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SHOULDER SURGERY: COMPLICATIONS (X LI, SECTION EDITOR)

Complications after arthroscopic labral repair for shoulder instability

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Abstract Arthroscopic labral repair is a widely performed and safe technique for anterior or posterior shoulder instability; however, complications have been reported in the literature. Postoperative injection of local anesthetic via an intra-articular pain pump should be avoided to prevent chondrolysis of the glenohumeral joint. Postoperative stiffness of the shoulder can be treated with physiotherapy, and a surgical treatment is indicated in shoulders that failed a conservative treatment. Although nerve injury is relatively rare, the axillary nerve should be given careful attention. Recurrent shoulder instability is the most common complication after labral repair, but most reported rates of recurrent instability after arthroscopic Bankart repair are less than 10 %. Augmentations, such as rotator interval closure and Hill-Sachs remplissage, have a potential to reduce the rate of recurrence. A better understanding of these possible complications, including their pathology and treatment, is essential for optimization of outcomes after arthroscopic labral repair.

Keywords Complications · Arthroscopic surgery · Shoulder instability · Labral repair

Introduction

Shoulder instability is a common disorder, especially in young athletes involved with contact sports, and labral injury is commonly associated with most traumatic anterior and/or posterior instability. Surgical stabilization is often required for recurrent shoulder instability due to labral injury. Historically, open stabilization has been considered the gold standard treatment. However, arthroscopic labral repair, especially arthroscopic Bankart repair, for traumatic anterior shoulder instability has become a standard surgical treatment since its introduction in the 1980s. In the USA, 71.2 % of Bankart repairs were arthroscopic from 2003 to 2005, while 87.7 % were arthroscopic from 2006 to 2008 [1].

Arthroscopic surgery has several advantages over open surgery, including better diagnostic ability and repair of all accompanying intra-articular shoulder lesions, less risk of postoperative shoulder stiffness, and avoidance of tenotomy or splitting of the subscapularis [2]. In addition, outcomes of recent arthroscopic stabilization surgeries have been shown to be comparable to those of open procedures in terms of recurrence rate. Moreover, the complication rate of arthroscopic stabilization is lower than that of open procedures [1]. Although arthroscopic labral repair is a secure and safe procedure, several complications have been reported in the literature. The surgeon must be cognizant of these potential complications to recognize them and provide optimal and timely management to improve outcome and patient satisfaction.

Nerve injury

Nerve injury is a commonly reported complication in arthroscopic labral repair. However, Owens et al. [1], who reviewed data from the American Board of Orthopedic Surgery, reported that the rate of nerve injury in arthroscopic Bankart repair (0.3 %) is significantly lower than that in open procedures (2.2 %).

The most frequently involved nerve is the axillary nerve. The axillary nerve courses anterior to the subscapularis muscle and proceeds to lie on the inferolateral border of the

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subscapularis tendon. Then, it passes posteriorly into the quadrilateral space. Along this path, the nerve lies adjacent to the inferior capsule, and the closest point between the axillary nerve and the glenoid rim is at the 6-o'clock position on the inferior glenoid rim [3]. The axillary nerve can be injured when placing sutures at the anteroinferior and inferior positions (the 4:30- and 6-o'clock positions, respectively, in the right shoulder) [4] or when repairing capsular lesions, such as capsular tear or humeral avulsion of the glenohumeral ligament. In our experience, we have encountered few cases of axillary nerve injury after capsular repair (Fig. 1).

There have been few recently published reports concerning nerve injury. Ahmed et al. [5] reported one case of temporary brachial plexus palsy in a review of 302 patients who underwent arthroscopic Bankart repair and capsular shift. They noted that the palsy might have been due to the regional anesthetic block. Brilakis et al. [6] also reported one case of temporary ulnar nerve palsy in a review of 48 patients who underwent arthroscopic Bankart repair using the remplissage technique.

Once a patient is suspected to have nerve injury after surgery, we soon perform electromyography (EMG). We usually wait and see for 3–6 months even if EMG suggests denervation. Surgical treatment should be indicated when the symptoms are not improved after the period. In our experience, the outcomes of the surgery are generally good even if the patient needs a nerve graft.

Infection

Owens et al. [1] reported that the rate of infection in arthroscopic Bankart repair is 0.22 %, which is not significantly different compared with that in open procedures. Ahmed et al. [5] reported five out of 302 patients with superficial portal infection, which resolved with antibiotics. Infection in deep tissues or intra-articular in the glenohumeral joint is rare; however, it can result in severe dysfunction of the shoulder. Thus, prevention of infection is of importance, especially in patients at high risk, such as those with diabetes mellitus or atopic dermatitis.

When postoperative infection is suspected, culture of the synovial fluid is recommended to confirm offending bacteria. However, it is sometimes difficult to detect pathogens. Intravenous or oral antibiotics should be empirically used as soon as infection is suspected. We usually use penicillin-based or cephalosporin antibiotics as the first choice because the major pathogens of infection are staphylococci (*Staphylococcus aureus*, coagulase-negative staphylococci, or *Staphylococcus epidermidis*) [7]. Antibiotics can be changed according to the results of the culture and are used until CRP turns negative. When infection is not controlled with antibiotics, we perform an arthroscopic treatment (synovectomy and drainage). We sometimes take out sutures but do not remove anchors unless peri-anchor infection is apparent.

Problems associated with suture anchors

Results of arthroscopic labral repair in the early days using staples or bioabsorbable tacks were discouraging, with a 30 % rate of implant-related complications, including loosening, migration, and breakage [8–10]. However, implant-related complication rates have decreased since the introduction of suture anchors as well as the development of various advanced arthroscopic instruments for secure insertion of the anchor in the glenoid. In a recent report, the failure rate was reported to be 0.3 % [1]. Despite such developments, anchor failures may occur due to technical errors as proper anchor insertion depends on the surgeon's technique and experience. In a cadaveric study, Lim et al. [11] demonstrated that the most inferior anchors (the 5:30- and 6-o'clock positions in the right shoulder) had a high risk of perforating the inferior cortex of the glenoid when inserted via an anteroinferior portal in the lateral decubitus position. Frank et al. [12] evaluated the effect

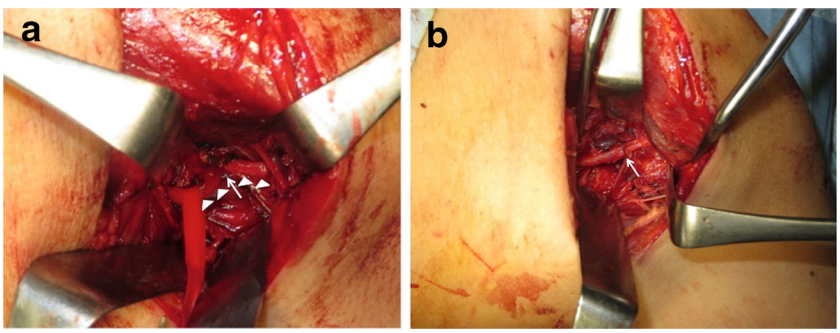

Fig. 1 A case of axillary nerve palsy after arthroscopic Bankart repair combined with repair of capsular tear. Surgical treatment was performed at 6 months after the initial surgery, and symptoms were fully recovered in 6 months after the surgery. **a** The axillary nerve (*arrow heads*) was strangled by a suture (*arrow*) that passed through the nerve. **b** The suture and scar tissue at the strangled site were removed, and the axillary nerve was sutured (*arrow*)

of portal placement and using a curved drill guide for the inferior suture anchor placement and found that trans-subscapularis portal resulted in the lowest opposite cortex perforation compared to the straight and curved mid-glenoid portal. However, there was no difference in the ultimate load to failure among the three different techniques of inferior anchor placement. The authors prefer labral repair in the beach chair position because the arm is not firmly fixed, which allows more freedom to insert the most inferior anchors compared with that in the lateral decubitus position.

Another complication associated with suture anchors is related to the use of bioabsorbable materials, especially anchors made of poly-L-lactic acid (PLLA). Inflammatory reaction, osteolysis, and chondrolysis have been reported to be associated with the use of PLLA anchors. McCarty et al. [13] macroscopically and microscopically investigated patients who underwent arthroscopic debridement after index surgery with PLLA anchors. They found intra-articular anchor debris in >50 % of cases and chondral damage in 70 %. Microscopically, giant cell reaction, presence of polarizing crystalline material, and papillary synovitis were observed in most cases. Therefore, the use of PLLA anchors has decreased with the evolution of suture anchors, such as polyether ether ketone (PEEK) anchors and osteoconductive anchors. These anchors may have less influence on inflammatory reaction [14].

Chondrolysis

Chondrolysis is characterized by rapid destruction of articular cartilage in a joint. It results in a complete loss of articular cartilage due to destruction of chondrocytes and dissolution of cartilage matrix. Radiographs of affected joints show joint space narrowing, while magnetic resonance images show a loss of articular cartilage on both the glenoid and humeral head [15, 16]. Chondrolysis of the glenohumeral joint leads to a progressive, severe, and refractory loss of shoulder comfort and function.

Thermal energy devices, such as radio-frequency or laser devices, have been implicated in the development of chondrolysis [17–20]. Recently, several articles have reported that postoperative infusion of intra-articular local anesthetic is strongly associated with chondrolysis of the glenohumeral joint [16, 21, 22, 23•]. Anderson et al. [16] reviewed 18 cases of glenohumeral chondrolysis and found that all patients had received postoperative infusion of bupivacaine with epinephrine through an intra-articular pain pump catheter. Scheffel et al. [21] systematically reviewed the English literature and identified 100 shoulders that developed postsurgical glenohumeral chondrolysis. In 59 of those cases, chondrolysis was reported to be associated with the use of an intra-articular pain pump, and bupivacaine was used in 50 shoulders. Matsen and Papadonikolakis [23•] analyzed all published cases of glenohumeral chondrolysis and concluded that there is a causal relationship between infusion of local anesthetic and development of glenohumeral chondrolysis. They also reported that the risk of chondrolysis in shoulders receiving intra-articular infusions via a pain pump was significantly greater with higher doses of local anesthetic. Thus, infusion of local anesthetic, especially bupivacaine, via an intra-articular pain pump should be avoided after arthroscopic surgery.

Osteoarthritis

It is well known that osteoarthritis (OA) of the glenohumeral joint can develop after both conservative and surgical treatment for traumatic shoulder instability. Incidence of OA after a conservative treatment has been reported to be as high as 60 % [24].

Kavaja et al. [25] conducted a long-term follow-up of 13 years after arthroscopic Bankart repair and found that 50 out of 74 shoulders were diagnosed with radiographic arthrosis. However, 40 of them were classified as mild arthrosis and their clinical and functional outcomes were relatively good. Franceschi et al. [26] reported that the incidence of postoperative OA in patients who underwent arthroscopic Bankart repair was 21.8 % (12 of 55 patients) in their study with an 8-year follow-up. They also reported that the incidence of OA of the glenohumeral joint was associated with older age at first dislocation and at surgery, increased length of time from first episode to surgery, increased number of preoperative dislocations, increased length of time from initial dislocation until surgery, increased number of anchors used at surgery, and more degenerated labrum at surgery. Harris et al. [27], who conducted a systematic review analyzing long-term outcomes after shoulder stabilization, reported that the incidence of postoperative OA after arthroscopic procedures was 26 % and that there was no significant difference between open (33 %) and arthroscopic procedures. In our experience, four patients who underwent arthroscopic Bankart repair combined with repair of large rotator cuff tear with highly degenerated muscles developed postoperative OA (unpublished data). All patients were older than 68 years of age, and their first dislocation was at 40 years of age or older. Therefore, based on personal experience, we recommend not repairing Bankart lesions in the setting of chronic, large rotator cuff tear in older patients.

Postoperative stiffness

Postoperative stiffness is a well-known complication after shoulder surgery, including arthroscopic labral repair that may result in a severe loss of range of motion (ROM). It can

cause severe pain and disturb activities of daily life. Elmlund et al. [28] reported that two out of 40 patients developed severe restriction of ROM after arthroscopic Bankart repair using absorbable tacks. Ahmed et al. [5] reported five out of 302 patients who developed postoperative shoulder stiffness, which resolved with physiotherapy.

Treatment of postoperative shoulder stiffness usually begins with physiotherapy. When pain is severe, injections of anesthetic and corticosteroid into the glenohumeral joint can be an option to reduce pain. Most patients with stiffness respond to conservative treatment; however, a surgical treatment should be considered for patients who fail in a conservative treatment. Manipulation under anesthesia is sometimes applied in such patients; however, we prefer arthroscopic capsular release because of its safety. We usually perform arthroscopic capsular release when they have severe stiffness of the shoulder even after a 6-month conservative treatment.

Selective loss of external rotation sometimes occurs after stabilization of traumatic anterior glenohumeral instability, which causes functional disability [29•]. This loss of motion may be caused by interruption of transverse movement of the subscapularis tendon during arm rotation. A recent report proposed an arthroscopic solution for a selective loss of external rotation after arthroscopic Bankart repair [29•]. This procedure is called the restoration of anterior transverse sliding (RATS) and includes removal of scar tissue of the rotator interval and release of the subscapularis tendon from the anterior glenoid neck. Ando et al. [29•] reported an improvement of the external rotation ROM from 2.9°±4.9° to 47.9° ±.1° in seven patients with severe loss of external rotation after arthroscopic Bankart repair.

Recurrent instability

Recurrence of instability after surgical stabilization may be the biggest concern among shoulder surgeons. The recurrence rate in open procedures is approximately 8 %, according to recent systematic reviews [2, 27, 30]. Harris et al. [27] reported in their systematic review that the recurrence rates in arthroscopic Bankart repair using tacks, the Caspari transglenoid technique, and suture anchors were 24, 11, and 12.5 %, respectively. Petrera et al. [30] reported that the recurrence rates in arthroscopic Bankart repair using suture anchors and in open procedures were 6 and 6.7 %, respectively, and that the difference was not statistically significant. However, the difference was significant in studies conducted after 2002 (recurrence of 2.9 % in arthroscopic Bankart repair vs. 9.2 % in open procedures). Thus, the rate of recurrent instability is decreasing with recent improvements in surgical techniques and devices.

Another major issue concerning recurrent instability is the high recurrence rate in contact/collision athletes. Petrera et al. [31] compared outcomes after isolated arthroscopic Bankart repair between collision and noncollision athletes at a minimum follow-up of 24 months and reported that the rates of recurrent instability were 9 and 0 %, respectively.

Various efforts have been made to reduce the rate of recurrent instability after arthroscopic Bankart repair. One possible solution may be arthroscopic rotator interval closure, which is performed in addition to arthroscopic stabilization. One or two sutures are usually used for this procedure, which passes the suture above both the superior border of the subscapularis tendon and the superior glenohumeral ligament. To avoid loss of external rotation, tightening of the sutures should be done with the arm in maximum external rotation at the side. Chechik et al. [32] compared the outcomes of arthroscopic Bankart repair with and without rotator interval closure and reported that the rate of recurrent instability in patients with rotator interval closure was 8.1 %, though 41 % of patients had systemic joint laxity. On the other hand, the recurrence rate in patients without rotator interval closure was 13 %, but fewer patients had systemic joint laxity (28 %). Although there is no strong evidence in the literature supporting the addition of rotator interval closure to reduce the risk of instability, the authors do perform rotator interval closure in addition to arthroscopic stabilization.

A major innovation in arthroscopic stabilization for anterior shoulder instability may be the remplissage technique. This technique aims to fill bony defects of the posterosuperior humeral head (known as Hill-Sachs lesions) with the posterior aspect of the capsule and rotator cuff tendon to prevent engaging the bony defects and glenoid rim. Originally, Connolly [33] proposed this technique as an open procedure. Then, Wolf et al. [34, 35] first described, as a modification of the open procedure, the arthroscopic technique of Hill-Sachs "remplissage." There have been many articles to report the outcomes of remplissage performed in combination with arthroscopic Bankart repair [6, 36, 37••, 38]. Boileau et al. [36] performed this procedure in 47 of 459 shoulders, and only one shoulder (2.1 %) had recurrent instability. Wolf et al. [37••] reported the 2- to 10-year follow-up results of Hill-Sachs remplissage and noted that only two of 45 patients (4.4 %) experienced recurrence. Brilakis et al. [6] reported recurrence in three of 48 patients (6.3 %) after the remplissage procedure. Zhu et al. [38] retrospectively investigated the outcomes of Hill-Sachs remplissage and found four recurrences in 49 patients (8.2 %). Recent systemic reviews have described the overall recurrence rate after Hill-Sachs remplissage to be 3.4 to 5.4 %, without ROM restrictions [39, 40]. This technique may have a powerful stabilization effect and can be a useful augmentation with potential to reduce the rate of recurrent instability in high-risk patients; however, the recurrence rate currently varies among studies which maybe attributed to differences in technique. Based on several patient-specific factors including age, sports activity, joint laxity, size of

glenoid bone loss, and size of Hill-Sachs lesion, we judge the risk of recurrence for each patient. We apply the remplissage only for patients who are thought to be at high risk. The typical indication for the remplissage is young contact/collision athletes with a large Hill-Sachs lesion. We rarely perform the remplissage for dominant shoulders of throwing athletes to avoid loss of external rotation.

Conclusions

Arthroscopic labral repair for shoulder instability is a well-established and relatively safe procedure. However, a better understanding of the possible intraoperative and postoperative complications, including their pathology and treatment, is essential for satisfactory outcomes.

Compliance with Ethics Guidelines

Conflict of Interest Keisuke Matsuki and Hiroyuki Sugaya declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by the authors.

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