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Similar Outcomes for Knotless and Knot-Tying Anchors in Bankart Repairs: A Systematic Review

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Abstract

Subject: Even though either knotted or knot-tying anchors can be used in arthroscopic Bankart repairs, there are few studies that directly compared these constructs. After conducting a systematic review involved reviewing clinical and biomechanical studies, which were found through a PubMed search. Only those comparing knotless to standard suture anchors in Bankart repairs were included.

Several clinical studies matched our search parameters. Ng et al found no significant differences in the anchors in clinical outcome measures, operative time, or range of motion. Kocaoglu et al's study found no significant difference between the anchors in redislocation rates, but a significant difference in operative time (seconds/anchor) (380 and 225, P<.05, respectively). A study by Cho et al showed favorable outcomes for knot-tying anchors in visual analog scale (0.4 and 1.7, P=.007, respectively), patient satisfaction (4.53 and 3.3, P=.007, respectively), and redislocation rates (4.9% and 23.8%, P=.012, respectively).

Biomechanical studies varied in outcome. Ranawat et al found no difference between the anchors for the cause of failure. Leedle et al found that knotless anchor has the highest load to failure rate when comparing the two (Panalok and the GII) (650N, 434.8N, and 471.5N, P=.02, respectively). Nho et al found that knotless anchors had a significantly lower ultimate load to failure compared to 3 configurations of knotted anchors (103.9N, 184N, 189N, and 216.7N, P=<.05, respectively).

Conclusion: Due to scarce literature regarding the subject, it is still unclear if the two anchor designs perform equally or not. Two of the three biomechanical studies examined found that knotless anchors were similar to or superior to knot-tying anchors. Clinical studies have similarly demonstrated inconsistent results regarding the use of knotless suture anchors. Therefore, more clinical and biomechanical studies need to be conducted before a consensus can be reached.

Keywords: Arthroscopy; Bankart Repair; Glenoid Labrum; Knotless; Knot-tying; Shoulder Instability

Abbreviations

VAS : Visual Analog Scale

Introduction

The glenohumeral joint has the largest range of motion of any joint in the human body. This unique feature predisposes the shoulder to dislocation with an incidence rate of 23.9 per 100,000 people in the United States per year **[1]**. Anterior dislocations account for 85-98% of shoulder dislocations and 73-85% of these dislocations result in Bankart lesions **[2-6]**. A Bankart lesion is an injury to the anterior inferior glenohumeral ligament and the anteroinferior labrum **[7]**. Surgical Bankart repair is indicated in patients who are at high risk for recurrent instability or those who have failed non-operative treatment **[8]**.

Labral-ligamentous repairs of the shoulder were initially performed as an open technique and this has become the gold standard of treatment **[9]**. However, complications can occur with this approach including a slight decrease in external rotation as well as subscapularis insufficiency **[10-12]**. The arthroscopic surgical technique avoids the subscapularis damage, has a quicker recovery, shorter hospital stay, improved range of motion, and better cosmesis **[13]**. Initially, arthroscopic Bankart repairs led to increased recurrence rates, up to 34% when compared to the open procedure. This was due to outdated techniques including staple capsulorrhaphy and transglenoid suturing **[13].** The recurrence rates were greatly reduced through modernization of surgical techniques and implants and there is currently no significant difference in the rates **[10, 13-15]**. Knot tying in arthroscopic Bankart repairs can be time consuming, produce bulky ineffective knots or abrasions, and can potentially damage cartilage in the humoral head. Additionally, Cadaveric studies completed by Kim et al, demonstrated that even when knots are placed at the capsular side, during shoulder motion migration of the knot can occur towards the glenoid surface **[16]**. The knot location on the articular surface in combination with bulky knots both contribute to articular cartilage injury **[16]**. The knotless anchor became a great alternative to help resolve many of the issues of the knot-tying anchors providing secure and low profile repairs **[17]**.

We aim to provide a systematic review of the biomechanical properties and clinical outcomes of Bankart labral repairs using knotless anchors when compared to standard knot-tying anchors. The hypothesis of the study is that the knotless anchors can provide similar results to knot-tying anchors without compromising the outcomes of the repair and offering unique advantages. We hope to demonstrate whether knotless suture anchors are a viable alternative to the standard knot-tying suture anchor.

Methods

A total of 30 studies were identified through a PubMed search using the keywords "knotless Bankart repair." Only clinical and biomechanical studies in the setting of Bankart lesions were of interest to our systematic review. All other studies were excluded, especially if there was no direct comparison between knotless and standard knot-tying anchors in Bankart lesion repairs. Out of the 30 studies initially obtained, only 3 biomechanical and 3 clinical studies matching these criteria were identified. Our systematic review also identified 3 articles that described the surgical procedures which have been utilized to illustrate knotless anchor techniques**.** Only articles available in full English text were reviewed.

Results

Clinical Comparison Studies

In a 2014 prospective comparative study by Ng et al, one surgeon performed arthroscopic Bankart repairs on 42 patients with knotless suture anchors and 45 patients with standard knot-tying suture anchors. The study included patients with at least 2 dislocations who failed conservative treatment and were managed with arthroscopic Bankart repairs. Patients requiring additional procedures in addition to the Bankart repair were excluded. The knot-tying suture group experienced a patient satisfaction score of 6.9 with significant improvements in preoperative and postoperative visual analog scale (VAS) and Constant scores from 2.5 to 0.7 (P<.05) and 64 to 92 (P<.05) respectively. The knotless suture group experienced a patient satisfaction score of 7.1 with significant improvements in preoperative and postoperative VAS and Constant scores from 2.8 to 0.9 (P<.05) and 62 to 89 (P<.05) respectively. There was no significant difference between knotless and knot-tying postoperative VAS (0.9 and 0.7, P= .778), Constant score (89 and 92, P= 8.12), operative time (minutes) (65 and 74, P=.325), and change in degrees of both forward flexion and external rotation (3 and 2, P=.576 and -4 and -3, P=.647, respectively). Furthermore, there was one sports-related trauma leading to one redislocation in either group with no evidence of anchor pullout. Overall, both techniques demonstrated statistically significant and similar improvements in both VAS and Constant scores. Limitations of this study included small group sizes, short follow up at an average of 2.7 months, and a constrained number of clinical outcome measurements **[18]**.

In a study performed by Kocaoglu et al in 2009 knotless suture anchors were compared to standard knot-tying suture anchors in Bankart repairs. There were 38 collision athletes included, 18 were in the standard knot-tying group and 20 in the knotless suture anchor group **[19]**. No additional procedures were performed in this study and every patient, except 3, underwent surgery after their first dislocation. The standard knot-tying suture anchor group exhibited statistically significant improvements in instability with Rowe scores improving from 41 to 92 (P= 0.0032). The knotless suture anchor group also demonstrated significant improvements in their Rowe score from 43 to 91.2 (P= 0.0038). Both groups had 1 patient with a redislocation that occurred while playing sports that did not result in anchor pullout and was repaired. There was no significant difference between knot-tying and knotless anchors in redislocation rates (5.5 and 5, P=.562, respectively), but a significant difference in operative time (seconds per anchor) (380 and 225, P<.05, respectively). There was no significant difference in clinical measures. This study is unique in that it only included collision athletes, as most studies have a more heterogenous patient population. A limitation of this study is that the anchor configuration and insertion type used was different for each suture anchor. One was inserted by tapping it with a mallet and the other inserted like a screw **[19]**.

Cho et al performed a study in 2006 in which 82 patients underwent Bankart repair, 61 patients with knot-tying suture anchors and 21 with knotless **[20]**. The patient population was a mixture of athletes and non-athletes that were randomly assigned to their respective treatment groups. Both groups saw significant shoulder score improvement (P<.05). However, the knot-tying group had a statistically significant redislocation rate of 4.9% versus 23.8% in the knotless suture anchor group

(P.012). The knot-tying group also saw significantly improved VAS scores (0.4 and 1.7, P=.007, respectively) and patient satisfaction scores (4.53 and 3.3, P=.007, respectively). The higher redislocation rate is believed to be due to difficulty in determining anchor depth. This caused the anchor barbs to improperly lock into the bone resulting in gap formation and loosening of the fixation. Additionally, the knot-tying group had less postoperative pain and a higher patient satisfaction score. Limitations in this study include failure to mention whether concomitant lesions and procedures were performed in addition to the Bankart repair, and there was a discrepancy in the number of participants placed into each group **[20]**.

Biomechanical Comparison Studies

In 2011 Ranawat et al performed a biomechanical study comparing the modes of failure and biomechanical properties of bioabsorbable knotless to knot-tying anchors in Bankart lesion repair **[21]**. Eight pairs of shoulders were studied, one receiving a Bioknotless anchor (Mitek, Westwood, MA) and the other receiving a knot-tying Bio-SutureTak anchor (Arthrex, Naples, FL). The knot-tying anchor utilized sliding-locking arthroscopic knots with 3 alternating half hitches on alternating posts. This study left the capsulolabral structures anchored to the glenoid during their biomechanical testing and focused their efforts on failure modes, while other studies removed all soft tissue. Additionally, the capsulolabral lesion was created and repaired arthroscopically before dissecting the tissues free in order to test them. They found that 23/32 anchors cut through at the suture tissue interface and 9/32 pulled out of the bone. There was no significant difference in the rate of cut-out vs bone pullout between the two groups (P=.37). There was also no significant difference found in either ultimate load (P=0.41) or stiffness (P=.75). They ultimately found no difference between the two anchors on any of the testing parameters examined **[21]**.

In 2005 Leedle et al compared the tensile strength and load to failure of one knotless Mitek Suture Anchor (Mitek, Norwood, MA) to two knot-tying suture anchors, the GII Quick Anchor and the Panalok Anchor **[22]**. They tested three groups of 10 anchors on 15 fresh frozen cadaveric glenoids which were stripped of all soft tissue prior to testing. It was found that the knotless suture had the highest load to failure at 650.0 N, with knot-tying anchors Panalok and GII averaging 434.8 N and 471.5N, respectively (P=.02). The majority of failures in all of the groups were due to suture breakage. They concluded that the knotless suture anchor resulted in a stronger construct during the repair of soft tissues while making the insertion both quicker and easier **[22]**.

In 2010 Nho et al studied the biochemical properties of several repair constructs used in fixation of Bankart lesions in fresh-frozen cadaver shoulders with all soft tissue was removed prior to testing [23]. In this study, the knot-tying suture anchors were PEEK SutureTak and the knotless group was PEEK PushLock (Arthrex, Naples, FL). The study had 2 phases. The first phase examined load to failure without cyclic loading in a single loaded suture anchor in a simple stitch configuration, and a knotless suture anchor. In this phase, no significant difference was found in the ultimate load of failure or the mode of failure. Although, the load required to reach 2 mm of displacement was significantly greater in the simple stitch anchor than knotless suture anchor (66.5 N vs 35.0 N respectively, P = .02) **[23].**

Phase 2 compared the biomechanical properties of four different groups with cyclic loading: simple stitch anchor, single loaded suture in a horizontal mattress configuration, double loaded suture anchors in a simple stitch configuration, and knotless suture anchor. The knot-tying groups were tied with reverse half stitches on alternating posts. In the second phase they found that with cyclic loading the simple stitch anchor group (184.0 N), horizontal mattress configuration group (189.6 N), and double loaded suture anchors group (216.7 N) had significantly (P<.05) higher loads to failure when compared to the knotless suture anchor group (103.9 N). Additionally, the mode of failure differed significantly (p=.018). Simple stitch anchor all failed by anchor pull out while the horizontal mattress configuration groups failed at the glenolabral junction (80%) or the capsule (20%). The double loaded suture anchors group failed at the anchor (60%), glenolabral junction (20%), or capsule (20%) while the knotless suture anchor group failed at the anchor (60%) or capsule (40%). There was no significant difference found in 2 mm displacement, stiffness, or gapping with cyclic loading between the four groups **[23]**.

Ultimately, this study concluded that without cyclic loading the simple stitch anchor required greater loads than the knotless suture anchor group to achieve 2mm of gapping. However, with cyclic loading there was only a difference between the knotless suture anchor group when compared to the knot-tying group in terms of load to failure, but not in 2 mm displacement. The authors went on to say that the displacement measurement may be more clinically relevant than the ultimate load to failure, unless a macro traumatic event occurred in the postoperative period in which case the knotless suture anchor was more likely to fail **[23]**.

Discussion

The major drawback to arthroscopic surgery lies in difficulty tying knots inside the body which can lead to inferior knots. Significant variations in knot strength have been found between individual surgeons and between knots created by the same surgeon during the course of a single procedure **[24]**. The knots themselves can be bulky and on average are 5.6mm in height which occupies 50-90% of the space between the cranial portion of the humeral head and acromion in the neutral position. As the arm is elevated the knot may be encroached upon **[24]**. Knotless anchors seem to be a potential solution to many of the knot related problems that frequently occur arthroscopically, but it is not known if they possess superior biomechanical or clinical properties to replace knotted anchors.

The clinical studies reviewed lacked a clear consensus. Two of the three comparative clinical studies, Ng et al and Kocaoglu et al, detected no significant difference in either

clinical outcomes or redislocation rates. Both studies demonstrated significant improvements in clinical scores VAS, Constant, and Rowe scores. Among these, Kocaoglu et al's study was particularly well designed with the Bio-Knotless anchor system. The anchor depth was controlled with a self-stopping drill, thereby preventing gap formation **[19]**.

Overall, two of the three biomechanical studies examined found that knotless anchors were similar to or superior to knot-tying. The study that found the knotless suture to be inferior primarily found that knotless anchors failed more quickly than knot-tying when cyclically loaded. We would like to point out that the study that found no difference between the anchors is also the only study that inserted the anchors arthroscopically. Therefore, this is the only study that truly tested knots tied arthroscopically to knotless while the other studies assessed open knot-tying to knotless. Additionally, this was the only study that left the soft tissues on the cadaver during the biomechanical testing, more accurately replicating the conditions inside the body.

Descriptive Techniques

There are many techniques that can be used to place knotless suture anchors during an arthroscopic Bankart repair. Here, we will describe 3 different techniques. In the single working portal technique described by Ng et al a standard posterior viewing portal and anterior working portal are used **[25]**. Following glenoid preparation, the anterior portal is utilized to capture the detached labrum with FiberWire (Arthrex, Naples, FL) and threaded through a 2.9 mm PushLock anchor (Arthrex, Naples, FL). Three to four anchors are typically used for labral repairs using this technique. The advantages to using one working portal includes improved cosmesis, decreased cost, shorter operative time, and decreased risk of the cephalic vein hemorrhaging into the joint which tends to occur with anterior superior portal placement **[25]**. The disadvantages of this technique include difficulty managing sutures in the setting of knot-tying anchors and the occurrence of point loading, which is described and alleviated in the following two techniques **[25]**.

Point loading is increased pressure on soft tissue due to smaller contact area. This can be avoided by utilizing a hybrid technique incorporating 1.5mm LabralTape (Arthrex, Naples, FL) in addition to knotless suture anchors in a Labral Bridge technique described by Ostermann et al **[26]**. Following glenoid preparation, No. 2 FiberWire and LabralTape are passed through the detached labrum and threaded through a 3.5mm PushLock anchor. One LabralTape limb from this anchor is advanced to secure the labral and capsular tissue between anchors and is incorporated into all subsequent anchors. Point loading is resolved by securing the labral and capsular tissue between suture anchors, which creates a seal and uniform pressure distribution from the first to the final anchor. Other advantages of this technique include optimizing labral blood supply by avoiding constricting horizontal fixation and decreased suture placement adjacent to cartilage resulting in damaged cartilage. Disadvantages to this procedure include a potential for total construct failure should a single point fail, technical difficulty, and an obstacle for revising if a mistake is made in the initial operation **[26]**.

The Double Bankart Bridge technique described by Aboalata et al also avoids point loading by creating a uniform seal with one superiorly placed knotless anchor (3.5 mm PushLock, Arthrex, Naples, FL) and two inferiorly placed standard knot-tying suture anchors (2.8 mm Fastak, Arthrex; or 2.8 mm Twinfix, Smith & Nephew) **[27]**. After the two inferior knot-tying anchors are positioned in the glenoid and the knots are tied, all four sutures are left uncut. In the superior position, all 4 uncut sutures capture the detached labrum, are passed through a knotless anchor eyelet, and then advanced into the glenoid. The advantages of this technique include no risk for total failure should there be a problem with any of the individual anchors. Additionally, the 2 inferior knots are unable to slip due to superior tension and uniform pressure distribution. The disadvantages, apart from the technical difficulty, include lack of biomechanical testing to compare the efficacy of this technique to other approaches **[27]**.

One limitation to this review is the limited number of studies available. Further studies are required to determine if knotless anchors are sufficient to replace knot-tying. Operative time and financial burden are two factors that should be explored further. Two clinical studies in this systematic literature review examined operative time. In the study by Ng et al, the operative time between the knotless and knot-tying was not significant while Kocaoglu et al's study did find a significant difference **[18, 19]**. This study also mentioned the knotless anchors were 25% more expensive when compared to the knot tying system. Although, this may change with time. Additionally, biomechanical studies should place their anchors arthroscopically as this is the only way to directly compare the two types of knots in the conditions that they are used.

Conclusion

Due to scarce literature regarding the subject, it is still unclear if the two anchor designs perform equally or not. Two of the three biomechanical studies examined found that knotless anchors were similar to or superior to knot-tying anchors. Clinical studies have similarly demonstrated inconsistent results regarding the use of knotless suture anchors. Therefore, more clinical and biomechanical studies need to be conducted before a consensus can be reached.

Conflicts of Interest

We declare that we have no conflicts of interest in the authorship or publication of this contribution.

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