# Suture Anchors and Tacks for Shoulder Surgery, Part II

## The Prevention and Treatment of Complications

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The use of suture anchors and tacks around the shoulder requires a thorough knowledge of the proper use of the devices and how to insert them. Although typically not technically demanding, suture anchors and tacks can present unique and frustrating challenges to the patient and the surgeon. These challenges can occur whether the procedure is performed via an open or arthroscopic approach, but knowledge of the potential challenges may optimize the surgical result and prevent complications. Complications can be categorized as technique-related or device-related issues (mechanical or biologic failure). Technique-related complications include problems with the delivery systems, anchor malpositioning, and suture management issues, such as knots not sliding. Device-related complications include implant fracture, migration secondary to poor fixation, synovitis from implant degradation, and osteolysis. This review describes the prevention of these and other complications, addresses the indications or need for intervention, and suggests potential solutions when intervention is indicated.

**Keywords:** shoulder; anchors; complications; synovitis; infection

The use of suture anchors and tacks in shoulder surgery has engendered an increasing appreciation of the fact that there are technical considerations unique to the use of these devices in this anatomical location. Specifically, successful implantation of these devices for a Bankart procedure or repair of superior labrum anterior and posterior (SLAP) lesions depends on comprehensive knowledge of the normal and pathologic glenoid anatomy. New delivery systems and techniques are created frequently in attempts to make the use of these devices around the shoulder efficient and effective.

However, despite the best efforts of the surgeon and the use of delivery systems not expected to fail, technical difficulties with the devices and complications secondary to any surgical procedure or related to the type of device inserted can occur. Some of these complications are within the control of the surgeon and some are not. This review has 4 purposes: (1) to identify steps to help prevent these technical difficulties, (2) to enumerate solutions for those that do occur, (3) to present conditions produced by the devices that may not necessarily need treatment (such as osteolysis), and (4) to recommend treatment when complications require intervention.

## PREVENTION

The best way to optimize the use of suture anchors or tacks is to prevent possible complications. It is important to distinguish between complications related to details of the surgical technique and those related to the mechanical or biologic failure of the devices implanted at the time of surgery.[59] Prevention of complications associated with the use of suture anchors and tacks in the shoulder depends on anticipation of pitfalls related to these devices and their insertion techniques, and such anticipation in turn depends on a surgeon's familiarity with the devices and knowledge of their indications and limitations. Familiarity with and knowledge of these details are essential, particularly in an environment in which new implants seem to appear every day with little guidance and information about their performance.

Snyder[49] provided some guidance for the surgeon using these devices around the shoulder. First, the surgeon should follow the manufacturer's guidelines and be familiar with the proper insertion technique for that implant. Although not strictly necessary, it is recommended that the surgeon gain familiarity with the delivery system and the device from supervised instructional courses or by using them in artificial bone models or cadavers. Second, the surgeon

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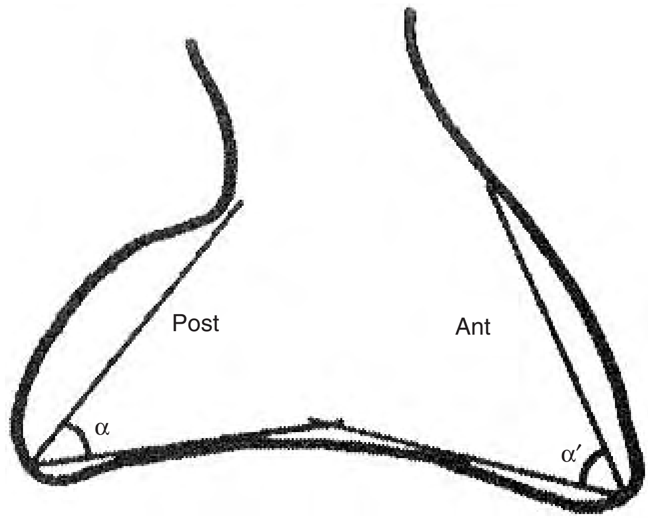


**Figure 1.** The glenoid rim angle, as seen in a cross-section of the glenoid, is a measure of how much bone is available for insertion of a suture anchor or tack. (Reprinted from *Arthroscopy,* 20, Lehtinen JT, Tingart MJ, Apreleva M, et al, Variations in glenoid rim anatomy: implications regarding anchor insertion, 175-178, 2004, with permission from The Arthroscopy Association of North America.)

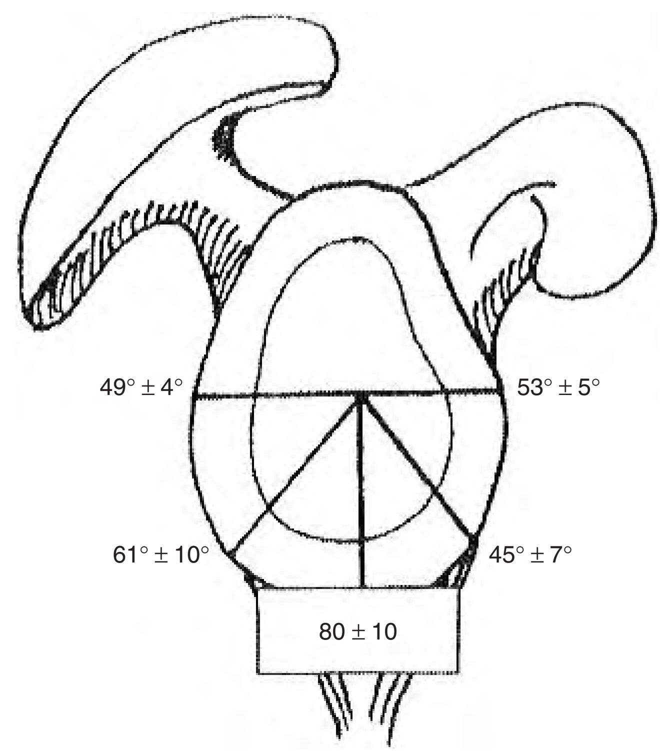


**Figure 2.** The glenoid rim angle is smallest in the anterior-inferior glenoid but largest in the inferior glenoid. (Reprinted from *Arthroscopy,* 20, Lehtinen JT, Tingart MJ, Apreleva M, et al, Variations in glenoid rim anatomy: implications regarding anchor insertion, 175-178, 2004, with permission from The Arthroscopy Association of North America.)

should use drill guides for accurate placement of the implant on the glenoid rim or in the tuberosity. A variation of that recommendation is that the anchor should be placed in bone under direct vision, with removal of enough soft tissue to verify the anchor position. Third, the anchor should be inserted through an appropriately sized cannula so that the surrounding soft tissue is protected and does not impede the anchor's insertion. Snyder's last recommendation was to try to use safety sutures that would allow the anchor to be retrieved if it became loose or dislodged during insertion.

Meyer and Gerber[37] elucidated important factors for a successful Bankart repair, including adequate anchor pull-out strength, optimum repositioning of the capsule at the edge of the glenoid (not down the scapular neck), appropriate suture material, secure knotting techniques, sufficient number of anchors, and gapless contact between tissue and bone. They indicated that the type of suture anchor (eg, a screw-in versus a lodging-type anchor) used will not compensate for inadequate surgical technique (eg, an incorrectly positioned anchor). Lehtinen et al[32] showed that the rim angle (Figure 1) is smaller in the anterior glenoid than in other portions of the glenoid (Figure 2). The surgeon should be aware that the anterior-inferior glenoid has the least margin of error for the placement of stabilization anchors.[32] Similarly, for rotator cuff repairs, the surgeon should know which areas of the humerus have the strongest and weakest bone.[55,56] Some anchors and tacks perform well in hard but not soft bone.

The surgeon also should have a backup surgical plan should the device fail or not fulfill its function to oppose the tissue to the bone. We recommend that, before beginning the procedure, the surgeon should have in place the following: (1) a variety of implants for different applications and locations, such as devices that might provide better purchase in the glenoid or the tuberosities; (2) a plan to accommodate a loose implant or a broken insertion system; (3) a plan to retrieve the device should it migrate or be positioned incorrectly; and (4) for arthroscopic procedures, a plan to convert to an open procedure should failure occur between the suture-tissue or anchor-bone interfaces.

Lastly, it is recommended that before surgery, the surgeon discuss with the patient that the soft tissue will be attached to bone via anchors or tacks, depending on the indications during surgery. Regardless of whether metal or absorbable implants are to be used, the patient also should be informed that although complications related to these devices are uncommon, they can occur secondary to multiple factors and that technical difficulties or implant failure during surgery may necessitate the use of other fixation techniques.

## COMPLICATIONS

### Implant Malpositioning and Migration

The potential implications of hardware malpositioning or migration after open shoulder surgery have been recognized for years,[60] but they also can occur after arthroscopic procedures, depending on the device used.[12,25,53] The migration of

TABLE 1
Aseptic Synovitis in the Shoulder After Use of Absorbable Tacks[a]

| Study (date) | Procedure[b] | N | N (%) Effective | ESR | CRP | Symptom Onset | Comments: Result | Comments: DJD |
|---|---|---|---|---|---|---|---|---|
| Edwards et al[14] (1994) | 1 | 100 | 5 (5) | N/A | N/A | N/A | 3 of 5 SLAP lesions | N/A |
| Laurencin et al[30] (1996) | 1 | 20 | 0 | N/A | N/A | N/A | 10% failure rate | N/A |
| Speer et al[50] (1996) | 1 | 52 | N/A | N/A | N/A | N/A | Failure rate 21% | N/A |
| Resch et al[43] (1997) | 1 | 98 | 4 (4) | Y | Y | 3-5 wk postoperatively | 3, symptoms resolved within 3 d; 1, needed arthroscopy | N/A |
| Segmuller et al[47] (1997) | 1 or 2 | 70 | 3 (4.2) | N/A | N/A | N/A | All labral repair; 1 required 3 debridements, no problem long term | N/A |
| Burkart et al[8] (2000) | 2 | 3 | 18 (17) | Y | Y | 9 wk average | N/A | N/A |
| O'Brien et al[39] (2002) | 2 | 31 | 0 | N/A | N/A | N/A | No complication | N/A |
| Freehill et al[21] (2003) | 1 | 52 | 10 (19) | N/A | N/A | 8 mo | 7, no problem; 2, continued pain; 1, pain at throwing | 3 patients (severe) |

[a]ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; DJD, degenerative joint disease; Y, yes; SLAP, superior labrum anterior and posterior lesions; N/A, not available.
[b]1, stabilization; 2, superior labrum anterior and posterior lesions.

pins, staples, and screws from the shoulder joint has been documented extensively.[17,26,33,35,48,60] Zuckerman and Matsen[60] divided these complications into 4 groups: (1) incorrect placement, (2) migration after placement, (3) loosening, and (4) device breakage. These complications may relate more frequently to surgical technique, but they also may be the result, in part, of using an implant that cannot meet the demands placed on it.

Fortunately, symptomatic hardware and fixation device malpositioning or migration appear to be infrequent complications, but the exact incidence is unknown because most reports represent retrospective case series.[4,17,26,35,44,48] Few studies specifically evaluate this issue in large patient cohorts. In 1989, Hawkins[25] reported a 4% incidence of staple migration in his early experience with using staples for arthroscopic Bankart repairs.

Cummins and Murrell[12] reported 1 case of suture anchor migration in a series of 81 rotator cuff repairs. Tamai et al[53] described their early experience with a threaded suture anchor device (Statak, Zimmer Inc, Warsaw, Ind) for Bankart repairs in 15 patients treated with an open approach and suggested that failure of the operation was the result of incomplete anchoring of the device. The devices did not migrate, but they protruded on the glenoid rim. In another study, Tamai et al[52] reported that of 28 shoulder reconstructions for instability, there was 1 metal suture anchor dislodgment (Mitek G-2, Mitek, Norwood, Mass). Potzl et al[42] reported no suture anchor migrations on postoperative radiographs in 85 shoulders that had been repaired with open Bankart procedures.

Tack migration can occur, but the exact incidence is difficult to assess because most of these devices are radiolucent. However, studies evaluating synovitis of the shoulder suggest that tack migration might be more common than suture anchor migration (Table 1). Cummins et al[13] reported finding portions of a bioabsorbable screw in the subacromial space of a patient with a failed rotator cuff repair.

Kaar et al[26] reported that in 8 patients with suture anchor complications after open or arthroscopic procedures of the shoulder, the complications depended in part on the anchor placement site. Suture anchors placed on the humeral side seemed to be more prone to loosening and dislodgment into the subacromial space or into the joint than did anchors placed into the glenoid rim. Penetration of the articular cartilage and anchor malpositioning resulting in symptoms were associated more commonly with suture anchors placed into the glenoid rim than with anchors placed in the proximal humerus. Those authors believed that failure of humeral-side anchors or tacks and that of glenoid-side anchors or tacks may have different sequelae, depending on the mechanism of failure.

Chondral damage after anchor or tack malpositioning has been reported[17,21,26,36,44,48] on the glenoid or the humeral articular surfaces; in some cases, this damage was considered extensive. Chondral damage can occur whether the device is absorbable or nonabsorbable and whether the procedure is done arthroscopically or via an open approach (Figure 3).

The patient with a malpositioned or migrated shoulder suture anchor may have symptoms of pain or catching in the postoperative period. These symptoms can be secondary to the anchor protruding through the articular surface or to loose-body mechanisms. Rhee et al[44] recommended plain radiographs for patients who have pain, catching, or decreased motion after shoulder stabilization. Computed tomography can be helpful in determining if metallic devices appear to penetrate the articular surfaces, and

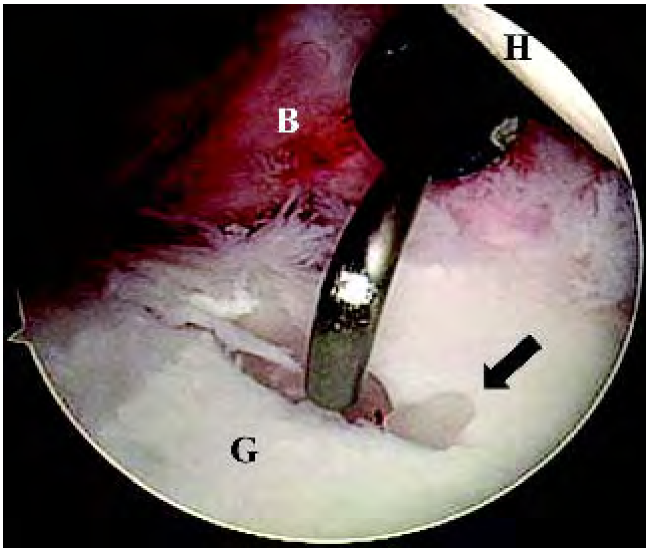


**Figure 3.** Arthroscopic view of a shoulder from a posterior portal of an absorbable tack that was positioned too superficially in the articular cartilage (arrow). This patient had corresponding wear with loss of the articular cartilage of the humeral head. B, biceps; G, glenoid; H, humeral head.

magnetic resonance imaging (MRI) may be helpful for the patient with absorbable implants who has synovitis or mechanical symptoms.

The treatment for malpositioned or migrated suture anchors and tacks depends on several factors. One such factor is the location of its migration. Anchors in the axillary pouch that do not cause symptoms probably can be left in place; however, even though the possibility of distant migration of a device in the synovium of the shoulder joint has not been reported, the possibility cannot be ruled out.[26] Another factor is whether the anchor is believed to be the cause of the symptoms. For example, suture anchors or tacks used for rotator cuff repairs that have become dislodged do not necessarily require removal unless they cause symptoms.

The treatment for anchors that appear to be malpositioned depends on the perceived accuracy of the imaging studies and on the symptoms of the patient. In a patient whose anchor or tack is believed to be penetrating the articular cartilage (based on radiographic evaluation), arthroscopic assessment is recommended. If the anchor or tack is protruding, the options are to remove it or to attempt to depress it beneath the surface. The best option is device removal, which can be challenging in a patient in whom the implant is fixed securely. Some screw-in anchors can be removed easily with the system provided, but if the insertion device becomes unloaded from the anchor, the suture can be used as a guide for reinsertion of the insertion device into the anchor head. Rhee et al[44] described the use of a high-speed, dental-type bur to make a hole around the anchor to facilitate its removal. However, we have seen radiographs and computed tomography scans that indicated the suture anchors might be protruding, and yet subsequent arthroscopy found no articular cartilage damage. In such a case, removal of the malpositioned device may not be necessary.

## Device Displacement at the Time of Surgery

At surgery, there are 2 options for addressing anchors that pull out of the bone at the time of implantation: (1) use a different anchor type (such as threaded anchors, which appear to perform better than wedge or hooked anchors in soft bone[55]) or (2) use transosseous suture techniques. If, despite these measures during rotator cuff surgery, the transosseous sutures still pull out of the bone, consideration should be given to button, plate, or patch supplementation on the humeral side of the construct.[10,19,23,51] If the initial anchor pulls out of the bone after SLAP repairs or anterior stabilizations, then a larger implant can be placed in the same hole, a different type of implant can be used in the same hole, or another anchor can be implanted nearby; for the last method, care should be taken not to violate the previous implant hole. Another option for implant pullout is bone supplementation with polymethylmethacrylate cement or with bone graft materials that can solidify and hold the device in place.

## Suture Failure

Suture failure in suture anchors can be related to surgical technique, quality of the soft tissue, and quality of the anchors and suture materials used. Two of the most common, if not the most frustrating, difficulties encountered with the use of anchors for open or arthroscopic procedures are knots not sliding or sutures breaking. These 2 complications usually can be avoided by practice and familiarity with the suture material and its limitations. For arthroscopic procedures, there are only 3 options for salvaging a suture whose knot does not slide or gets stuck in a cannula: (1) attempt device removal, which is possible with some anchor designs, but which can be difficult or nearly impossible with most implants; (2) try to untie the knot, which is equally technically difficult; and (3) place another device in the same hole (possible with some device designs) or near the existing hole of the failed anchor to fix the tissue more securely. Use of differently colored suture material also prevents suture tangling (which can lead to knots not sliding), especially during arthroscopic procedures.

If the suture breaks, intervention options depend on the device used and whether retrieval is possible. It may be necessary to evaluate exactly what caused the suture to break and then to use another type of anchor or suture. Implanting another anchor or using the same hole for another anchor depends on how much space is available and what type of anchor is used.

If the suture pulls out of the soft tissue at the time of surgery, the surgeon should reassess the location of the original suture in the tissue before placing another anchor or attempting to resuture the tissue. The surgeon should be careful to avoid macerating the tissue with too many suture passes, which would make fixation difficult. Some devices provide better suture passage and allow more knot security than others.[45] In some cases, such as when the

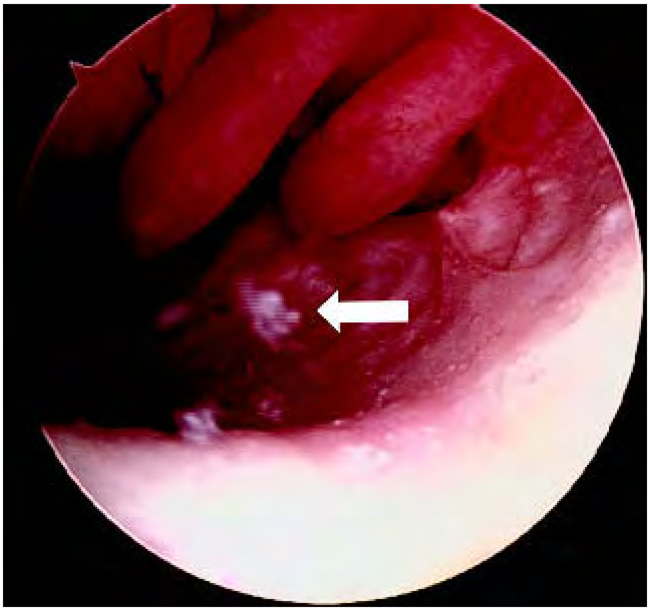

**Figure 4.** Arthroscopic view of the inferior pouch of the shoulder with synovitis secondary to fragments of an absorbable anchor (arrow).

tissue is not healthy, the sutures may have to be placed where the tissue is healthier. Cummins et al[13] found that the second most common cause of rotator cuff failure after suture pullout of the tendon was tearing of the rotator cuff in a location other than where the sutures were placed initially. The use of multiple sutures also may provide more fixation and prevent soft tissue disruption.

For rotator cuff repairs, augmentation of the suture–soft tissue interface with synthetic or biologic tissues has been found to increase the strength of the repair.[19,23,28] In an in vitro sheep model, Koh et al[28] studied a woven polylactic acid (PLA) scaffold to reinforce suture anchor repairs of the infraspinatus tendon and found that the failures of the construct still occurred with the tendon pulling out of the PLA patch. Although the pull-out strength was higher when the patch was used, their study reinforced the concept that, in many instances, the weak link in rotator cuff repairs is the suture-tendon interface.[28] Although it has been suggested that such scaffolds might stimulate the repair biologically, biomechanical studies of this contention are lacking. Sclamberg et al[46] found that the use of a biologic scaffold afforded no benefit in the repair of massive rotator cuff tears. In addition, synovitis has been reported as a complication of biologic grafts used for augmentation of rotator cuff repairs.[34] The use of synthetic grafts to supplement the suture-tendon interface has not been studied adequately, and additional study of their indications and efficacy is warranted.

## Tack-Tissue Complications

When tack devices are used for fixation, the tissue is compressed against the bone by the head of the device. Although some tacks may produce uniaxial strength-to-failure values similar to those of suture anchor devices, cyclical loading of rotator cuff defects has shown that tack failure occurs because of the tack cutting out of the tissue, tack head breakage, and tack pullout from bone.[11,31,41] Tacks can buttonhole the tissue if multiple attempts at placing a device are performed, which would create a hole so large that the tissue does not hold. We have experienced soft tissue disruption, particularly with barbed tacks that macerated the tissue during insertion. When tacks are used and tissue-tack interface problems occur, one of the potential solutions is to use suture anchors or transosseous suturing techniques.

## Synovitis

Synovitis after the use of absorbable suture anchors and tacks in the shoulder is similar to the inflammatory response reported after the use of absorbable plates and screws for fracture repair.[5-7,22,29] In a report of 286 patients, Bostman[5] indicated a 6.3% rate of sterile inflammatory response to absorbable implants used to repair ankle fracture. The reaction appeared clinically at 2 to 4 months after the surgery. In a review of the literature, Bostman and Pihlajamaki[6] reported a 4.3% incidence of clinically significant inflammatory responses to a series of primarily polyglycolic acid (PGA) implants used for fracture repair. They also found the incidence of reactions to absorbable implants used for fracture repairs was 2.0% to 46.7%. The reactions to PGA implants occurred, on average, approximately 11 weeks postoperatively, and those for PLA implants occurred approximately 4.3 years postoperatively.[6]

The inflammatory reaction to these devices represents a typical biologic response to a foreign body and to the degradation and absorption of these materials.[6] Although it appears that the polymers' degradation products trigger the reaction, the exact inciting mechanism or critical factor is unknown. The degradation and absorption of the biomaterials depend on many factors, such as the composition of the implant, whether it is placed intra-articularly or extra-articularly, and whether it is buried under the bone or near the surface. When the anchors or tacks are used intra-articularly and a tissue reaction occurs, the clinical appearance is of a synovitis of the joint (Figure 4).

The incidence of inflammatory reactions to suture anchors appears to be relatively low because most series do not report this complication. Almost all of the reported cases of synovitis in the shoulder have been in association with tacks and not suture anchors (Table 1). The exact reason for this discrepancy is unclear, but it may be the result of any or all of the following factors, which expose the tissue to more surface area of the polymer: (1) tacks inherently have more exposed surface because of their design, (2) the composition necessary for the machining of the anchors or tacks may increase the degradation, and (3) fractures at the head-shaft junction may have frequent displacement into the joint.

Aseptic synovitis in the shoulder has been reported with the use of absorbable tacks for the repair of SLAP lesions or for anterior stabilization (Table 1). The most commonly used PGA tack for shoulder surgery has been the Suretac (Acufex Microsurgical Inc, Mansfield, Mass) device. As a result, it


**Figure 5.** Magnetic resonance image (oblique coronal view) of suture anchors with osteolysis around the anchors. The patient had severe synovitis and 1 anchor floating in the joint.

has been the most studied implant for this complication in the shoulder. The reported incidence of aseptic synovitis in the shoulder varies from 0% to 22% (Table 1). Warner et al[58] reported on 2 patients with recurrent instability after a failed absorbable tack procedure, and although neither patient had clinical signs of synovitis, histologic analysis of biopsies of granulomas at the anchor insertion sites showed deposits of PGA surrounded by foreign-body giant cells and a chronic histiocytic infiltrate.

Freehill et al[21] described synovitis of the shoulder associated with PLA implants (Bankart Tack, Bionx Implants Ltd, Blue Bell, Pa) for anterior stabilization, a SLAP repair, or both. Because PLA devices generally degrade more slowly than those predominantly made of PGA, the patients with this complication (10 of 52) sought consultation an average of 8 months (range, 3-19 months) after their index procedure.[21] The symptoms were pain and gradual loss of motion. The results of laboratory hematologic studies were not reported, but all patients had MRI scans that showed a large effusion and tack debris in the joint. At arthroscopy, 9 of the 10 patients had identifiable debris visible to the eye, and all had synovial biopsies that showed giant cells and histiocytes typical of a foreign-body reaction. Of their 10 patients, 3 had severe osteochondral damage, which was speculatively ascribed to debris in the joint abrading the cartilage surfaces or to enzymatic degradation.

Any patient suspected of having implant-related synovitis should be assessed for infection as part of the overall evaluation. Blood studies such as a sedimentation rate, a C-reactive protein, and a white blood cell count should be considered. Magnetic resonance imaging of the shoulder can show whether any implants are free-floating or if portions of the tacks are present in the joint. If there are no signs of infection, the treatment is similar to that for patients with idiopathic adhesive capsulitis or other aseptic synovitis of the shoulder; nonoperative treatment to decrease the synovitis can be attempted first. Treatment should include pain medications, nonsteroidal anti-inflammatory medications, and oral steroids. Physical therapy to assist the patient in regaining range of motion may be helpful. For patients who do not respond to this regimen, arthroscopic evaluation with debridement of any debris and partial synovectomy have been shown to be effective.[8,21,47] Some patients may require more than 1 debridement to alleviate their symptoms. If the patient has severe pain or other signs of sepsis, an aspiration of the joint before the administration of antibiotics would be appropriate. If the aspiration finding is positive for organisms, then incision and drainage arthroscopically or via open techniques are warranted.

## Infection

Infection after surgical procedures in the shoulder involving suture anchors or tacks has been reported infrequently. For example, in a review of the literature, Freedman et al[20] suggested an infection rate of less than 1% for arthroscopic stabilization. Most series reporting on procedures using these devices, particularly for rotator cuff repairs and shoulder stabilizations, make no mention of any postoperative infection. Ferretti et al[18] had 1 deep infection in a series of 42 patients who underwent open anterior stabilization with nonabsorbable wedge-type anchors (TAG Wedge, Acufex Microsurgical Inc). The infection resolved with open debridement and removal of the anchor, followed by intravenous antibiotics. In a case report, Ticker et al[54] documented 1 deep infection after shoulder stabilization with a metal anchor (Statak, Zimmer, Warsaw, Ind). The patient did not become symptomatic until 8 weeks after surgery, and despite nonoperative treatment with antibiotics, he required surgery 6 weeks later. At surgery, the anchors were loose and easily removed.

Because there are few reported cases of infections after the surgical implantation of tacks or suture anchors, one can assume that the risk of associated infection is not high. However, infection can occur after these procedures, and the clinician should be aware of this potential complication. The symptoms and clinical course when anchors or tacks are used for fixation are not different from those for any other deep infection in a shoulder stabilized via other techniques. Initially, postoperative symptoms may be only a pain level higher than that expected for that procedure. Deep infections of the shoulder often do not appear until 2 to 8 weeks after surgery, and delayed symptoms of pain, fevers, and chills should be investigated with blood studies, including a sedimentation rate, a C-reactive protein, and a white blood cell count. Aspiration can be considered if there are clinical indications of a deep infection.

If surgery is performed to debride the joint, it is unknown if the implants have to be removed to eradicate the infection. Currently, there are no guidelines for the removal of absorbable or nonabsorbable anchors in an infected joint. If removal of the implant might cause wide destruction of the bone, consideration can be given to leaving the implant in place. The joint should undergo an extensive irrigation and debridement, followed by intravenous antibiotics. If the

**Figure 6.** Plain anteroposterior radiograph of a shoulder with osteolysis around absorbable anchors. This patient had a successful result with no recurrence of instability.

**Figure 7.** Plain anteroposterior radiograph of the shoulder of a patient with suture anchors placed deep in the humeral head.

infection recurs after this regimen, then the devices may have to be removed.

## Osteolysis

Osteolysis of the bone surrounding both absorbable and nonabsorbable implants has been described for implants used for fracture management and also for implants in the knee (eg, interference screws) and shoulder (eg, suture anchors).[1-3,6,15,27,57] The exact cause of the tunnel-widening seen on radiographs is not known entirely, but in some instances, it has been associated with a foreign-body reaction and loosening of the implant[6,21] (Figure 5).

The most extensive studies of this issue have been performed by Ejerhed et al[15,16] and Kartus et al.[27] Those authors[15,16,27] radiographically evaluated and compared the results of patients who underwent open anterior shoulder stabilization with absorbable TAG anchors (Acufex Microsurgical Inc) with those of a similar cohort who had Suretac tack fixation (Acufex Microsurgical Inc).[27] At a minimum of 18 months' follow-up, there were visible drill holes or cystic areas around the anchors in 56% of those with TAG anchors and in 23% of those with Suretac devices. However, these findings could not be associated with clinical result.[27] Similar findings were obtained when they compared the results of absorbable and nonabsorbable suture anchors for the open repair of posttraumatic anterior instability in 33 patients.[16] The incidence of visible holes or cystic changes was 60% in those with absorbable anchors and 66% in those with nonabsorbable anchors. There was no relationship between these lucencies and the final clinical outcome[16] (Figure 6).

Muller et al[38] used a PLA anchor for anterior instability in 24 patients and found osteolysis at 16 weeks in 7 of the 15 patients who had radiographs. Those authors speculated that the lysis might have resulted in part from mechanical effects of loading on the anchor and that it might be part of a normal resorption process. Warme et al[57] studied 40 patients who underwent an anterior stabilization with absorbable suture anchors. The size of the holes doubled in each group by 6 months, but at 1 and 2 years after surgery, the holes were difficult to detect radiographically.

Such studies show that osteolysis around suture anchors and tacks is very common. In most cases, these holes or small areas of lysis are not clinically important and can be disregarded. Glueck et al[24] described one case of massive osteolysis around an anchor inserted into the greater tuberosity, but the patient remained totally asymptomatic. They[24] and others[27] have suggested that mechanical effects may contribute to the development of osteolysis because the degree of osteolysis is highly variable among patients. However, in patients with symptoms of synovitis, these holes or cysts should alert the clinician to the possibility of implant loosening and failure. Similarly, these findings may be more clinically important in patients with clinical signs of possible implant failure. In such patients, serial radiographs might be indicated, and MRI scanning should be considered.

## Avascular Necrosis and Humeral Head Collapse

To our knowledge, suture anchor implantation has not been implicated in the disruption of the humeral head's blood supply except in 1 case.[40] In that report, the patient was an adolescent with anterior instability secondary to humeral avulsion of the glenohumeral ligaments. Two suture anchors were placed in the proximal humerus, and care was taken to avoid the anterior humeral circumflex blood vessels. The patient developed stiffness and pain, and an MRI revealed compromise of the blood supply to the humeral head. Fortunately, the patient recovered without complications, but suture anchors around the physis of the shoulder should be used with care.

Deep implantation of suture anchors in the humeral head also may compromise the blood supply of the humeral head in rare instances (Figure 7). Deep implantation has been shown to shift the mode of failure of suture anchors from abrasive wear of the suture at the eyelet to suture cutting through the bone.[9] In some systems for inserting anchors and tacks, the depth of penetration is not well controlled, especially in osteoporotic bone. In our practice, 2 patients with deeply inserted anchors developed bone collapse and pain. Although the exact cause of bone collapse in these patients is speculative, we believe deep insertion of the anchors may have contributed. It is recommended that patients with increasing pain and loss of motion after the use of suture anchors or tacks have plain radiographs and, if necessary, MRI to evaluate for this complication.

## SUMMARY

The development of tacks and suture anchors has revolutionized the ability to fix tissue securely to bone around the shoulder via open and arthroscopic techniques. New implants, stronger sutures, and more surgeon-friendly instrumentation continue to be developed, which should increase the successful application of these devices for shoulder surgical procedures. However, the successful use of any implant requires an understanding of the potential complications, how to avoid those complications, and what to do when they occur. The clinician faced with a new device, suture, or instrumentation should consider the biologic, mechanical, and clinical implications of the innovation. Anticipation of the pitfalls and a plan to deal with them will promote successful surgical results.

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