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Shoulder arthroplasty for chondrolysis

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Background: Chondrolysis is a rare complication after shoulder arthroscopy leading to early joint destruction. Shoulder arthroplasty may be considered for end-stage chondrolysis, but concerns exist about implant survivorship, given the younger age of this population. This study aimed to assess pain relief, function, and survivorship of shoulder arthroplasty for chondrolysis and to assess risk factors for failure.

Methods: Between January 2000 and January 2013, 26 consecutive shoulders with chondrolysis were treated at our institution with shoulder arthroplasty. All shoulders had a prior arthroscopic procedure that predated a phase of rapid joint destruction. Twenty-three shoulders were followed up for a minimum of 2 years or until reoperation (mean, 4.0 years; range, 0.7-8.6 years). The mean age of the patients was 40 years (range, 21-58 years). Outcome measures included pain, range of motion, postoperative modified Neer ratings, American Shoulder and Elbow Surgeons scores, complications, and reoperations.

Results: At most recent follow-up, only 14 of 23 shoulders had no or mild pain. Overall pain scores improved from 4.7 to 2.6 points. Abduction and external rotation improved significantly. Five shoulders required reoperation, 2 for glenoid loosening and 1 each for infection, instability, and stiffness. Subjectively, 8 patients rated their shoulder as much better, 7 as better, 4 the same, and 4 worse. Most recent American Shoulder and Elbow Surgeons scores averaged 64 points (range, 20-95 points).

Conclusions: Shoulder arthroplasty for the treatment of chondrolysis improves pain and range of motion. However, patient satisfaction is variable. Early follow-up shows a higher than expected rate of reoperation (25%). Patients undergoing shoulder arthroplasty for chondrolysis should be counseled appropriately about expectations after surgery.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: Shoulder arthroplasty; chondrolysis; arthroscopy; postarthroscopic; young; active

Multiple potential causes have been cited for chondrolysis, including gentian violet, local anesthetic pain pumps, radiofrequency ablation probes, suture material, bioabsorbable anchors, and low-grade infection.[5,11,16,20-22] Regardless of the initial insult, the final common pathway leads rapidly to joint destruction, pain, and limited function. Most of these patients are relatively young and present with cartilage destruction on both sides of the joint. Total shoulder arthroplasty (TSA) in this population of patients is an attractive salvage option and at the same time concerning because of the characteristics of these patients. In an attempt to avoid TSA, various authors have reported treatment of this condition with meniscal allograft, tissue interposition, osteoarticular allograft, and microfracture.[4,5,12,13]

With end-stage joint destruction, limited goals operations, such as arthroscopic débridement, may offer only temporary relief. Ultimately, prosthetic arthroplasty may represent the final option. Currently, studies on shoulder

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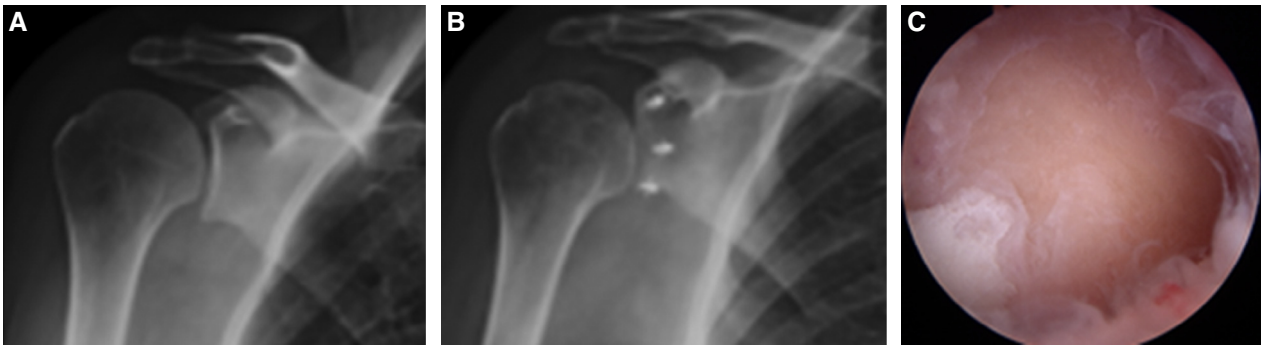

Figure 1 Preoperative (**A**) and 1-year postoperative (**B**) radiographs of a 46-year-old status post Bankart repair with loss of the joint space. (**C**) Fourteen months postoperatively, arthroscopic views of the glenoid showed extensive cartilage loss, with anchors having previously been removed. Ultimately, the patient underwent a TSA.

arthroplasty for chondrolysis are limited to case reports and 1 small series of 11 shoulders.[8,10,12] The purpose of this study was to report our experience treating shoulder chondrolysis with arthroplasty and to assess pain relief, function, survivorship, and risk factors for failure.

Methods

Between January 2000 and January of 2013, 26 consecutive shoulders with chondrolysis were treated at our institution with shoulder arthroplasty after failure of conservative treatment measures. All surgeries were performed by a fellowship-trained shoulder surgeon (6 participating surgeons). Twenty-two shoulders underwent TSA. Four patients did not want to accept the restrictions of a TSA and chose to undergo hemiarthroplasty (HA) despite glenoid cartilage loss. Twenty-three shoulders (19 TSAs, 4 HAs) were followed up for a minimum of 2 years or until reoperation. One patient died during the first 2 years after surgery, 1 patient was lost to follow-up, and 1 chose to be removed from research. These 3 shoulders were eliminated from the clinical analysis but included in survival analysis. Therefore, 92% (23/25) of eligible shoulders were available for clinical analysis.

Unfortunately, no standardized diagnosis of chondrolysis has been accepted among orthopedic surgeons. For inclusion purposes in the current study, we used the definition by Provencher et al: "surgical, radiographic, or imaging findings demonstrating diffuse cartilage loss of joint-space narrowing due to involvement of apposing articular surfaces, and rapid cartilage destruction"[17] (Fig. 1). Cases were identified by crossmatching patients in our institution's arthroplasty database with a clinical chart text search (terms: chondrolysis, rapid cartilage loss, postarthroscopic, and pain pump). All cases were then reviewed independently by 2 orthopedic surgeons to confirm the diagnosis of chondrolysis. Any disagreements were then reviewed by all authors to determine if a final diagnosis of chondrolysis was appropriate. Shoulders were documented to undergo rapid cartilage loss, within 2 years, after initial arthroscopic surgery. Evidence of cartilage loss before index arthroscopy was considered degenerative, thus excluding the shoulder from a diagnosis of chondrolysis. Any shoulder with a confirmed infection identified at any time point preoperatively or intraoperatively was excluded. All cultures at our institution are held for 14 days to assess for *Propionibacterium acnes*.

Patients' charts were reviewed for preoperative risk factors as well as for clinical and radiographic outcomes. Risk factors from the prior surgery were reviewed and included local anesthetic pain pumps, radiofrequency ablation probes, suture material, bioabsorbable anchors, and low-grade infection. Twenty-three shoulder arthroplasties were performed at an average age of 40 years (range, 21-58). Arthroplasties were performed at an average of 71 months (range, 14-162) after the index arthroscopy. Eleven of 23 shoulders had undergone more than 1 previous surgery, with the average shoulder undergoing 2 surgical procedures before arthroplasty. A list of prior surgeries is outlined in Table I. Only 2 patients were confirmed to have prior postoperative pain pumps.

After arthroplasty, all shoulders were followed up at regular intervals.[2] Shoulders are routinely observed at 6 weeks, 3 months, 1 year, 2 years, 5 years, and every 5 years thereafter. Shoulders were followed up for an average of 4.0 years and a minimum of 2 years or until reoperation (range, 0.7-8.6 years). The patients' charts were reviewed to assess preoperative and postoperative pain (scale of 1 to 5).[14] Patient satisfaction was recorded as "much better," "better," "the same," or "worse" compared with immediately before index arthroplasty. Active abduction and external rotation were measured in degrees. For those patients unable to return for inpatient evaluation, range of motion (ROM) was assessed using a validated questionnaire.[18] Internal rotation was recorded as the most cephalad vertebrae reached by the thumb. Modified Neer ratings and American Shoulder and Elbow Surgeons (ASES) scores were determined at follow-up.[3,14] Ten shoulders returned for in-person examinations, and the remaining 13 were followed up by questionnaire.

Preoperative radiographs were available for all shoulders (Fig. 2). These included a standardized 40° posterior oblique view with internal and external rotation of the humerus and axillary radiographs. Postoperative radiographs at a minimum of 1 year were available for 20 shoulders at a mean of 4.1 years (range, 1.4-8.3 years). All radiographs were reviewed by 2 orthopedic surgeons. Discrepancies were reviewed with the senior author for final grading. Preoperative radiographs were evaluated for preoperative subluxation, cartilage loss, and glenoid erosion. Glenohumeral subluxation was evaluated according to the direction and amount of central humeral head subluxation in reference to the center of the glenoid. Subluxation was graded as none, mild (<25% displaced), moderate (25%-50% displacement), or severe (>50% displacement). Glenoid erosion was classified as none, mild (to the subchondral plate), moderate (through the subchondral plate), or severe (to or beyond

Table I Surgeries before arthroplasty, by patient

Patient	No. of prior surgeries	Surgeries
1	1	Unknown arthroscopic procedure
2	2	SLAP repair; rotator cuff repair
3	1	Arthroscopic labral repair
4	1	Rotator cuff repair + labral débridement + biceps tenodesis + distal clavicle excision
5	1	Labral repair
6	3	Arthroscopic débridement; arthroscopic labral repair; arthroscopic capsular release
7	2	SLAP repair; arthroscopic débridement
8	3	Distal clavicle excision, unknown arthroscopic procedure, SLAP repair
9	5	SLAP repair; rotator cuff repair + acromioplasty; revision SLAP repair + acromioplasty; revision SLAP repair; biceps tenodesis
10	1	Arthroscopic labral repair
11	2	Arthroscopic labral repair; arthroscopic débridement
12	2	SLAP repair + thermal capsulorrhaphy; arthroscopic débridement
13	1	Arthroscopic capsular release
14	1	Arthroscopic labral + SLAP repair + rotator cuff tear débridement
15	3	SLAP repair; arthroscopic débridement; arthroscopic capsular release
16	2	SLAP repair + thermal shrinkage; arthroscopic débridement
17	2	Arthroscopic labral repair; arthroscopic débridement
18	2	Arthroscopic labral repair + thermal capsulorrhaphy; arthroscopic débridement
19	3	Arthroscopic labral repair; arthroscopic labral repair; arthroscopic débridement
20	4	Arthroscopic acromioplasty + distal clavicle excision; arthroscopic capsular release/débridement × 3
21	1	Arthroscopic labral repair
22	1	Rotator cuff repair
23	2	Arthroscopic labral repair; arthroscopic débridement

SLAP, superior labral anterior-posterior.

the lateral aspect of the coracoid base). Postoperative radiographs were evaluated for subluxation, glenoid erosion, periprosthetic lucency, and component shift in position. Radiolucency about both the humeral stem and glenoid components was graded on a scale of 0 to 5. Grade 0 represented no lucent lines, whereas a lucent line was considered to be grade 1 if incomplete and ≤1 mm, grade 2 if complete and ≤1 mm, grade 3 if incomplete and ≤1.5 mm, grade 4 if complete and ≤1.5 mm, and grade 5 if complete and ≥2 mm. Any prosthetic component with a grade 4 or grade 5 radiolucency or a shift in component position between early postoperative and final radiographs was determined to be radiographically "at risk" for clinical failure.[19]

Operative technique

Shoulders were approached through a deltopectoral incision. A subscapularis tenotomy was performed in 18 shoulders, with 2 shoulders undergoing subscapularis peels and 3 undergoing a lesser tuberosity osteotomy. In the presence of joint tightness, capsular releases were performed from the proximal humerus inferiorly, the glenoid rim anteriorly and posteriorly, and above the long head of the biceps superiorly. Many shoulders had hypertrophic synovium requiring synovectomy. Any remaining implants were removed when visible. When reaming the glenoid, patients often have relative osteopenia and lacked the subchondral sclerosis seen with osteoarthritis. No cases required glenoid bone grafting. Seventeen of the 19 glenoid components were pegged and included Smith & Nephew–Cofield 2 (10) (Memphis, TN, USA), Biomet Comprehensive (6) (Warsaw, IN, USA), and Stryker Reunion (1) (Kalamazoo, MI, USA). Two keeled Tornier Aequalis (Memphis, TN, USA) glenoid components were used. In 4 cases, the glenoid was not resurfaced despite cartilage loss. Humeral components were seated in place in 30° of retroversion, unless the implant technique called for matching the anatomic version (Tornier Aequalis). When there was tightness of the joint preoperatively, the humeral head component was slightly undersized. One humeral component was cemented, with the remaining being placed uncemented. Humeral component manufacturers included Smith & Nephew–Cofield 2 (10), Biomet Comprehensive (8), Tornier Aequalis (3), Stryker Reunion (1), and DePuy (1) (Warsaw, IN, USA). Postoperatively, the operative limb was placed in a shoulder immobilizer worn at all times for 6 weeks at night. A sling was worn during the day for 1 month to 6 weeks. Passive ROM within the limits determined at surgery was started on the second postoperative day. At 6 weeks, active assisted ROM was begun with progression to gentle strengthening at 8 weeks postoperatively.

Statistical methods

Descriptive statistics are presented as mean (range) for continuous measures and number (percentage) for discrete variables. All 25 shoulders with research consent were included in the survivorship analysis. Implant survival was defined as a shoulder not undergoing any reoperation. Survivorship was estimated using the Kaplan-Meier method, reported as estimated survival (95% confidence interval). The 19 TSAs and 4 HAs with minimum 2-year follow-up or until reoperation before 2 years were included in clinical analyses. A paired *t*-test was used to evaluate preoperative vs. postoperative changes in pain and ROM. The α level for all tests was set at .05 for statistical significance.

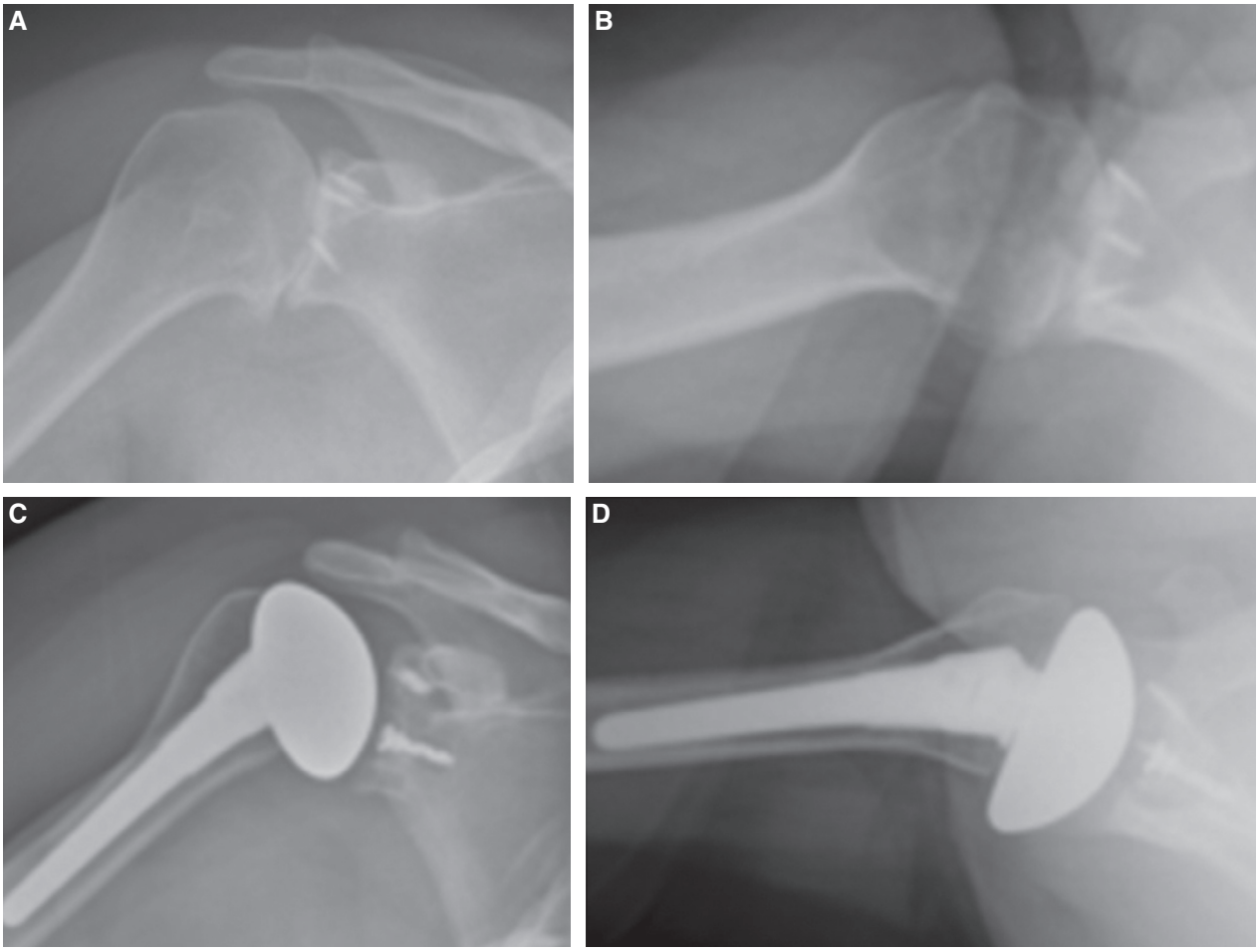

Figure 2 Preoperative radiographs (**A**, **B**) of a 33-year-old showing full-thickness cartilage loss and a centered humeral head, with glenoid anchors after a superior labral anterior-posterior repair. Two-year postoperative radiographs (**C**, **D**) showing a well-aligned TSA 1 year after surgery.

Results

Shoulder arthroplasty significantly reduced pain (scale, 1-5) from 4.7 preoperatively to 2.6 postoperatively ($P < .001$). Preoperatively, 21 patients rated their pain as moderate or severe compared with 8 (35%) at follow-up. Pain was secondary to stiffness (1), glenoid loosening (1), instability (1), acute hematogenous infection (1), progressive cartilage wear (1), and unexplained in 3 shoulders. One of 4 HAs (25%) reported moderate pain, which was consistent with progressive cartilage wear. Of the 19 TSAs, 7 had moderate or severe pain (37%) for reasons outlined before. Mean abduction improved from 107° to 137° ($P = .012$). Active elevation at follow-up was ≤90° in 5 shoulders, 91° to 120° in 2 shoulders, and >120° in 16 shoulders. Three of 4 HAs had active elevation >120°, with 1 having elevation of 120°. Mean external rotation improved from 25° to 45° ($P = .016$). External rotation was ≤20° in 6 shoulders, 21° to 45° in 6 shoulders, >45° in 10 shoulders, and not recorded in 1 shoulder. The same HA with elevation of 120° also had limited external rotation of 20°. Internal rotation improved from the sacrum to L3 ($P = .08$). Twelve shoulders with preoperative abduction <90° and 14 shoulders with external rotation <30° were compared with those with greater amounts of preoperative motion. At follow-up, there were no differences in pain ($P = .9, .13$), abduction ($P = .6, .2$), or external rotation ($P = .8, .7$).

Overall, 15 patients were satisfied, rating their shoulder as much better or somewhat better. Four patients rated their shoulder the same, and 4 reported being worse than before arthroplasty. Three of these underwent reoperation (see later), and 1 was subjectively dissatisfied despite excellent ROM and pain control. Excellent Neer ratings were achieved in 6 shoulders and satisfactory ratings in 8 shoulders. Nine shoulders were rated unsatisfactory (8 TSAs, 1 HA). Unsatisfactory ratings were due to reoperation (5), pain (1), decreased motion (1), and a combination of both pain and loss of motion in 2 (including the 1 HA). ASES scores were calculated for 14 shoulders (12 TSAs, 2 HAs; 11 by mailed questionnaire, 3 by clinic questionnaire) and averaged 64 (range, 20-95). ASES scores were 20 to 40 (3 TSAs, 1 HA), 41 to 60 (1 shoulder), 61 to 80 (4 TSAs), and >80 (4 TSAs, 1 HA).

Table II Postoperative radiographic outcomes

HA	
Progressive glenoid erosion	3
Mild central	2
Severe central	1
Humeral lucency	0
Subluxation	0
TSA	
Glenoid lucencies	
Grade 1	4
Grade 3	5
Glenoid shift	1
Humeral lucency	
Grade 3	1
Humeral shift	0
Subluxation	
Severe anterior	2

Preoperatively, infection was worked up at the discretion of the treating surgeon. Two patients with no cultures had normal erythrocyte sedimentation rate and C-reactive protein level. Four shoulders had prearthroplasty open cultures that were negative for infection. Four frozen sections were negative. Intraoperative cultures were available for 9 shoulders. Two of these grew *P. acnes* from 1 of 2 cultures. Both shoulders were seen and evaluated by an infectious diseases expert who thought these were contaminants. The first shoulder was treated with 5 weeks of minocycline and was doing well with no pain at 2 years. The second shoulder was treated with 8 weeks of cephalexin and ultimately underwent arthroscopic excision of the glenoid component 8.5 years postoperatively for aseptic glenoid loosening. Cultures at the time of reoperation showed no evidence of infection. Six shoulders had no infection workup. One of these 6 had late glenoid component loosening with the cultures being negative at the time of revision.

Preoperative radiographs were available for all shoulders and demonstrated marked cartilage loss after their previous arthroscopic procedures. Moderate central glenoid erosion was present in 2 shoulders. Moderate posterior subluxation was present in 3 shoulders. Postoperative radiographs were available for 20 shoulders at a mean follow-up of 4.1 years (range, 1.4-8.3) (Table II). One glenoid component had shifted in position, leaving 1 glenoid component at risk (5%). No humeral components had shifted in position, leaving no humeral components at risk.

Five TSAs underwent reoperation at a mean time of 5 years after index arthroplasty (range, 0.7-8.6). No HA underwent reoperation. Two TSAs underwent reoperation for aseptic glenoid loosening, both 8.6 years after index arthroplasty. One shoulder was revised immediately to a cemented keeled glenoid component. The other underwent arthroscopic removal of the glenoid component but ultimately required 3 additional operations, with the last being a conversion to a reverse TSA. One shoulder developed an acute hematogenous infection 5 years after arthroplasty following a tooth extraction and required a 2-stage exchange to a reverse TSA. One shoulder underwent an arthroscopic capsular release for postoperative stiffness 1.5 years postoperatively. Elevation improved 80° to 150° and external rotation improved 30° to 50° at 5 months after the procedure. The last patient required a pectoralis major transfer for a subscapularis tear and clinical instability 1 year postoperatively. One additional patient with severe shoulder pain underwent placement of a spinal stimulator, which decreased her postoperative shoulder pain to a 3 with excellent ROM. Estimated survivorship at 5 years was 91.5% (confidence interval, 80.8-100).

Discussion

Reports on shoulder arthroplasty for chondrolysis are limited to case reports and a single series of 11 patients.[12,13] To our knowledge, this is the largest series of shoulder arthroplasty for chondrolysis. The results of our study indicate that shoulder arthroplasty can be expected to provide pain relief and improved motion for patients with chondrolysis. However, outcomes scores and subjective satisfaction are variable, with 35% of patients reporting that their shoulder is the same or worse than before surgery. The reasons for this variability were many, with residual pain, stiffness, instability, later infection, and glenoid component loosening each contributing to poor outcomes. A component of subjective dissatisfaction may be secondary to the patient's expectations and a previously high-functioning shoulder. In this young population, concern about the longevity of the implants appears to be well founded, but early failures have not demonstrated a common failure mechanism. At an average follow-up of 4.0 years, 22% of shoulders in this series had already undergone reoperation.

Chondrolysis, as a surgical pathologic process, is different from osteoarthritic and post-traumatic cases.[7,15,21] The bone is often osteoporotic, demanding care when placing a glenoid component. There may be hypertrophic synovium requiring débridement; however, more commonly, the synovium and capsule are fibrotic. Capsular releases are only partially effective in regaining joint flexibility and movement. These issues have led to unanticipated variability in patient outcomes. Although average pain is reduced and motion is improved, pain relief can be incomplete, motion can be limited, healing of the anterior joint capsule and subscapularis can be affected and lead to instability, and early glenoid loosening can occur. Although there is not a single cause for poor results, complications, or reoperation, all of these things affected outcomes in this small cohort.

Similar to Levy's series of chondrolysis treated with shoulder arthroplasty, initial surgery in a large percentage of patients involved labral fixation (78% vs. 72%). Significant pain relief and improvement in elevation and external rotation were similar to previous reports on chondrolysis.[6,10] The 22% reoperation rate in our series is similar to that reported by

Hasan and Fleckenstein (18.5%) and may explain the lower rate of patient satisfaction compared with that reported by Levy et al (65% vs. 91%).[6,10] ASES scores in our series (64) were similar to those of Hasan (65.8) but less than those of Levy (77.5). In addition, Levy et al included 1 patient with positive cultures for *P. acnes*. It is unclear if this was considered a contaminant. If this represented a true infection, this patient would have been eliminated from our study, and it would have been considered an occult infection rather than chondrolysis.

The high early rates of reoperation after shoulder arthroplasty for chondrolysis are significantly higher than those reported for TSA for the treatment of osteoarthritis in patients younger than 55 years. Bartelt et al reported an estimated survivorship of 100% for TSA at 5 years compared with 91.5% in this series, which combined TSA and HA. In this series, no patients undergoing HA had undergone reoperation compared with an estimated survivorship of 85% for HA at 5 years in Bartelt's series.[1] This certainly raises concerns about how these younger patients treated with HA for chondrolysis will do in the future, given that the average age of these patients was 6 years less than in the Bartelt series at the time of surgery.[1] These younger patients undergoing shoulder arthroplasty for chondrolysis will need to be observed closely over time to monitor for clinical failures.

Our study presents several strengths, including the relatively large number of patients for an uncommon condition that affects <5% of shoulders treated arthroscopically.[4] The incidence has likely decreased further as more risk factors are identified and eliminated from surgical protocols. In addition, 92% of eligible shoulders were followed up. The study remains limited by its retrospective nature and small case numbers, which did not allow a direct comparison of HA and TSA. As a tertiary referral center, only 3 of the original arthroscopic procedures were performed at our institution. Therefore, it is possible that other risk factors, such as indwelling pain catheters or radiofrequency ablation probes, may have been used but not documented in the records obtained. Therefore, we are unable to completely assess preoperative risk factors. It is also possible that some patients with chondrolysis undergoing arthroplasty at our institution were missed if their chart did not accurately document their condition or contain the searched phrases. However, the authors attempted to use broad search terms and clinical chart reviews in an attempt to capture as many patients as possible. The use of multiple implants and surgeons also leads to small deviations in surgical techniques that could affect results. As a tertiary referral center, a portion of our patients do not return for in-person follow-up. In addition, some patients who do return forgo radiographs because of expense not covered by insurance. Both of these limit the number of patients who obtain radiographic follow-up. To be inclusive, radiographs were reviewed at a minimum of 1 year of follow-up, leaving the possibility that more components may have been "at risk" at the time of clinical follow-up.

Concerns remain when arthroplasty is performed in the young population, who can be expected to use their arm with high demands. This study supports earlier findings of younger patients being more likely to undergo revision arthroplasty.[9] Although this study eliminated patients with preoperatively or intraoperatively diagnosed infection, occult infection remains a concern for early failures and unexplained postoperative pain. Arthroscopic soft tissue biopsies before arthroplasty may be beneficial in patients thought to have chondrolysis in an effort to rule out occult infection. The myriad poor outcomes and high rate of reoperation should caution surgeons about the success of prosthetic arthroplasty in patients with chondrolysis.

Conclusion

At early follow-up, shoulder arthroplasty provides pain relief and improved ROM for chondrolysis. The early failure rate is higher than expected, with 22% of patients undergoing reoperation. In addition, 35% of patients remain unsatisfied. Surgeons should remain cautious in performing shoulder arthroplasty in the young patient affected by chondrolysis.

Disclaimer

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