J Orthop Spine Trauma. 2024 June; 10(2): 60-4. DOI: 10.18502/jost.v10i2.15513

Research Article

Functional Outcome of Arthroscopic Bankart Repair with Knotless Suture Anchor: A Retrospective Observational Study

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Received: 10 November 2023; **Revised:** 14 January 2024; **Accepted:** 02 February 2024

Abstract

Background: The soft tissue in the shoulder plays a significant role in anterior shoulder instability, leading to humeral head displacement from the glenoid fossa. Arthroscopic Bankart repair is a widely accepted method to restore the labrum to the joint rim. This study aims to evaluate the clinical outcomes of Bankart repair by knotless suture anchors at medium-term follow-up, assess the functional outcomes of the knotless suture anchor method for recurrent anterior glenohumeral instability, and conduct clinical assessment using the Rowe score at 6-week, 3-month, 6-month, and 12-month intervals in patients.
Methods: In this retrospective study, patients who underwent arthroscopic Bankart repair using a 2.8 mm knotless suture anchor (MINI-VIM PK®) were enrolled. They were assessed for shoulder stability, range of motion (ROM), and functional outcomes using the Rowe scale at the baseline, 6-week, 3-month, 6-month, and 12-month follow-up intervals as part of the planned early efficacy measures. All the statistical analyses were performed using SPSS software.
Results: The mean age of the subjects was 28.10 ± 6.14. In this trial, 51 patients (69.86%) were diagnosed with recurrent shoulder dislocation on the left side, and 22 patients (30.14%) on the right side. The Rowe score demonstrated a significant improvement ($P < 0.0001$), increasing from 44.73 ± 1.64 to 95.62 ± 18.33 at the 12-month follow-up period. This indicated better clinical outcomes and reduced recurrence of instability with the use of knotless suture anchors.
Conclusion: The use of knotless suture anchors demonstrated reduced recurrence rates, improved post-operative shoulder motion, and increased stability without adding complexity to the procedure.

Keywords: Arthroscopy; Glenoid Labrum; Sutures; Shoulder

Citation: Chauhan R, Pande A, Singh Shaktawat D, Dwivedi A, Thomas S. **Functional Outcome of Arthroscopic Bankart Repair with Knotless Suture Anchor: A Retrospective Observational Study.** *J Orthop Spine Trauma* 2024; 10(2): 60-4.

Background

The shoulder joint is a multiaxial ball and socket joint. It allows the glenohumeral joint to serve as a stable fulcrum for the upper extremity at various positions in three-dimensional space, thereby facilitating a wide range of motion (ROM). However, the shoulder joint's inherent instability contributes to approximately 50% of dislocations due to its anatomy and biomechanics (1). Dislocations of the shoulder are associated with a relatively high rate of complications, including pain, prolonged instability, reduced quality of life, and impaired ability to resume sports activities (2). The wide-ranging variability of injuries and unique differences among individuals, such as hand dominance, injury severity, and age, pose challenges in estimating the exact timeline for patients where the ROM and strength on the affected side can be compared to the unaffected side. Consequently, there exists significant disagreement among medical professionals regarding the optimal treatment and recovery timeline for individuals with anterior shoulder instability (3). This instability, affecting the soft tissue of the shoulder, leads to the displacement of the humeral head from the glenoidal fossa. Physicians typically classify this condition into categories: traumatic, unilateral, Bankart lesion, surgery (TUBS) and atraumatic, multidirectional, bilateral, rehabilitation, inferior capsular shift (AMBRI) (4). In cases of anterior shoulder instability, classic Bankart lesions are often present. However, various other labrums can be observed, including anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesions, a triple labral (anterior, posterior, and superior) lesion, superior labrum anterior-to-posterior (SLAP) lesions, and glenoid fractures associated with surgical procedures (5).

Bankart repair resolves complications such as postoperative pain, increased loss of blood, external rotation limitation, and glenoid fractures, which are types of surgical complications (1). The use of suture anchors for arthroscopic Bankart repair is a widely accepted procedure to restore labral anatomy (6). It is considered a benchmark in treating cases of recurrent anterior shoulder instabilities. Arthroscopic repair is a procedure that is less time-consuming and offers a better ROM post-surgery. The doctors performing arthroscopic Bankart repair in patients with glenohumeral instability endorse its benefits, which include enhanced cosmesis, reduced morbidity, reduced post-surgery stiffness, pain mitigation, and improved ability for identifying and treating intra-articular pathology while avoiding subscapularis detachment (7). According to various studies, the combined arthroscopic repair of Bankart/SLAP lesions has demonstrated positive postoperative outcomes, including a low recurrence rate, reduced pain, and improved shoulder function (8).

The current use of knotless suture anchors in arthroscopic repair provides a uniform distribution of tension along the entire incision length (9). In contrast, traditional knot-tying suture anchors, while effective at securing the knots, presented issues related to

consistency, quality, and other technical challenges. Undoubtedly, concerns were also raised about the potential damage to the glenohumeral joint cartilage caused by suture knots and associated materials. Knotless suture anchors, on the other hand, offer the advantage of stable repair without the technical difficulties of arthroscopically tying knots and pose fewer concerns regarding cartilage damage due to their low-profile materials (10). These anchors are devoid of a solid element and can be inserted into tunnels with a smaller diameter, thereby preserving the glenoid bone stock (11). Knotless sutures offer significant advantages in terms of both time and cost savings, while delivering excellent cosmetic and functional outcomes in comparison with standard suture (12). Moreover, they demonstrate a higher resistance to failure compared to knotted standard sutures, used to achieve a watertight closure (9). The use of knotless, tensionable suture anchor reduces potential complications associated with knot-tying suture anchors, such as difficulties in knot passage, impingement, and chondral abrasion. This study is a level IV retrospective case study to assess the clinical outcomes of Bankart repair by knotless suture anchors at medium-term follow-up. The preliminary goal of arthroscopic surgery was to eliminate the post-operative recurrent instability and restore the labrum to the rim of the glenoid. We conducted clinical assessments and evaluated the functional outcomes of the knotless suture anchor technique for recurrent anterior glenohumeral instability using the Rowe score at 6-week, 3-month, 6-month, and 12-month intervals in these patients.

Methods

Prior to commencing the study, approval of the Institutional Review Board (IRB) was obtained. Patients' shoulder stability, mobility, and function were evaluated at baseline, 6-week, 3-month, 6-month, and 12-month intervals using the Rowe scale. The Rowe scale is a questionnaire that includes a combined assessment of both objective and subjective factors, encompassing various factors like functionality, pain, stability, and mobility as reported by the patients themselves. The scale allows for a maximum score of 100, with higher scores indicating better functionality of the shoulder (13). A comprehensive imaging assessment, including anteroposterior (AP), axial, and Y-view radiographs along with magnetic resonance imaging (MRI), is essential to rule out relevant bony defects and evaluate possible concomitant soft tissue pathologies.

The MINI-VIM PK® (Chetan Meditech Pvt. Ltd., Ahmedabad, India) used in Bankart repair is a knotless suture anchor composed of polyether ether ketone (PEEK) material. It consists of an anchor implanted into the bone, with a non-absorbable suture attached to the anchor through its eyelet. The eyelet is a hole or a loop in the anchor that connects it to the suture. The anchor is preloaded onto a disposable inserter designed to facilitate its deployment. The BioFiber® FiberLoop used for approximation and ligation is a non-absorbable, sterile surgical suture with multiple needle options made up of ultra-high-molecular-weight polyethylene (UHMWPE).

Eligibility Criteria: Patients undergoing arthroscopic Bankart reconstruction were enrolled into the study post MRI at the affected shoulder to confirm the anterior detachment of the glenoid labrum. The patients who met the inclusion criteria had episodes of anterior dislocation necessitating manual resolution, subluxation followed by spontaneous reduction, and recurrent cases of shoulder instability. The study considered patients within the age group of 18-45 years. Patients with a bony Bankart lesion requiring additional bone fixation procedures, those with > 20% loss of glenoid bone, significant Hill-Sachs lesion involving the anterior glenoid, glenohumeral ligament avulsion at the humerus, or patients who had undergone rotator cuff repairs were excluded from the study.

Surgical Technique: All surgeries were performed with patients in the lateral decubitus position. Working portals included anterosuperior and anteroinferior portals, and for visualization, standard arthroscopic portals, along with a posterior portal were employed. The posterior portal was positioned at the posterior soft spot, situated approximately 3 cm below the posterolateral corner of the acromion (Figure 1, A). Through the intervening space between teres minor and infraspinatus tendons, the arthroscope was able to access the joint. The anteroinferior portal was positioned as close to the superior border of the subscapularis tendon as possible, allowing for access to the anterior and inferior parts of the glenoid rim. The anterosuperior portal, located in the rotator interval, was situated just above and anterior to the bicep tendon. The anterior labrum was appropriately prepped following the diagnostic arthroscopy, and the visible labral border was debrided using a motorized cutter to facilitate healing. An arthroscopic rasp and burr were used to exfoliate the anterior glenoid neck.

A 45° curved suture portal, accessed through the anteroinferior muscle, was used to position the labrum approximately one centimeter lateral from the glenoid rim at its most inferior point (Figure 1, B-D).

Figure 1. A) Posterior portal with scope in situ; B-D): Placing patients in the lateral decubitus position, with the arm elevated at an angle of 45-60 degrees of abduction and applying 12-14 pounds of traction

The FiberLoop (BioFiber®) was pulled through and retrieved via the anterosuperior portal, then attached to one end of a free knotless suture (MINI-VIM PK®) (Figure 2). The loaded pulling suture subsequently released through the anteroinferior portal, threading through the capsulolabral structure.

Figure 2. Preparation of antero-superior portals

The other end of the knotless suture, positioned outside the anterosuperior portal, was also retrieved through the anteroinferior portal. Drill holes were created to penetrate the glenoid surface at an angle of 50° to 70° from the glenoid plane, approximately 1-2 mm from the glenoid rim (Figure 3, A-C).

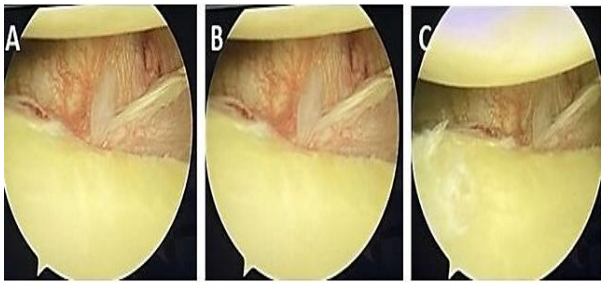

Figure 3. Complete loss of labrum from 2 o'clock position to 6 o'clock position (Bankart lesion)

For the left side and the right shoulder, the first drill hole was placed at 6:30 and 5:30, respectively. The knotless suture was passed through the anchor's distal ring on both ends before being inserted through a drill hole to the required depth (Figure 4, A-D).

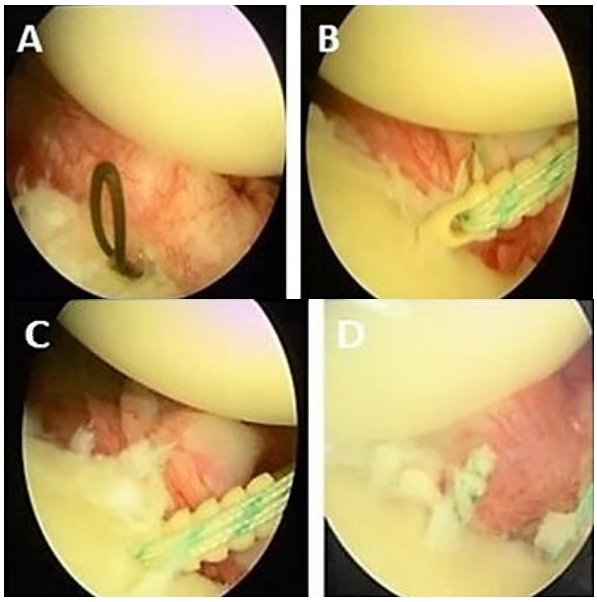

Figure 4. Placement of knotless suture anchors

Additional anchors were added as necessary, extending up to the right shoulder's 3 o'clock point and the left shoulder's 9 o'clock point (Figure 5). In each case, a total of 4 knotless suture anchors were employed, typically ranging from 3 to 5 anchors in total (14).

Figure 5. Bankart repair done using 3 knotless suture anchors at 2:30, 3:30, and 5:30 positions

Statistical Analysis: The sample size was determined to be 73, considering an error margin of 0.17%, a confidence level of 95%, and an expected variation of the standard deviation (SD) in anterior dislocation of 0.5%. For each categorical component, such as relative frequencies and percentages, the data were summarized using frequency distribution. The analysis was conducted using SPSS software (version 20, IBM Corporation, Armonk, NY, USA). For continuous variables, the results were presented as mean ± SD, and for nominal variables, as a number (%). The results were found to be statistically significant at $P < 0.0001$.

Results

To access the functional outcomes of arthroscopic Bankart combined with knotless suture anchors, a retrospective study was conducted on 73 patients. The mean age of the patients was found to be 28.10 ± 6.26 years, out of them, 72 patients (98.63%) were men and 1 (1.37%) was woman. Among the study participants, 51 patients (69.86%) had a history of recurrent shoulder dislocation on the left side, while 22 patients (30.14%) had recurrent shoulder dislocation on the right side. The X-ray and MRI assessments confirmed that these patients underwent arthroscopic Bankart repair procedures (Table 1).

Table 1. Demographic parameters and concomitant injury details of the patients (n = 73)

Parameter	Value
Age (year) (mean ± SD)	28.10 ± 6.26
Gender [n (%)]	
Men	72 (98.63)
Women	1 (1.37)
History of diagnosis [n (%)]	
Recurrent shoulder dislocation (left)	51 (69.86)
Recurrent shoulder dislocation (right)	22 (30.14)
X-ray/MRI performed [n (%)]	
Arthroscopic Bankart repair	73 (100)

MRI: Magnetic resonance imaging; SD: Standard deviation

Table 2 provides a comprehensive overview of patient data observed at different follow-up periods, starting from 6-week to 3-month, 6-month, and 12-month. The statistical analysis revealed a highly significant increase in the Rowe score across all these time intervals ($P < 0.0001$), indicating a successful outcome. A gradual and consistent improvement in the Rowe score was observed throughout

the follow-up period, with a mean difference in Rowe score increasing from 44.73 ± 1.64 at the 6-week mark to 95.62 ± 18.33 at the 12-month follow-up period.

Table 2. Rowe scores at different follow-up periods

Rowe score	Mean ± SD	P-value (from 6-week to visit)
6-week	44.73 ± 1.64	NA
3-month	66.10 ± 11.06	< 0.0001
6-month	95.62 ± 18.33	< 0.0001
12-month	95.62 ± 18.33	< 0.0001

SD: Standard deviation

The Rowe score is a clinical tool used to assess outcomes of shoulder stabilization surgery, measuring factors like pain, ROM, and function. It helps evaluate the success of surgical interventions for conditions like shoulder instability.

Discussion

The field of orthopedics is dedicated to analyzing the function of bones in the human body, with the most common cause of failure often being a subject of controversy (15). Orthopedic specialists frequently employ the Bankart repair technique to treat patients with recurrent shoulder instability. Arthroscopic Bankart repair stands out as a minimally invasive procedure, resulting in less surgical trauma and reduced blood loss. Notably, this technique does not compromise the postoperative ROM in the pursuit of stability (4). Knotless anchors offer several advantages, including a more efficient procedure and the elimination of the weak points associated with knotted anchor repairs for shoulder instability. The knotless all-suture anchor repair's self-locking mechanism saves time and prevents inconsistency that can occur with traditional knot-tying, thereby reducing the risk of knot-related problems that could lead to unintended damage to soft cartilage or tissue. Additionally, this design compresses and secures the soft tissue with the suture.

The primary focus of this study revolves around the clinical outcomes of knotless suture anchors in addressing recurrent anterior glenohumeral stability, with the majority of patients having undergone the arthroscopic Bankart repair technique. The improvement in patients was measured using Rowe scale at 6-week, 3-month, 6-month, and 12-month intervals. A significant number of patients achieved favorable clinical evaluations as reflected in their high Rowe scores, indicating improved functional outcomes. The results of this study can serve as valuable information for patient counselling, providing insights into the rates of recurrent instability and anticipating results following the Bankart repair procedure. The elevation in the patient conditions with the improved ROM was observed in the shorter period of time.

The level of dislocation arthropathy was found to be correlated with the number of dislocations experienced prior to Bankart repair (16). This indicates that long-term joint degeneration can still occur despite surgical intervention, influenced by the extent of preoperative trauma (17). The treatment of shoulder instability is challenging due to its multifactorial origins, encompassing abnormalities in bony and delicate tissues, insufficiency in the shoulder joint or deltoid muscle, and/or excessive ligament elasticity (18).

In the present study, Rowe scores were significantly correlated both before and after treatment and across various patient age groups and types of therapy. The Rowe score is a comprehensive survey that combines subjective and objective responses, addressing aspects related to both motor (movement and stability) and cognitive (pain or discomfort) aspects. The score's effectiveness relies on its responsiveness, reliability, and authenticity. For evaluating the ROM, a surgeon's assessment is required, which can influence the Rowe score (19).

Wu et al. reported that postoperatively, the group that used traditional knotted sutures had a significantly higher rate of recurrent subluxation (20). Brown et al. concluded that out of 274 patients in the knotless anchor group, 22 experienced instability, resulting in an 8.0% pooled mean recurrent instability rate (7). In contrast, a recent study by Aydin et al. found no significant difference between patients who underwent combined Bankart + SLAP repair and those who underwent isolated Bankart repair in terms of re-dislocation rates, post-operative constant or Rowe scores, or post-operative ROM (5). The rates of failure following any properly indicated stabilization procedure may be more influenced by variables beyond the surgeon's control, such as patient demographics and participation in high-risk athletic activities. Age is typically considered the most significant demographic indicator of future instability (21). In contrast to other studies, the present study did not observe any post-surgery re-dislocations in the selected patient population, despite numerous studies reporting higher rates of re-dislocation rates when treated with knotless suture anchors.

In the assessment of arthroscopic Bankart repair, the most frequently used method for patient-recorded outcomes is the Rowe score, which takes into account factors like stability, ROM, and function. For instance, according to Milchteim et al., the average Rowe score was 84.3, with 82% of scores falling in the good and excellent range (14). Whereas Saper et al. reported a mean Rowe score of 85.0 ± 24.2, which is considered an excellent score (22). Similarly, Ono et al. found that patients who experienced postoperative recurrent instability had significantly lower Rowe scores than patients without recurrence (23). Feng et al. also observed a statistically significant improvement in mean Rowe score after combined Bankart repair (8). In line with these findings, our study also reported an improvement in the Rowe score, with a mean score of 95.62 ± 18.33 at the 12-month follow-up.

Current results indicate that neither pre-operative nor concurrent repair significantly affected the clinical or radiographic results. At the follow-up time, all patients displayed relative constant scores and improved ROM. They also rated their overall outcome as good or excellent. Thus, for arthroscopic labral repair, the knotless suture anchor method appears to be an effective substitute for traditional suture anchors.

The study has several limitations that need to be considered when interpreting the results. Firstly, the sample size was relatively small, potentially limiting the generalizability of the findings to a larger population. Secondly, the study's retrospective design may introduce confounding variables that are challenging to control. Additionally, the evaluation of outcomes was based on a single scoring system, which might not capture the full complexity of the variables under investigation. Incorporating multiple assessment tools or objective measurements could have enhanced the comprehensiveness and reliability of the results.

Conclusion

For the instability of anterior shoulder, arthroscopic

Bankart repair using a knotless suture anchor is a helpful and effective procedure with excellent medium-term results. The benefits of a knotless repair construct include strong fixation, preservation of bone, and saving time. To improve patient outcomes, this technique can be applied to both primary and revision Bankart repairs by the doctor. The knotless suture anchor has turned out to be the realistic option that provides higher stability with excellent post-operative shoulder motion in the short period of time. It also reduces the chance of recurrence. The meticulous surgical technique and proper suture anchor positioning played a major role in functional outcome.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

The authors want to thank all the staff members of department of orthopedics; the conduction of this study would not have been possible without their assistance. They are extremely thankful to the postgraduate students of the department, for their technical support during the tenure of this study.

This study received no funding.

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