:

Given the high rates of recurrent instability following the initial arthroscopic Bankart repair (ABR), it is crucial to provide recommendations for appropriate surgical interventions for patients at a higher risk of experiencing recurrent instability. Previous research has identified that on-track Hill-Sachs lesions (HSL) with specific prognostic factors (i.e., younger age, increased shoulder laxity, lower distance-to-dislocation (DTD), and 2+ preoperative instability events) were associated with a greater risk of failure. Therefore, the objective of this study was to develop a risk assessment tool that takes into account significant prognostic factors for recurrent shoulder instability following primary ABR and evaluate the role of remplissage augmentation given a patient's risk profile.

METHODS: We retrospectively reviewed prospectively collected data of consecutive patients aged 14-40 who underwent either ABR (arthroscopic Bankart repair) or ABR+R (ABR with remplissage) procedures between 2013 and 2021 for anterior glenohumeral instability. Preoperative magnetic resonance imaging was used to determine the values of glenoid bone loss, Hills-Sachs Interval (HSI), glenoid track (GT), and DTD. On-track lesions have a distance-to-dislocation (DTD) value greater than zero. In addition, within the category of on-track lesions, there is a subset known as "near-track" lesions, with a DTD ranging from 0 to 10 mm. Capsuloligamentous laxity scores were categorized according to hyperlaxity status, defined as external rotation greater than 85 degrees and/or grade 2+ posterior and inferior load-and-shift on examination under anesthesia. Recurrent shoulder instability was defined as recurrent dislocation and/or subjective subluxation postoperatively. Patients were excluded if the indexed surgery was a revision procedure, < 2-year follow up, or glenoid bone loss (GBL) >20%. A final multivariate survival analysis was constructed using categorical prognostic factors (i.e., patient age, "near-track" status, hyperlaxity, and 2+ preoperative instability episodes), while adjusting for GBL and stratifying by contact athlete status given its established importance in prior literature. Multivariate hazard ratio estimates were utilized to create a risk assessment tool and correlated with patient-specific risk estimates via post estimation analysis.

RESULTS:

One-hundred-fifty-five patients were included for analysis (ABR: 116 | ABR+R: 39) with an average age of 21.6 ± 6.2 years and an average follow up of 5.1 ± 2.0 years (range: 2.0 – 8.7 yrs). Patients with near-track lesions had a three-fold higher risk of recurrent instability (Hazard Ratio [HR]: 2.5, $p = 0.03$) compared to on-track HSL with DTD > 10mm. Individuals with evidence of hyperlaxity exhibited a five-fold increased risk (HR: 5.4, $p=0.03$) relative to patients without hyperlaxity. Younger patient groups had twice the risk of recurrent shoulder instability (HR: 2.2, $p=0.003$) compared to older adjacent groups. Patients with two or more preoperative recurrent instability episodes faced a four-times greater risk (HR: 4.2, $p=0.004$) for recurrent shoulder instability compared to patients who experienced a single instability event preoperatively. Lastly, patients who underwent primary ABR only had almost 10-times greater risk of recurrent shoulder instability (HR: 9.5, $p=0.002$) than those who underwent primary ABR+R.

The Pittsburgh Instability Tool (PIT) risk assessment score considers patient age, near-track status, hyperlaxity, preoperative instability episodes, and surgical technique (ABR vs. ABR+R) as important prognostic indicators, Table 2. The PIT score was created with risk stratifying subgroups: Low-risk (0 – 2), Moderate-risk (3 – 6), High-risk (7 – 9), and Extreme-risk (10+). Figure 1 illustrates a strong correlation between patient PIT scores with patient-specific hazard ratio estimates derived from the multivariate cox regression modeling. According to PIT score subgroups, recurrent shoulder instability rates range from 4.3% among low-risk groups to 54.6% among extreme-risk groups, Figure 1.

DISCUSSION AND CONCLUSION: Patients with a low-risk PIT score without ABR+R may not benefit from remplissage augmentation. Their risk for recurrent instability would remain low despite the addition of remplissage. However, patients with a high- or extreme-risk PIT score prior to considering ARB+R would likely benefit from remplissage supplementation. The PIT score may be an effective risk assessment tool that may help identify patients who may benefit from a primary Bankart repair with remplissage augmentation. The risk assessment tool developed may optimize surgical treatment and allow physicians to determine patient risk scores with and without remplissage augmentation.

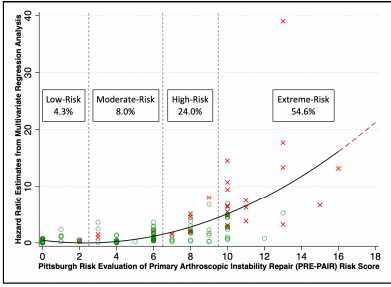


Figure 1: Illustrates how the Pittsburgh Risk Evaluation of Primary Arthroscopic Instability Repair (PRE-PAIR) risk assessment tool correlates with predicted hazards estimated from our final multivariate cox regression model. Red "x" denotes patients who experienced recurrent shoulder instability. Green "o" identifies successful stabilization procedures. Each risk group ranging from low- to extreme-risk displays the proportion of individuals who experienced recurrent shoulder instability. Although the PRE-PAIR tool ranges from 0 – 18, our patient cohort had values from 0 – 16. Therefore, the maroon dotted line represents a forecasted trend.

	Hazard Ratio	95% Confidence Interval	P Value
Primary Arthroscopic Stabilization Surgery	1	[Reference]	
<i>Bankart Repair + Remplissage</i>	9.52	(2.22 – 40.81)	0.002
<i>Bankart Repair Only</i>	2.16	(1.31 – 3.57)	0.003
Age Categorized (<16, 17 – 19, 20 – 24, 25+)			
<i>Near-Track Status</i>			
<i>On-Track Lesion (DTD > 10mm)</i>	1	[Reference]	
<i>Near-Track Lesion (0 mm < DTD ≤ 10mm)</i>	2.52	(1.08 – 5.89)	0.032
Hyperlaxity Status			
<i>No Evidence of Hyperlaxity</i>	1	[Reference]	
<i>Evidence of Hyperlaxity</i>	5.36	(1.13 – 25.4)	0.034
Preoperative Instability Episodes			
<i>Only 1 Instability Event</i>	1	[Reference]	
<i>2+ Instability Events</i>	4.24	(1.60 – 11.29)	0.004
Percent Glenoid bone loss – mean (SD)	1.08	(1.00 – 1.16)	0.038

Note: although contact athlete status was not identified as a significant predictor of recurrent shoulder instability, the final model stratified by contact athlete status. DTD- distance to dislocation; significant P-values are **bolded**.

Prognostic Factors	Points
Patient Age at Surgery	
<i>Under 18 years</i>	6
<i>18 – 20 years</i>	4
<i>21 – 24 years</i>	2
<i>25+ years</i>	0
Distance-to-Dislocation (mm)	
<i>Near-Track Lesion (DTD ≤ 10 mm)</i>	3
<i>On-Track Lesion (DTD > 10mm)</i>	0
Shoulder Laxity Evaluation Under Anesthesia	
<i>Hyperlaxity</i>	5
<i>No evidence of hyperlaxity</i>	0
Preoperative Instability Episodes	
<i>2+ Instability Events</i>	4
<i>Only 1 Instability Event</i>	0
Primary Arthroscopic Stabilization Surgery	
<i>Bankart Repair Only (ABR)</i>	0
<i>Bankart Repair + Remplissage (ABR+R)</i>	-10

Note: PIT risk scores are the sum of prognostic factors with scores ranging from 0 – 18. Patients who undergo ABR+R reduce PIT scores by 10 points, but scores never fall below zero. Low-risk: 0 – 2, Moderate-risk: 3 – 6, High-risk: 7 – 9, Extreme-risk: 10+. DTD- distance to dislocation; ABR- arthroscopic Bankart repair only; ABR+R- arthroscopic Bankart repair with remplissage