Nonarthroplasty Options for the Athlete or Active Individual with Shoulder Osteoarthritis

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KEY POINTS

- Young, active individuals with shoulder osteoarthritis pose a unique management challenge.
- Nonoperative modalities have been poorly studied and, therefore, recommendations for or against certain treatments are not well established.
- There is weak evidence for use of viscosupplementation in patients with glenohumeral osteoarthritis; however, specific evidence for its use in young, active individuals remains unknown.
- Arthroscopic debridement is a reasonable next-line treatment if antiinflammatory medications and therapy fail. It has good short-term results and minimal complications in patients with small, contained, unipolar lesions.
- Overall, young patients with small, contained unipolar lesions of the glenohumeral joint have good outcomes with microfracture (increased clinical outcome scores, increased range of motion, decreased pain scores) at short-term follow-up.

INTRODUCTION

Management of young, active patients with glenohumeral joint (GHJ) osteoarthritis (OA) can pose a significant clinical challenge. Nonoperative management should be attempted before consideration of other invasive options, with the goal to minimize pain, improve or maintain functionality, and minimize progression of the disease process. The success of nonoperative management should be based on a combination of

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the patient's severity of symptoms and expected functional capabilities instead of radiographic severity of GHJ OA because there is a wide variability between present-ing symptoms and the severity of OA on radiographs.[1–3] Unlike other joints that develop OA, strong recommendations for a specific or guided conservative approach remain elusive for the shoulder in the general population.[1] The current American Acad-emy of Orthopaedic Surgeons (AAOS) clinical practice guideline on the treatment of GHJ OA for the nonarthroplasty treatments, created in 2009 and reaffirmed in 2014, only provides weak recommendations for injectable viscosupplementation as a treat-ment modality, whereas there is inconclusive evidence to support the use of therapy, pharmacotherapy, injectable corticosteroids, arthroscopic procedures, or open debridement.[1] There is an overall lack of strong evidence for the use of nonarthro-plasty treatments for GHJ OA compared with AAOS guidelines for nonarthroplasty treatments for knee OA, which strongly recommend use of nonsteroidal antiinflamma-tories (NSAIDs), low-impact rehabilitation, wellness activity, education, and weight loss while advocating against arthroscopic procedures, viscosupplementation, glucosamine, chondroitin, insoles, and acupuncture.

Furthermore, there are several factors that differentiate decision-making for younger, active patients, from older patients. Younger patients tend to have a more complex disease etiologic factors, such as posttraumatic arthritis, osteonecrosis, or rheumatoid arthritis, compared with primary etiologic factors, such as degenerative OA, which is more common in older populations, which may affect treatment deci-sion-making.[4] As such, nonoperative modalities continue to be an attractive option as a primary low-risk approach before consideration of arthroplasty-related options. Therefore, this article focuses on the contemporary literature surrounding nonarthro-plasty treatment modalities for GHJ OA.

NONOPERATIVE MANAGEMENT OF YOUNG PATIENTS WITH OSTEOARTHRITIS OF THE GLENOHUMERAL JOINT

Initial management should consist of a trial of rest, activity modification, patient education, and physical therapy for strengthening and rehabilitation because these modalities are inexpensive, pose minimal risk, and may mitigate patient symp-toms.[5] These modalities may not alter the ultimate progression and course of the disease; however, the goal is to prolong the time until more invasive options, such as surgical arthroscopy procedures or shoulder arthroplasty, become neces-sary. Physical therapy programs have proven to be an effective treatment of other disease processes and, although the consensus remains inconclusive due to a paucity of data, have begun to demonstrate promise for its application in GHJ OA in younger patients. Therapist-directed exercise regimens, manual therapy, manipulations, and a combination of manual therapy and tailored exercise regi-mens have been shown to decrease pain and improve function for other shoulder disorders.[6–11]

Furthermore, recent studies have demonstrated that individualized home therapy with patient adherence to rehabilitation protocols have been effective in treating the pain associated with glenohumeral arthritis.[12] Initial patient supervision by a therapist is encouraged to guide appropriate performance of such exercises. In addition to su-pervision, the therapist may use a series of modalities (eg, surface heat, therapeutic ultrasound, low-level laser therapy, electrotherapy) to assist in pain control and relax-ation surrounding therapy exercises.[2] Exercise programs use a series of advancing joint mobilization techniques, progressing the patient from passive movements and stretching exercises to strengthening and resistance training after mobility and joint

elasticity are established.[2] Specific forms of strength training are used, starting with isotonic and isometric types, and advancing to concentric strengthening. Eccentric exercises may also be used; however, evidence specifically for eccentric strengthening is currently insufficient.[13]

In addition to lifestyle modifications, pharmacologic analgesics and NSAIDs can be used simultaneously. Primary options include acetaminophen or, if tolerated, NSAIDs, due to their relatively low toxicity profiles.[2] In a 2004 meta-analysis of 10 randomized controlled trials assessing the effectiveness of acetaminophen in reducing pain from OA, the investigators found that providing 1 g of acetaminophen 3 to 4 times a day significantly reduced pain complaints compared with placebo. Acetaminophen has a better safety profile than NSAIDs, although NSAIDs were found to have better pain relief compared with acetaminophen and were preferred by more subjects.[14] Additional randomized trials have further confirmed that NSAIDs are superior to acetaminophen, which is itself superior to placebo.[15] There are currently no recommendations for the use of glucosamine, chondroitin sulfate, vitamins, or other herbal medications in subjects with GHJ OA due to a lack of high-quality data, although these modalities have been better studied in other sites of OA.[2]

If other noninvasive measures fail to provide relief, injectable medications provide another alternative treatment option. Intraarticular steroid injections are an alternative if there are no medical contraindications in patients who are unresponsive to oral medications. However, limited use over time is recommended due to concern for eventual effects on articular cartilage and surrounding tissues.[12,16,17] Ramírez and colleagues[17] evaluated 53 subjects with shoulder pain and without full-thickness rotator cuff tears who received a subacromial injection of triamcinolone acetate 40 mg. These subjects were followed for 12 weeks, at which point 17% were found to have developed full-thickness rotator cuff tears on ultrasound assessment, 66.6% of which occurred in subjects with previously documented partial tears. Overall, however, subjects experienced a significant reduction in pain and improvements in their function after 12 weeks.[17]

The only recommendation from the AAOS guidelines, albeit weak, advocates for the use of intraarticular, high-molecular-weight hyaluronates for symptomatic relief in patients with GHJ OA, although the specific administration in young patients remains unclear.[1] Blaine and colleagues[18] performed a randomized controlled trial evaluating the use of sodium hyaluronate for subjects with GHJ OA. They separated subjects into those who received a 3-injection series (n = 136), a 5-injection series (n = 129), and a control group (n = 133). Subjects who received either the 3 or 5 injections had a significant reduction in shoulder pain visual analog scale scores compared with the control group. Furthermore, Silverstein and colleagues[13] reported that viscosupplementation resulted in significant improvement in shoulder pain 6 months following injection for subjects with GHJ OA. Other injectable medications, including platelet-rich plasma, growth factors, or stem cells, are still undergoing investigation and, therefore, cannot be recommended at this time.[2]

ARTHROSCOPIC DEBRIDEMENT IN YOUNG PATIENTS WITH OSTEOARTHRITIS OF THE GLENOHUMERAL JOINT

Although shoulder arthroplasty is considered the definitive treatment of GHJ OA and provides reliable pain relief and increased function, it is not an ideal procedure for the young patient because younger patients have a significantly higher incidence of component failure and inferior patient-reported outcomes.[19] Consequently, if nonoperative management fails in the young patient with shoulder OA, arthroscopy may,

depending on the extent of disease, be considered as the next treatment choice.[20] Arthroscopy is considered a palliative treatment, and its goals are to reduce pain and potentially increase range of motion.[20–22] Although the ideal candidate is an older, low-demand individual with a small defect (usually <2 cm^2),[23] several studies have demonstrated good short-term outcomes in the younger patient.[23–25] Another potential advantage arthroscopy is that other intraarticular pathologic conditions can be addressed during surgery, such as capsular contracture, impingement, loose bodies, and biceps tendonitis.[23–27]

A variety of arthroscopic techniques to address chondral injury in the shoulder have been described in the literature. Many combine the management of chondral injury with loose body removal, capsular release, labral debridement, synovectomy, osteophyte resection, bursectomy, subacromial decompression, microfracture, and biceps tenotomy or tenodesis to address potential pain generators.[23–27] To address the cartilage injury, a combination of motorized shavers and arthroscopic curettes can be used to remove the chondral flaps.[20] Arthroscopic debridement is carried down to stable rim of cartilage and subchondral bone.[21] A stable, vertical transition zone should be created between the defect and surrounding cartilage in grade IV lesions,[21] which has been demonstrated in a canine model to slow disease progression.[28]

There are only a handful of studies that describe arthroscopy for the young patient with GHJ OA and, overall, these studies demonstrate good pain relief in the short term.[23–25,29,30] Van Thiel and colleagues[25] described arthroscopic debridement along with capsular release, acromioplasty, loose body removal, osteophyte resection, subacromial decompression, biceps tenotomy or tenodesis, and microfracture in 71 subjects at the mean age of 47 years (range 18–77 years). At final follow-up, 16 subjects (22%) went on to have arthroplasty at a mean of 10 months, and there was no difference in age or gender when comparing subjects who progressed to arthroplasty versus subjects who did not. Subjects who did not undergo arthroplasty at a mean follow-up of 27 months had improved functional outcome scores and range of motion. Risk factors that were associated with the eventual need for arthroplasty in this study were cases with a radiographic joint space less than 2 mm, grade IV bipolar disease, and large osteophytes. Weinstein and colleagues[24] also reported good or excellent outcomes in 20 of 25 subjects (average age of 46 years, range 27–72 years) at 30 months. Young subjects did as well as the older subjects, and there were no complications reported. Cameron and colleagues[23] reported significant improvement in pain (mean duration of relief being 28 months) and function in 54 of 61 subjects with a mean age of 49.5 years (range 21–73 years) with grade IV chondral disease. Six subjects required arthroplasty at a mean of 16.3 months, and all had large lesions measuring greater than 2 cm. Skelley and colleagues[30] retrospectively reviewed 33 subjects (average age of 55.2) who underwent arthroscopy and capsular release. In this series, 20 subjects (60%) were not satisfied with the procedure, 14 (42.4%) went on to have a total shoulder arthroplasty at an average of 8.8 months postarthroscopy, and the subjects who did not go on to arthroplasty did not have improvement in American Shoulder and Elbow Surgeons (ASES) and visual analog pain scores at final follow-up. Subjects who underwent arthroplasty were more likely to have bipolar disease.

Millett and colleagues[27] described the comprehensive arthroscopic management (CAM) procedure, a joint-preserving arthroscopic treatment of young, active patients with advanced GHJ OA. CAM couples extensive glenohumeral debridement and capsular release with meticulous osteophyte removal and transcapsular axillary nerve decompression. It is hypothesized that inferior osteophytes can encroach on the

axillary nerve and potentially affect its function. In their series of 27 shoulders in 26 subjects with a mean age of 52 years (33–68 years), there was high subject satisfaction, decreased pain, increased range of motion, and improved ASES scores at a mean of 20 months follow-up. Six subjects went on to arthroplasty at a mean of 1.9 years.

Overall, the results of arthroscopic debridement and lavage for OA of the GHJ in young patients show short-term relief with low complication rates. The ideal candidate has a small unipolar lesion with adequate joint space (>2 mm) in the absence of large osteophytes.

REPARATIVE TREATMENT

If the chondral lesion is a small and well-contained defect that has not eroded into the subchondral plate,[5,22] marrow stimulation techniques may be applicable. These techniques include microfracture, abrasion chondroplasty, and drilling, and these techniques do not preclude future restorative surgeries.[20] Although most of the published literature regarding microfracture is about the knee, the goals of the procedure are similar in the shoulder, which is to achieve fibrocartilage filling of the defect and to reduce pain.[22] However, there are structural differences between the shoulder and knee articular surface that may affect outcomes. The cartilage in the shoulder is much thinner and the convex shape of the humeral head and the location of the defects, oftentimes found on the periphery, may limit the ability to contain the initial fibrin clot.[22,31] Reparative techniques are contraindicated in defects in which the subchondral plate has been violated and in which there has been bone and cartilage loss.[20]

The technique described for microfracture in the shoulder is similar to the technique described in the knee by Steadman and colleagues[32] and can be performed arthroscopically. The lesion should be defined with vertical walls using a curette and motorized shaver, and debrided down to the calcified cartilage.[21,27,31,32] Then awls are used to penetrate the subchondral plate every 2 to 3 mm to promote bleeding, allowing for the mesenchymal marrow elements to form a fibrin scaffold, which is eventually replaced by fibrocartilage.[20,31] It is imperative to have visual confirmation of bleeding because these bleeding elements contain the growth factors, stem cells, and proteins that generate fibrocartilage.[22]

Currently, there are limited studies regarding the use of microfracture for glenohumeral cartilage defects. Frank and colleagues[31] reported outcomes of arthroscopic microfracture (with concomitant procedures) in the GHJ in 15 shoulders in 14 subjects whose mean age at the time of surgery was 37 years (range 18–55 years). Three subjects in their study underwent microfracture for avascular necrosis. In the short term, subjects reported lower pain scores, improved clinical outcome scores, and increased range of motion at an average of 27 months follow-up. They reported a failure rate of 20% (3 subjects). Millet and colleagues[27] also demonstrated significant improvement in pain, ASES score, and ability to work after microfracture (with concomitant procedures) in 31 shoulders in 30 subjects whose average age was 43 years (range 19–59 years) at a mean follow-up of 47 months. Six subjects failed and went on to have subsequent surgery. Subjects with small lesions of the humeral head were noted to have the best results, and subjects with bipolar defects had the worst results. In a study by Porcellini and colleagues,[26] 11 out of 47 subjects with a mean age of 41.7 years (range 30–55 years) who underwent microfracture received the engineered hyaluronic acid membrane, Hyalofast (Fidia Advanced Biopolymers S.r.l., Abano Terme, Italy), which was found to not have any effect on outcomes.[29] Snow and Funk[33] also found

significant improvement in Constant and Oxford scores. In 2 subjects who required reoperation (1 requiring revision of a superior labrum anterior to posterior [SLAP] repair and another requiring subacromial decompression) confirmed good filling of lesion with fibrocartilage with repeat arthroscopy at a mean follow-up of 15.4 months.

RESTORATIVE TREATMENT

The goal of restorative treatment is to reestablish hyaline or hyaline-like cartilage. The 2 main techniques for this are osteochondral grafting (either autograft or allograft) and autologous chondrocyte implantation (ACI). Unlike microfracture, which is done arthroscopically with minimal risk, chondral transfers often require an open procedure with potential for donor site morbidity.[5,21] The ideal candidate for this procedure is a young, active individual with an isolated, focal cartilage lesion of the humerus or glenoid who has failed nonoperative and reparative treatments.[34]

Osteochondral autograft transfer has been successfully used to treat lesions in the knee, talus, and distal humerus. This procedure is usually reserved for small humeral lesions (1–1.5 cm^2)[20] in which the first line of treatment has failed. Benefits include the potential to achieve osseous integration and preserve the articular tidemark.[20] A disadvantage of this procedure is the donor site morbidity, typically from the knee. Garretson and colleagues[35] demonstrated increased contact pressures in the knee at donor sites, especially when harvested from the central trochlea and lateral condyle. The literature provides limited reports of osteochondral autograft transfer in the shoulder. Schiebel and colleagues[36] described a small case series of 8 grade IV lesions (105 mm^2–250 mm^2) with 32 months of follow-up in subjects whose average age was 43 years (range 23–57 years) in which osteochondral transfer from the knee was performed. Subjects had improved shoulder outcome scores, and MRI revealed good osseointegration of the osteochondral plugs and congruent articular cartilage in all except 1 subject. One subject reported donor site morbidity, though the shoulder was painless. At the latest follow-up, all subjects had radiographic signs of osteoarthritic changes; all subjects had inferior osteophyte formation.

To avoid donor site morbidity, osteochondral allografts can be used, though its disadvantages include limited chondrocyte viability, loss of matrix structure, and transmission of disease.[5] Osteochondral allografts also remain among the most versatile options for large lesions that are deep, extensive, and uncontained.[21] Fresh frozen femoral head allograft,[37–41] fresh frozen humeral head allograft,[34,42–44] and allograft osteoarticular plugs[39,45] have been used, and fixation can be achieved by press fit,[37,38,42,46] partially threaded cancellous screws,[40,45] or headless cancellous screws.[41,47] A systematic review by Saltzman and colleagues,[48] which examined 12 studies using osteochondral allograft transplants for humeral defects, found improved range of motion, improved functional outcome scores, and low subsequent dislocation rates. However, the complication rate was between 20% and 30%, with a 26% reoperation rate. At 5 or more years of follow-up, conversion to total shoulder arthroplasty was 50%. The reported complications were mostly intraoperative and minor, including damage to the biceps tendon requiring tenodesis and posterior capsular avulsion requiring suture anchors. Postoperative complications included reoperation for prominent hardware. Another notable finding from their review was high allograft resorption rate of 36%, though the investigators speculate this may be due to the use of acellular tissue that has been previously frozen because improved results have been demonstrated in the knee with the use of fresh allografts. Riff and colleagues[49] reported osteochondral allograft transfer in 20 subjects at the average age of 24.8 years to have a survivorship of 61% at a mean follow-up of 66.5 months;

however, all subjects requiring reoperation had chondrolysis secondary to continuous infusion of local anesthetic via pain pump. Radiographic analysis demonstrated incorporation of the graft at an average of 14.8 months, except in 2 subjects.

Although ACI in the knee has shown good outcomes,[50,51] the use of ACI remains investigational in the shoulder. Romeo and colleagues[52] reported on a 16-year-old male baseball player who underwent ACI to the humeral head with periosteal graft from the tibia and 2-stage growth and implantation. At 12 months, this subject was pain free and had full range of motion.

SUMMARY

There is a great need for higher quality data on the nonarthroplasty management options for GHJ OA, especially in younger individuals for whom arthroplasty is a less attractive option. In particular, level I or II studies are needed to investigate the role of physical therapy as nonsurgical treatment and postoperative rehabilitation, the role of pharmacotherapies, the role of injectable corticosteroids and viscosupplementation, and the role of arthroscopy and open debridement with possible nonprosthetic arthroplasty or interposition grafts.[53] Smaller studies with short-term follow-up demonstrate some benefit in reducing pain and improving motion with arthroscopy, microfracture, and reparative treatment, though the literature lacks strong evidence to support the routine use of these modalities and they should be reserved as a second-line treatment following exhaustion of all conservative interventions. There is an increased interest in newer procedures, such as ACI and osteochondral autograft or allograft, that provide potential significant benefit; however, more investigations are required and clinicians are left to extrapolate recommendations from either older, less-active populations or management regimens for other locations of OA.

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