

[CASE REPORT]

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Humeral Resurfacing Hemiarthroplasty With Meniscal Allograft in a Young Patient With Glenohumeral Osteoarthritis

The most common reasons and diagnostic classifications for which shoulder arthroplasty is performed are degenerative osteoarthritis (OA), secondary degenerative OA, capsulorhaphy arthropathy, and rheumatoid arthritis.⁴⁶ While degenerative OA of the glenohumeral joint is less common than in the weight-bearing joints (ie, hip, knee) of the lower extremity, accounting for only 3% of all OA lesions, it still affects a significant

number of individuals.⁵ OA of the glenohumeral joint can be classified as primary or secondary. Primary OA usually

presents with no apparent antecedent cause and in the active athletic patient can occur solely from

repetitive loading and overuse, while secondary OA results from a pre-existing problem (ie, previous fracture, avascular necrosis, instability, rotator cuff arthropathy, and prior joint surgery).³⁹

The incidence of OA increases with age. However, OA commonly occurs in many young patients who have had a glenohumeral dislocation followed by a surgical stabilization procedure. This

process has been termed *capsulorhaphic arthropathy* or *dislocation arthropathy*.^{9,15,25,52,53} Neer et al⁴² initially reported glenohumeral arthritis in patients who had previously been treated mostly with operative procedures to stabilize the glenohumeral joint and required shoulder arthroplasty. Samilson and Prieto⁵² developed a radiographic classification of dislocation or instability arthropathy and reported on 74 cases of shoulder arthritis in patients with prior glenohumeral joint instability. They found that the older the patient was at the time of initial dislocation the more severe the arthritis. Additionally, the direction of instability had a significant association with the severity of the arthritic progression. Patients with posterior glenohumeral instability had more severe arthritis than those with anterior instability. Several studies^{2,29,45,50} have reported the incidence



● **STUDY DESIGN:** Case report.

● **BACKGROUND:** Management of glenohumeral joint osteoarthritis in young, active patients is challenging due to the significant functional limitations and progression of the disease, coupled with the limited lifespan of prosthetic implants presently in use. The purpose of this report is to present the detailed rehabilitation program and outcome of a patient who suffered an initial glenohumeral dislocation and, following multiple surgical interventions, required shoulder hemiarthroplasty and biologic glenoid resurfacing to return to function.

● **CASE DESCRIPTION:** An objectively based rehabilitation protocol was used for this patient following shoulder hemiarthroplasty. Data collected included passive and active range of motion, isometric rotational strength, and functional outcome scores to include the Single Assessment Numeric Evaluation (SANE) and American Shoulder Elbow Surgeons (ASES) outcome measures.

● **OUTCOMES:** Progressive improvements in active and passive range of motion were documented at numerous points during postoperative rehabili-

tation, including at 1 and 2 years postoperatively. The patient's initial functional outcome scores improved from 2/100 to 90/100 in the SANE and from 17/100 to 85/100 for the ASES rating scales. At 2 years postsurgery the SANE score was 60/100 and the ASES score 68/100.

● **DISCUSSION:** Early postoperative range of motion exercises performed in a range protecting the subscapularis, coupled with a progressive program of rotator cuff and scapular strengthening exercises, resulted in decreased pain, improved range of motion, and return to work in a limited capacity following hemiarthroplasty with biologic glenoid resurfacing. Further research in series of patients following this procedure will help to establish optimal treatment guidelines and prognosis for young active patients with severe glenohumeral joint osteoarthritis.

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● **KEY WORDS:** arthroplasty, biologic resurfacing, rehabilitation, shoulder

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of arthritis following operative stabilization of anterior glenohumeral joint instability to range between 12% and 62%, with critical factors being the inclusion of intra-articular hardware and excessive tightening of the anterior soft tissues.^{5,9,15,30,37,40,53}

Buscayret et al¹⁵ reported on 570 patients who underwent a stabilization surgery for anterior glenohumeral joint instability. Retrospective review showed the incidence of preoperative arthritis to be 9.2%. Postoperative arthritis among patients who did not have preoperative arthritis at a mean follow-up of 6.5 years was 19.7%. Factors significantly associated with postoperative arthritis were older age at time of initial dislocation and at surgery, higher number of dislocations, and longer follow-up. Deficiencies in glenohumeral joint external rotation range of motion at latest follow-up were associated with arthritis as well.

Another cause for the disappearance of glenohumeral joint articular cartilage is chondrolysis. Several reports have identified chondrolysis in the shoulder following arthroscopy, with likely causes being thermal energy application,³⁴ use of bioabsorbable implants,⁴ and pain pumps.^{24,47} Further research is needed to better understand the factors responsible for the development of chondrolysis following shoulder arthroscopy.

The treatment of glenohumeral OA can be challenging in the young, physically active patient, especially in the presence of persistent instability,^{30,39,53,58} glenoid wear, and multiple previous surgical procedures.^{9,12,25,39,54} Following the failure of initial nonoperative rehabilitation, treatment should focus on surgical options that reduce pain, increase range of motion, decrease mechanical symptoms, and preserve the joint and bony stock when possible. However, in the presence of severe OA, joint replacement may be necessary.

The most common surgical options include arthroscopy,^{16,27,61} hemiarthroplasty (replacement or resurfacing of the humeral head), and total shoulder

arthroplasty (TSA), which is replacement or resurfacing of both the humeral and glenoid joint surfaces.^{2,10,16,18,23,25} Recently, biological glenoid resurfacing or interpositional arthroplasty^{1,13,14,33} and humeral head resurfacing arthroplasty³⁵ have been advocated. Accelerated loosening of polyethylene glenoid components and increased polyethylene wear are of concern following TSA for young active patients.^{11,13,33} Therefore, biologic resurfacing of the glenoid, coupled with humeral resurfacing, have been reported for younger patients with glenohumeral OA.¹³ Biologic resurfacing or interpositional arthroplasty involves the use of a human tissue to resurface the joint. Verneriel first reported use of interpositional arthroplasty in 1860, using a flap of muscle and fascia in the temporomandibular joint.¹³ Prior reports of interpositional arthroplasty in the elbow³⁸ and, for complex proximal humeral fractures, of a fascia lata graft,³² have been published. Several materials have been used to resurface arthritic joints including autogenous fascia lata and capsular tissue, and human skin allografts.^{13,33} In addition to these early reports, several case series have been reported with biologic resurfacing of the glenoid coupled with humeral arthroplasty.^{6,13,33,43} In these case series and initial publications on humeral arthroplasty with biologic resurfacing, very brief and limited descriptions of the rehabilitation procedures and progressions, were presented, or rehabilitation information was not presented at all. A detailed description of the range-of-motion progression and upper extremity rehabilitative exercise program following this procedure is not presently outlined in the literature.

Therefore, the primary purpose of this report is to present the detailed rehabilitation program and outcome of a patient who suffered an initial glenohumeral dislocation, followed by multiple surgical interventions prior to shoulder hemiarthroplasty with biologic glenoid resurfacing.

CASE DESCRIPTION

History

THE PATIENT WAS A 28-YEAR-OLD male laborer who originally dislocated his dominant right shoulder while playing football at the age of 16. After the initial dislocation, the patient saw a local orthopaedic surgeon and immediately underwent an arthroscopic labral repair. The patient was subsequently able to return to full activity. Three years later the patient underwent a second arthroscopic surgical procedure for recurrent shoulder dislocation secondary to trauma. Observations made by the surgeon during the second surgical procedure included the presence of a posterior labral tear with detachment, a redundant anterior/inferior capsule, a severely stretched middle glenohumeral ligament, a loose body, and early degenerative changes of the humeral articular surface. Surgical debridement chondroplasty was performed, along with removal of the loose body, and an arthroscopic anterior capsulolabral reconstruction.

Following the second surgical procedure, the patient was able to return to some level of functional activity for a period of 7 years. Specifically, he was able to return to sport activities, which included cycling and limited overhead sports, as well as repetitive overhead work activity and work-related lifting. However, he incurred an injury at work that resulted in another glenohumeral joint dislocation. Over the next 2 years, the patient underwent 4 additional surgical procedures, including an arthroscopic subacromial decompression and capsular shift, an open Bankart with repeat capsular shift, an arthroscopic anterior capsular reconstruction with laser chondroplasty for diagnoses of recurrent anterior dislocation and progressive glenohumeral arthritis, and a posterior capsular reconstruction with thermal capsulorrhaphy for a diagnosis of recurrent posterior dislocation.

The patient was seen by an orthopaedic surgeon (D.S.B.) 1 year following the last procedure, because of continued pain

and reduced shoulder function. At the time of the initial examination the patient had been unable to work at his preinjury level for the previous 5 years and had an active worker's compensation claim. The specific work-related activities that he was unable to perform were heavy lifting, repetitive overhead lifting, and overhead arm positioning. The patient signed an informed consent form and publication of this case was approved by The Institutional Review Board of Physiotherapy Associates.

Initial Preoperative Orthopaedic Evaluation

The patient rated his pain at 9 (scale range, 0-10, with 0 being no pain and 10 the worst pain ever) and instability at 7 (scale range, 0-10, with 0 being stable and 10 unstable) on visual analog scales. The patient completed 2 shoulder function rating scales, the Single Assessment Numeric Evaluation (SANE)⁶² and the American Shoulder and Elbow Surgeons (ASES),^{41,49} on which he scored 2/100 and 17/100, respectively, with higher scores indicating greater levels of function. The patient was unable to use his arm for any daily-living or work-related activities.

On examination the patient had visible deltoid and infraspinatus atrophy. Active shoulder range of motion included full elevation with use of accessory muscles, external rotation to 30° with the arm at the side, external rotation to 70° with the shoulder at 90° of abduction, and internal rotation sufficient to reaching behind the back to the sacrum. Weakness of the rotator cuff was noted, in addition to a positive glenohumeral grind test and significant pain with the apprehension test. Pain was also elicited with the subluxation relocation test.¹⁹ Additional instability testing revealed 2+ multidirectional instability (MDI) sulcus test and a positive load-and-shift test posteriorly (**ONLINE VIDEOS**). Additionally, there was pain with the Gerber lift-off test.

Radiographs demonstrated evidence of suture anchors in the anterior-inferior glenoid, posterior glenohumeral sub-



FIGURE 1. Copeland implant with biological resurfacing using meniscal allograft.

luxation, and significant arthrosis with osteophytic changes of the glenoid and humerus. There was no glenoid erosion.

Following examination of this patient, humeral resurfacing was recommended, based on the findings of the initial evaluation as well as the patient's extensive history of multiple dislocations and failed prior reconstructions. Due to the patient's age and to allow for future revision, if needed, humeral resurfacing arthroplasty was recommended using the Copeland implant. Humeral resurfacing allows for less bone loss and no humeral stem, which minimizes the risk of periprosthetic fracture.³⁵ The use of a glenoid component was not considered a viable option due to the incidence of glenoid component complications¹¹ and this patient's very young age. A meniscal allograft was chosen for biologic resurfacing to provide both stabilization against posterior instability as well as provide glenoid resurfacing.

Surgical Procedure

A standard deltopectoral approach was used with the patient in a semiseated position. Adhesions were freed and the subscapularis exposed. The subscapularis was incised at the lesser tuberosity to maximize length. A 360° release of the subscapularis was done to increase its excursion. This included an anterior capsulotomy, release of the coracohumeral ligament attachment, and mobilization of adhesions.

A long head of the biceps tenodesis was performed to prevent recalcitrant



FIGURE 2. Copeland implant on anterior/posterior radiograph.

biceps tenosynovitis that may occur after arthroplasty in more active patients. The biceps was sutured using nonabsorbable suture to the surrounding rotator cuff tissue at its entrance into the joint at the end of the surgery. The intra-articular portion of the long head of the biceps was released from the superior labrum and excised.

The arm was externally rotated to completely view the humeral head. Osteophytes were removed and the humeral head prepared for placement of a Copeland implant (Biomet, Warsaw, IN) (**FIGURE 1**). A lateral meniscus allograft (Regeneration Technologies Inc, Alachua, FL) was thawed and reconstituted in preservative-free saline with Bacitracin. Suture anchors were placed around the glenoid rim and the meniscus was sewn into place, with the anterior and posterior horns placed near the anterior equator, thus forming a wedge buttress posteriorly (**FIGURE 1**).

The shoulder was reduced and stability and soft tissue tension was assessed. The subscapularis was repaired with suture anchors along the anterior neck to effectively lengthen this structure. **FIGURE 2** shows a postoperative anterior/posterior radiograph of the Copeland implant.

Postoperative Rehabilitation

Clinical decisions specific to the rehabilitation program used in this case were guided by knowledge of the surgical

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TABLE 1

SHOULDER ACTIVE RANGE OF MOTION

Movement	Left Uninjured Presurgery	Postsurgery				
		2.5 wk	8 wk	14 wk	8 mo	After Second Surgery (10 mo)
Flexion*	175	115	140	155	N/T	145
Abduction*	175	90	130	160	N/T	165
External rotation (45°)	N/T	5	45	N/T	N/T	N/T
Internal rotation (45°)	N/T	30	45	N/T	N/T	N/T
Standing flexion	170	N/T	80	110	150	N/T
Standing abduction	170	N/T	55	140	135	N/T
External rotation (90°)	90	N/T	N/T	70	78	68
Internal rotation (90°)	50	N/T	N/T	35	25	20

Abbreviation: N/T, not tested.
** Indicates passive range of motion.*

technique as well as understanding the patient's history of instability and joint degeneration prior to surgery. External rotation range of motion was closely monitored during the first 6 weeks due to the release and subsequent repair of the subscapularis tendon. This protective strategy is referred to as "subscapularis precautions." Additionally, the use of aggressive accessory joint mobilization (ie, anterior/posterior glides) was not initially indicated due to the use of the meniscal allograft for biologic resurfacing. Finally, resistive exercise to promote scapular stabilization and initiate rotator cuff activation was modified to limit activation of the subscapularis due to the release and subsequent repair of the subscapularis.

Immediate postoperative care consisted of complete immobilization in a sling in approximately 20° of elevation in the scapular plane. The sling was worn for the first 10 days following surgery. Elbow and wrist range of motion and Codman's pendulum exercise were performed by the patient starting on the first day post-surgery. Physical therapy was initiated 2 weeks following surgery. At initial presentation, passive motion was limited (TABLE 1). Passive range of motion was measured in the supine position for forward flexion and abduction. Glenohumeral internal and external rotation was initially measured at 45° of abduction and measured at 90° of coronal plane abduction after 8

weeks postsurgery as rehabilitation progressed. Rotational measures were performed with scapular stabilization,^{19,23} using a posteriorly directed containment force on the anterior acromion and coracoid process of the scapula. A standard universal goniometer was used, with all measures taken by 1 examiner (T.S.E.) during the course of rehabilitation.

Rehabilitation was initiated 3 times a week for the first 12 weeks postsurgery. Subscapularis precautions, which consisted of no passive external rotation beyond 30° at 45° of abduction and no external rotation "stretching" or forceful overpressure, were initially followed.^{35,39} Additionally, no shoulder internal rotation or biceps strengthening exercises were performed for the first 6 weeks postsurgery because of the subscapularis exposure and subsequent surgical repair, and biceps tenodesis, respectively. Emphasis was placed on physiologic mobilization (passive range of motion in flexion, abduction, internal rotation, and horizontal adduction) to increase glenohumeral joint range of motion. Physiological mobilization was the preferred mobilization technique over accessory joint mobilization to minimize the amount of anterior/posterior shear stress applied to the shoulder during the initial 6 weeks, due to the meniscal allograft used for biologic resurfacing of the glenoid. Gentle grade I accessory mobilization was used for pain

modulation interspersed between physiologic mobilization during the initial 6 weeks postsurgery.

In-clinic active assisted range of motion exercises were used, including the overhead-pulley and closed-chain Codman's exercise. The closed-chain Codman's exercise consists of circular patterns performed over a large exercise ball, with the hand resting against the exercise ball during the circular patterns. No pressing into the ball is performed nor are there any compressive loads used during this exercise. The hand resting on the ball is meant to minimize any anterior humeral head translation or subluxation during the Codman's exercise.

Home program instruction included use of an overhead pulley in a seated position for shoulder elevation in the scapular plane and active assistive exercise in the supine position as tolerated with a straight cane. The patient was instructed to do the active assistive exercises 2 to 3 times per day. Sling immobilization continued for the first 6 weeks, when the patient was outside the home or in precarious situations, such as in crowds or unbalanced walking conditions. The sling was also recommended for use during sleeping.

Scapular protraction and retraction exercises were performed with manual resistance, and shoulder external rotation resistive exercises were performed in supine, with 30° to 45° of shoulder abduction, as well as in sidelying with a pillow under the axilla with both manual resistance and light handheld weights. Supine rhythmic stabilization was also performed with the patient supine and the shoulder in 90° of flexion, with varied manual contacts (initially with contact proximal to the elbow to create minimal resistance progressing to distal to the elbow as the patient approached 5 to 6 weeks postsurgery) to encourage cocontraction of the glenohumeral and scapulothoracic musculature⁵⁶ (APPENDIX). Additionally, modification of the resistance application during rhythmic stabilization was used during the first 6 weeks postoperatively

to minimize subscapularis activation (ie, no horizontal adduction challenges). During the first 6 weeks, no resistive exercise was performed for elbow flexion due to the biceps tenodesis. Detailed reports by Levy et al³⁶ and Yamaguchi et al⁶⁴ show minimal biceps activation during shoulder flexion motions; therefore, there was no restriction on active shoulder flexion exercises or activities.

At 6 weeks postsurgery, the patient was treated with passive stretching to improve external rotation range of motion and began internal rotation strengthening as the subscapularis precautions were discontinued. A complete program of rotator cuff strengthening exercise, using a low-resistance (0.5-1.5 kg), high-repetition (3 sets of 15) format, was initiated, along with progressive scapular stabilization exercise.^{20,21} Closed-kinetic-chain exercises were not performed to minimize joint compressive forces. Open-kinetic-chain exercises aimed at maximizing activation of the rotator cuff and scapular stabilizers were performed, using positions with less than 90° of humeral elevation and positions anterior to the scapular plane.^{7,10,48,59}

OUTCOMES

14 Weeks Postsurgery

AT 14 WEEKS POSTSURGERY, THE patient's range of motion had progressed (TABLE 1) and isometric strength testing was performed using a Cybex 6000 isokinetic dynamometer (Cybex, Ronkonkoma, NY). Isometric testing, with stabilization following the guidelines of the manufacturer, was performed. The modified base position (dynamometer tilted 30° from horizontal), which placed the glenohumeral joint in 30° of scapular plane elevation, was utilized.²² The best repetition of maximal effort shoulder internal and external rotation of 2 trials served as the outcome measure for muscular strength. Testing of muscle strength with this isokinetic dynamometer has been shown to be reliable (ICC, 0.83-0.99).⁵⁷ Results showed sig-

TABLE 2		ISOMETRIC INTERNAL AND EXTERNAL SHOULDER ROTATION STRENGTH*		
Movement	Uninvolved Extremity [†]	14 wk Postsurgery	8 mo Postsurgery	
Internal rotation	67	35	30	
External rotation	35	10	20	
External/internal rotation ratio	52%	28%	66%	
* Strength expressed in ft-lb from a Cybex 6000 dynamometer, isometric mode (1 ft-lb = 1.35 Nm).				
[†] Tested on initial postsurgical evaluation.				

nificant deficits in right shoulder internal and external rotation strength (TABLE 2). Despite the deficits in strength and range of motion, the patient was discharged from formal physical therapy 14 weeks following surgery, and continued to perform a home exercise program of rotator cuff and scapular strengthening exercises, using elastic resistance and 1.0- to 1.5-kg weights, as well as active assistive range of motion with a pulley. He had attended 21 physical therapy sessions from the date of surgery to discharge at 14 weeks postsurgery. He was independent with his home exercise and understood the principles of home exercise for shoulder rehabilitation. He did not take any medications during the course of his rehabilitation and was not taking medications at the time of discharge. The modified ASES shoulder rating scale's self-report section was completed with the patient scoring 30/45 possible points. This portion of the scale consists of 15 questions detailing functional activities of the upper extremity, with each question scored from 0 (unable) to 3 (no difficulty). The patient was counseled regarding physical performance modification both in his recreational activities as well as in his job. It was recommended that he not return to repetitive overhead lifting at work, and he was able to modify his work activities to nonoverhead work without heavy lifting at this time postsurgery. No formal return-to-sport or return-to-work indices were used in this case, other than the subjective rating scales and the objective identification of shoulder rotational weakness and reduced overhead elevation range of motion, to guide decision making regarding modification of work

activities and recommended work activities using less than 90° of elevation. The status of the worker's compensation claim was not known.

Additional Follow-up

The patient was available for follow-up at 8 months postsurgery. At that time his (SANE) score was 50/100, and his external rotation strength had doubled when measured with isometric testing, as performed 14 weeks postsurgery (TABLE 2). The amount of active arm elevation against gravity is listed in TABLE 1, along with the glenohumeral rotation measured at 90° of abduction. The improvement in external rotation strength was noted along with improved elevation and external rotation range of motion, despite a mild decrease in internal rotation range of motion.

At 10 months postsurgery the patient began reporting mechanical symptoms, with no reported mechanism of reinjury, and a follow-up arthroscopic procedure was scheduled to look at the meniscus allograft. Observations with arthroscopic surgery included a stable humeral implant, dense adhesions in the subacromial and glenohumeral space, and a stable, well incorporated, meniscal graft. Following the arthroscopic procedure, the patient was immobilized for 1 week and subsequently initiated physical therapy for range of motion and rotator cuff and scapular strengthening. Active range of motion 2 weeks postsurgery was 145° of forward flexion against gravity, 165° of abduction against gravity, 20° of internal rotation measured at 90° of abduction, and 68° of external rotation measured at 90° of abduction. The patient complained

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of pain rated 1 out of 10 and instability of 2 out of 10 on visual analog scales. His SANE score was 90/100 and ASES score 85/100. He was discharged from care and instructed to perform a home exercise program for range-of-motion maintenance and rotator cuff and scapular strengthening.

Further outcomes data for this patient were available at the patient's 1- and 2-year follow-up visits with the physician. At 1 year postsurgery, the patient's scores on the SANE and ASES were 70/100 and 76/100, respectively, and at 2 years postsurgery the patient's SANE and ASES scores were 60/100 and 68/100, respectively. No further objective testing on range of motion or strength was performed, and the patient was not seen in physical therapy during this time.

DISCUSSION

TREATMENT FOR THE PATIENT WITH glenohumeral joint OA has many options, including surgical intervention. An understanding of the outcomes of each type of surgical treatment can assist therapists with rehabilitation goal setting and discharge parameters. Arthroscopy has been advocated in the treatment of arthritis by several authors.^{16,27,61} Cameron et al¹⁶ reviewed the outcomes for 45 patients who had been treated with arthroscopic debridement for a diagnosis of severe grade IV OA of the glenohumeral joint, with a minimum follow-up of 2 years. They concluded that this surgery offered significant reduction of pain and increased functional level when performed on patients who have a well-aligned joint, minimal osteophyte formation, subchondral sclerosis or cyst formation, and an osteochondral lesion 2 cm² or less.

With several studies reporting good, predictable outcomes with relatively few complications, shoulder hemiarthroplasty and TSA are currently the treatment of choice for advanced glenohumeral arthritis.^{3,18,39,44,54,58} Specifically, Torchia et al⁵⁸ reviewed the long-term results of 89

patients with TSA and demonstrated improvement in pain, function, and range of motion, with a 93% survival rate at 10 years and 87% after 15 years. Norris and Iannotti⁴⁴ performed a multicenter prospective study on 160 patients with OA and found good or excellent pain relief, functional improvement, and overall satisfaction in 95% of cases. Sperling et al⁵⁴ retrospectively studied 138 TSA and hemiarthroplasties in patients 50 years old and less with a follow-up of at least 5 years. They found no difference between the 2 surgeries and both procedures provided significant long-term pain relief and improvement in overall motion. Additionally, the authors noted that the risk of revision was significantly higher for those that had previous surgeries. In this group, survivorship of the implant was 84% at 5 years, 71% at 10 years, and 57% at 15 years.

In general, the literature has demonstrated arthroplasty to give predictable relief of pain and improvement in function. However, in the younger patient population, this must be weighed against the known long-term limitations of this procedure, specifically, prosthetic loosening, difficult revisions, and problems inherent to a stemmed prosthesis.¹¹ Glenoid component loosening, with lucent lines reported in 38.6% of TSA cases, is the most common postoperative complication following TSA.^{9,11} In fact, in a long-term follow-up of TSA, with an average duration of follow-up of 10 years or more, various authors have reported radiolucent lines in nearly 80% of all cases, and loosening, migration, tilting, or shifting of the glenoid implant in up to 34% of cases.¹¹ Therefore, hemiarthroplasty may be the preferred treatment in this younger, more active patient population.

Revisions can be complicated by cemented components and limited bony stock. This may require a longer stemmed prosthesis, or, in the event of insufficient bone, arthrodesis. Additionally, young, active patients may be more prone to trauma and, therefore, periprosthetic

fractures may occur with stemmed components.¹¹ Humeral resurfacing has been suggested as early as 1980 and is used much more extensively in Europe than the United States.³⁵ Surface replacement arthroplasty is designed to restore normal anatomy of the shoulder while maintaining patient bone stock. The implant (Copeland Mark-3; Biomet Inc, Warsaw, IN) used in this case has had several improvements since its inception, with the latest model featuring an uncemented, fluted taper fit peg with hydroxyapatite coating to facilitate tissue on-growth. Levy and Copeland³⁵ presented their results using the Copeland Mark-2 prosthesis in 2001. They retrospectively reviewed 103 implants, both hemiarthroplasties and total replacements, with an average follow-up of 6.8 years, and found that patients had significant improvement in pain relief, and increased range of motion and function, which is comparable to the published success rates of the stemmed prosthesis. Complications and revisions were limited and the authors noted that revision to a stemmed component was easily accomplished if needed.

Biologic resurfacing of the glenoid, using autogenous fascia lata or anterior shoulder capsule, was studied on 6 patients by Burkhead and Hutton¹³ over a period of greater than 2 years. The patients were between the ages of 33 and 54 years. They obtained excellent results using a Neer Rating Scale in 5 patients, and satisfactory results in the other patient. All patients were relieved of pain and obtained significant improvement of range of motion. They concluded that their technique of glenoid resurfacing using autogenous tissue improved the results of hemiarthroplasty and may be beneficial in the treatment of young patients with end-stage glenohumeral arthritis.

The patient in this case report had a clinical presentation consistent with a previously described diagnosis of capsulorrhaphy arthropathy. Patients with capsulorrhaphy arthropathy have characteristics consisting of a history of previous instability surgery, during

TABLE 3

CLINICAL REASONING FOR REHABILITATION FOLLOWING SHOULDER HEMIARTHROPLASTY WITH BIOLOGIC RESURFACING

Period	Short-Term Goals	Clinical Challenge/Decision	Modifications to Rehabilitation Program
Initial evaluation to 6 wk postsurgery	Increase passive ROM	Subscapularis precautions apply, based on surgical procedure	No ER stretching
	Initiate rotator cuff and scapular exercise		No IR resistive exercise
		Meniscal allograft requires healing/incorporation	Use of physiological mobilization in all planes within appropriate ROM restriction (limited ER)
			Limited or no use of accessory glides or shear forces secondary to meniscal allograft incorporation onto glenoid fossa. Minimize translational shear in all rehabilitation activities
		Severe weakness and loss of scapular control	Initiation of early posterior rotator cuff and scapular strengthening/activation exercises. IR exercise and perturbation exercises that engage the subscapularis cannot be used during this period
	Upper trapezius compensation during ADL and any elevation attempts	Use of shortened lever arms during resistive exercise	
		Focus on ER movement pattern	
		Use of gravity eliminated 90° elevated balance point position to minimize compensation in supine	
6 to 14 wk postsurgery	Increase PROM/AROM all planes	Subscapularis precautions stopped at 6 wk postsurgery	Initiate ER stretching in multiple positions of shoulder abduction
	Improve rotator cuff and scapular strength/stabilization		Advance rotator cuff strengthening program to include IR exercises
	improve functional elevation for performance of against-gravity tasks		Utilize elevation assistance exercise to minimize compensation from the upper trapezius. Supporting arm on wall against exercise ball or use of supportive sling to slightly unweight extremity are applied during this time frame
	Gain independence with home exercise program	Isometric testing shows significant deficits in IR and ER strength	Continued emphasis on IR and ER strengthening using exercises that can be replicated at home with elastic exercise and light weights. Use of oscillation exercise to increase the number of repetitions of activation also applied
14 wk postsurgery	Prepare for discharge from formal physical therapy	Lack of compliance with traditional home exercise program	Provide all materials and written instruction for rotator cuff and scapular exercise program
			Provide patient with specific recommendations on limiting overhead work and overhead recreational activities for joint preservation

Abbreviations: ADL, activities of daily living; AROM, active range of motion; ER, external rotation; IR, internal rotation; PROM, passive range of motion; ROM, range of motion;

which they were often overtightened anteriorly, leading to advanced arthritis associated with internal rotation contracture, posterior glenoid erosion, and posterior subluxation.¹⁵ Harryman²⁸ and others^{26,31} have demonstrated on cadavers the increase in anterior translation of the humeral head following experimental posterior capsular plication. Similar to the patient treated in this case, pa-

tients presenting with internal rotation contracture secondary to overtightening of the anterior capsule to treat anterior instability inherently possess increased translation of the humeral head in the posterior direction.^{26,28,31} Previous studies have described the difficulties of treating this problem.^{9,25,53} The shortened anterior structures may require soft tissue release and lengthening of the subscapu-

laris tendon. Green and Norris²⁵ found that, although patients had significant improvement of function and reduction of pain with standard arthroplasty, the results were inferior to those previously reported in other groups. Furthermore, Sperling et al⁵³ demonstrated similar improvements in function and reduction of pain with arthroplasty; however, increased incidence of implant failure,

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instability, and painful glenoid arthritis lead to a high rate of revision surgery and unsatisfactory results.

In light of the previous literature, as well as this patient's demands, we proceeded with the above-described procedure (TABLE 3). This allowed for a shoulder with greatly reduced pain, increased range of motion, improved stability, and functional improvement sufficient to return to work. Although the long-term results are unknown, this prosthesis and procedure did not require cemented components, allowed for the retention of bone stock, and provided anatomic positioning. This will allow for less complicated future revision surgeries, which he will most likely require. The use of a meniscal allograft gave this patient improved posterior stability, as well as a biological resurfacing of the glenoid for pain reduction. The use of a meniscal allograft in the shoulder has been sparsely reported^{6,43}; however, its use in the knee has been well studied with encouraging results.^{51,55,63}

CONCLUSION

LONG-TERM, SUCCESSFUL TREATMENT options for severe OA or capsulorrhaphy arthropathy are limited for young, active patients. This case presents a comprehensive surgical option and postoperative rehabilitation which demonstrated good results in short-term follow-up. Humeral resurfacing arthroplasty combined with biologic resurfacing of the glenoid gave this patient significant pain relief, increased range of motion, and muscular strength, and improved his ability to perform activities of daily living, improved joint stability, and allowed him to return to work activities in a limited capacity. In addition, this procedure still allows for future revision surgeries, including stemmed hemiarthroplasty and TSA. Further study of this surgical technique and postoperative rehabilitation is needed to improve the treatment of young, active patients with glenohumeral arthritis and instability. ●

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REHABILITATION FOLLOWING SHOULDER HEMIARTHROPLASTY: HUMERAL RESURFACING CAP WITH BIOLOGIC GLENOID RESURFACING

GENERAL GUIDELINES

- Sling use as directed by surgeon in postoperative instructions
- Immediate postoperative passive and active assistive range of motion, consisting of stomach rubs, sawing movements, and elbow range of motion, as instructed following hospital discharge
- Initial postoperative range-of-motion limitations may be set by surgeon based on underlying shoulder mobility status and range of motion obtained in the operating room postimplantation

POSTSURGERY WEEKS 1-4

1. Modalities to decrease pain and inflammation
2. Passive range of motion initiated with no limitation in flexion, abduction, or internal rotation. No external rotation stretching or anterior capsular mobilization in this rehabilitation phase to protect the subscapularis repair. Gentle passive range of motion into external rotation allowed without overpressure
3. Elbow, wrist, and forearm range of motion/stretching
4. Manually applied scapular resistive exercise for protraction/retraction and scapular mobilization
5. No biceps manual resistance for initial 6-8 weeks due to bicep tenodesis performed with procedure

6. Ball approximation (closed-chain Codman's exercise), using Swiss Ball or Table Top

POSTSURGERY WEEKS 2-4

1. Initiation of active assistive range of motion, using pulley for sagittal plane flexion and scapular plane elevation

POSTSURGERY WEEKS 4-6

1. Continuation of above program
2. Initiation of submaximal multiple angle isometrics and manual resistive exercise for shoulder external rotation, abduction/adduction, flexion/extension. No internal rotation resistance for initial 6 weeks to protect the subscapularis repair
3. Upper body ergometer
4. External rotation isotonic exercise using pulley or weight/tubing, with elbow supported and glenohumeral joint in scapular plane and 10°-20° of abduction (towel roll or pillow under axilla)

POSTSURGERY WEEKS 6-8

1. Initiation of passive external rotation range of motion and stretching beyond neutral rotation position
2. Initiation of internal rotation submaximal resistive exercise progression
3. Traditional rotator cuff isotonic exercise program

- a. Sidelying external rotation
 - b. Prone extension
 - c. Prone horizontal abduction (limited from neutral to scapular plane position initially with progression to coronal plane as range of motion improves)
4. Biceps/triceps curls in standing with glenohumeral joint in neutral resting position
 5. Oscillation exercise with resistance bar or body blade
 6. Rhythmic stabilization in open and closed kinetic chain environments
 7. Scapular stabilization exercise progression including seated rows, external rotation with retraction, low rows, and serratus presses

POSTSURGERY WEEKS 8-12

1. Continuation of resistive exercise and range-of-motion progressions
2. Addition of ball dribbling and upper body plyometrics with small Swiss Ball

POSTSURGERY WEEKS 12-24

1. Continuation of rehabilitation
2. Isometric internal/external rotation strength testing assessment in neutral scapular plane position, functional rating scales Simple Shoulder Test (SST), Single Assessment Numeric Evaluation (SANE), and American Shoulder Elbow Surgeons (ASES)