J Shoulder Elbow Surg (2014) 23, e185-e190

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Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

Biologic resurfacing of the glenoid with humeral head resurfacing for glenohumeral arthritis in the young patient

Stephanie J. Muh, MD[a], Jonathan J. Streit, MD[b], Yousef Shishani, MD[c], Samuel Dubrow, MD[c], Robert J. Nowinski, DO[d], Reuben Gobezie, MD[c,*]

[a]*Department of Orthopaedics, Henry Ford Health Systems, Detroit, MI, USA*
[b]*Department of Orthopaedics, Case Western Reserve University School of Medicine, University Hospitals of Cleveland, Cleveland, OH, USA*
[c]*Cleveland Shoulder Institute, University Hospitals of Cleveland, Mayfield Heights, OH, USA*
[d]*OrthoNeuro, New Albany, OH, USA*

Background: Resurfacing of the glenoid with an interposition soft tissue graft in conjunction with humeral head arthroplasty has been proposed as an option to improve glenohumeral arthritis in young patients while avoiding the potential complications associated with total shoulder arthroplasty. There currently exist minimal outcomes data for this procedure, and the results have not been consistent. The purpose of this study was to report on the outcomes in our cohort of patients aged younger than 55 years.
Methods: A multicenter review of 16 patients who had undergone humeral head arthroplasty with soft tissue interposition grafting of the glenoid was performed. All patients had a minimum follow-up time of 24 months, unless revision surgery was required because of failure of the procedure.
Results: At a mean follow-up of 60 months, the patients showed improvement in the visual analog scale score for pain from 8.1 to 5.8 ($P < .05$), and the American Shoulder and Elbow Surgeons score improved from 23.2 to 57.7 ($P < .05$). Forward elevation improved from 128° to 134° ($P = .33$), and external rotation improved from 28° to 32° ($P = .5$). Internal rotation showed no improvement. Conversion to a total shoulder arthroplasty was performed in 7 patients (44%) at a mean of 36 months.
Conclusions: The optimal management for the young patient with arthritis has not yet been established. Because of the limited improvement in patient outcomes and the relatively high revision rate, biologic resurfacing of the glenoid with humeral head resurfacing is no longer our primary treatment option for young patients and should be used with caution.
Level of evidence: Level IV, Case Series, Treatment Study.
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Keywords: Arthritis; biologic resurfacing; shoulder arthroplasty; young adult

Total shoulder arthroplasty (TSA) is an effective treatment for end-stage glenohumeral arthritis and has been shown to reliably provide pain relief and improve motion in properly selected patients.[2,8,16,17] However, the management of glenohumeral arthritis in the young patient

This study was approved by our institutional review board (IRB grant No. 11-11-16) (University Hospitals Case Medical Center, Institutional Review Board for Human Investigation, Cleveland, OH, USA).

*Reprint requests: Reuben Gobezie, MD, 5885 Landerbrook Dr, Ste 150, Mayfield Heights, OH 44124, USA.
E-mail address: clevelandshoulder@gmail.com (R. Gobezie).

1058-2746/$ - see front matter © 2014 Journal of Shoulder and Elbow Surgery Board of Trustees.
http://dx.doi.org/10.1016/j.jse.2013.11.016

is challenging because of the expected need for a revision of the TSA during his or her lifetime.[5,7,14,19,20] Resurfacing of the glenoid with an interposition soft tissue graft in conjunction with humeral head arthroplasty has been proposed as an option to improve outcomes and avoid the potential complications associated with TSA, such as component loosening and polyethylene wear.[5,17] Unfortunately, there currently exists minimal outcomes data for this procedure, and the results have not been consistent, with Burkhead and colleagues[5,11] reporting excellent outcomes in most patients and Elhassan et al[9] reporting a large number of patients with persistent pain.

The purpose of this study was to investigate the short-term to midterm outcomes of humeral head arthroplasty combined with glenoid resurfacing using soft tissue interposition allograft in a cohort of patients aged younger than 55 years. We hypothesized that our patients would show lasting improvement in pain and function after the procedure. In this report, we describe our preferred technique and experience with the procedure after a minimum of 2 years of clinical follow-up.

Materials and methods

We performed a retrospective review of 16 patients from 2 centers who had undergone humeral head arthroplasty with soft tissue interposition grafting of the glenoid between 2003 and 2008. We included all patients aged younger than 55 years who underwent the procedure for end-stage osteoarthritis. Patients needed to have shown severe limitation of their activities of daily living and failure of conservative management including anti-inflammatory medication, activity modification, and physical therapy for a minimum of 6 months before undergoing surgery. The procedure was not offered to patients with major glenoid osseous deficiency, advanced rheumatoid arthritis, prior shoulder arthroplasty, or chronic infection.

Surgical technique

All surgeries were performed with the patient in the beach-chair position by a standard deltopectoral approach. A subscapularis peel was performed to enter the joint. A complete capsular release outside of the labrum was performed, and any excess labrum and biceps were debrided. At surgery, all patients showed severe degeneration of the articular cartilage, glenoid wear and erosion, and flattening of the osseous surfaces. The humeral head was replaced with a standard hemiarthroplasty prosthesis (Tornier, Saint-Ismier, France) or humeral head resurfacing implant (Arthrosurface, Franklin, MA, USA). Seven glenoids were resurfaced by 1 surgeon(R.G.) using a commercially available, acellular, allograft human dermal matrix–based scaffold (GraftJacket; Wright Medical Technology, Arlington, TN, USA). An Achilles tendon allograft was used in 9 patients treated by a second surgeon(R.J.N.).

Glenoid resurfacing with acellular, allograft human dermal matrix scaffold

The glenoid was first prepared with a burr to decorticate the articular surface down to bleeding bone. The thawed graft with a 3-mm thickness was sized to the patient's native glenoid anatomy. A series of single-loaded suture anchors (Bio-SutureTak; Arthrex, Naples, FL, USA) were placed circumferentially around the glenoid at the 12-, 2-, 5-, 7-, and 10-o'clock positions. The sutures were then passed circumferentially in a mattress configuration through the graft material. A parachute technique was used to reduce the graft material onto the articular surface of the glenoid, and the sutures were secured with the aid of an arthroscopic knot pusher.

Glenoid resurfacing with Achilles tendon allograft

The glenoid was prepared with a burr to decorticate the articular surface to bleeding bone. The graft was thawed, and the osseous calcaneal attachment was excised. The tendon was folded over and contoured to create a shape of appropriate diameter with regard to the native glenoid. A running everted mattress suture was placed circumferentially around the periphery of the graft. Four single-loaded suture anchors were placed circumferentially around the glenoid at the 12-, 3-, 6-, and 9-o'clock positions. The sutures were then passed through the graft circumferentially in a horizontal mattress fashion. A parachute technique was used to reduce the graft material onto the articular surface of the glenoid and tied into place.

Patients followed a postoperative rehabilitation protocol according to the surgeon's preference. Surgeon 1(R.G.) kept patients in a sling for the first 2 weeks, with passive range of motion for the first 4 weeks; active range of motion started after 4 weeks. Surgeon 2(R.J.N.) immobilized patients for 6 weeks with passive range of motion. Active-assisted range of motion was initiated after 6 weeks and gradually progressed to active range of motion.

Outcomes analysis

Preoperative and postoperative outcome measures included active forward elevation, active external rotation, active internal rotation, the American Shoulder and Elbow Surgeons score, and a visual analog scale (VAS) pain score.[22] All patients had a minimum follow-up time of 24 months unless revision surgery was required because of failure of the procedure. A paired Student *t* test was performed to assess the degree of improvement in clinical parameters at the time of latest follow-up, and significance was set at $P < .05$.

Results

Our cohort consisted of 12 male and 4 female patients who underwent surgery at a mean age of 36.1 years (range, 14-45 years) and were evaluated at a mean follow-up of 60 months (range, 24-96 months). Preoperative indications for surgery (Table I) included glenohumeral arthritis (n = 11), glenohumeral chondrolysis after a prior arthroscopic stabilization procedure for persistent instability (n = 2), idiopathic glenohumeral chondrolysis (n = 1), instability arthropathy (n = 1), and capsulorrhaphy arthropathy after a Bristow procedure (n = 1). The 3 patients who had undergone prior shoulder surgery had each undergone a single procedure.

The patients showed significant improvement in the mean VAS pain score (±standard deviation) from 8.1 (±1.5) to 5.8 (±2.9) ($P < .05$), and the mean American Shoulder and

Table I Preoperative diagnoses and demographic characteristics

No. of patients	16
Mean age (range) (y)	36.1 (14-45)
Sex (female/male)	4/12
Mean duration of follow-up (range) (mo)	60 (24-96)
Diagnosis	
Glenohumeral arthritis	11
Glenohumeral chondrolysis after prior arthroscopic stabilization procedure for persistent instability	2
Idiopathic glenohumeral chondrolysis	1
Instability arthropathy	1
Capsulorrhaphy arthropathy after Bristow procedure	1
Previous surgery	3
Glenoid resurfacing	
Acellular, allograft human dermal matrix scaffold	7
Achilles allograft	9

Table II Outcomes at mean of 60 months

	Preoperative [mean (±SD)]	Postoperative [mean (±SD)]	*P* value
Forward elevation (°)	128 (±23)	134 (±28)	.33
External rotation (°)	28 (±15)	32 (±20)	.5
Internal rotation	L4	L4	.6
VAS pain score	8.1 (±1.5)	5.8 (±2.9)	<.05
ASES score	23.2 (±8.8)	57.7 (±20.9)	<.05

ASES, American Shoulder and Elbow Surgeons.

Elbow Surgeons score improved from 23.2 (±8.8) to 57.7 (±20.9) ($P < .05$) after the procedure. At the time of latest follow-up, other clinical outcomes showed improvement from preoperative levels, which were not statistically significant (Table II). The mean forward elevation improved from 128° (±23°) to 134° (±28°) ($P = .33$), and the mean external rotation improved from 28° (±15°) to 32° (±20°) ($P = .5$). Active internal rotation showed no improvement, with mean preoperative and postoperative rotation to the level of the L4 spinous process ($P = .6$).

In 7 patients (44%), the procedure was deemed to have failed and conversion to TSA was performed at a mean of 36 months postoperatively. Of these patients, 4 had an Achilles tendon allograft and 3 had glenoid resurfacing with the acellular, allograft human dermal matrix–based scaffold. In 6 of these patients, persistent pain continued to limit their function, and the decision was made to convert the procedure to TSA (Figs. 1-3). One patient was involved in a motor vehicle crash 10 months after the procedure and sustained a traumatic subscapularis rupture that required a pectoralis major transfer. This patient unfortunately had persistent pain and was converted to a TSA 21 months after the index procedure. On average, these patients showed worse postoperative VAS pain scores than patients who did not require revision to TSA: 8.4 versus 3.8.

Discussion

We have followed up a cohort of 16 patients for a mean of 60 months after humeral head replacement and soft tissue interposition arthroplasty of the glenoid, and our clinical outcome measures indicate that most patients achieve only modest improvements in motion and obtain moderate levels of pain relief after the procedure. Unfortunately, our hypothesis that the procedure would be a durable solution for early shoulder arthritis was not confirmed because a large proportion of our patients required conversion to standard TSA as a result of continued pain and diminished function.

The optimal management for the young patient with advanced glenohumeral arthritis has not yet been established. In many cases, these patients present with a complex history of chronic shoulder problems, and they often have seen other surgeons and have undergone multiple procedures. Although some investigators have shown satisfactory intermediate- to long-term pain relief and improvement in motion after a standard TSA in young patients, Sperling et al[19] reported a high glenoid loosening rate and poor implant survival after 5 to 8 years. Other authors have also noted frequent radiographic changes affecting the glenoid component and a relatively high rate of revision surgery.[2,4,20] Concerns regarding the longevity associated with prosthetic glenoid resurfacing in this patient population, such as polyethylene wear, glenoid loosening, and bone loss associated with glenoid revisions, have led some surgeons to consider interposition biologic resurfacing of the glenoid.[3,6,11,14,15] Biologic resurfacing is intended to create a permanent, durable, biologically active surface that preserves motion while providing pain relief and improved function.[3,6,17,21] Glenoid resurfacing avoids the potential problems associated with glenoid component loosening and leaves open the possibility of later conversion to TSA.

Conflicting results have been reported in the literature regarding outcomes after glenoid resurfacing with humeral head replacement (Table III). Burkhead and Hutton[5] initially reported successful outcomes in a case series of 6 patients (mean age, 48 years) who underwent a porous-coated humeral head replacement with biologic resurfacing of the glenoid with either autogenous fascia lata or anterior shoulder capsule. After a mean of 28 months (range, 24-34 months), pain relief was excellent in 5 patients and good in 1 patient. Forward elevation improved from a preoperative mean of 81° to 138° postoperatively. More recently, Burkhead and colleagues[11] reported longer-term follow-up of 2 to 15 years for 36 shoulders and found excellent or satisfactory results in 86% of patients and a high rate of return to premorbid activities, with improvement in active forward elevation from 70° preoperatively to 140° postoperatively. Unsatisfactory results were reported in 14% of patients, with

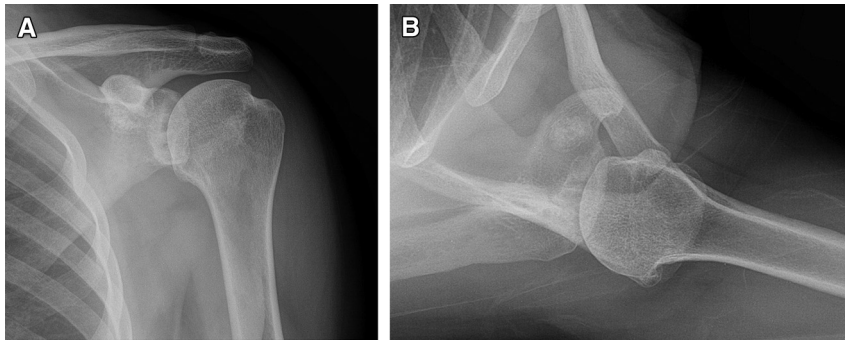

Figure 1 Preoperative anteroposterior (**A**) and axillary (**B**) radiographs in a 31-year-old woman showing glenohumeral joint arthritis.

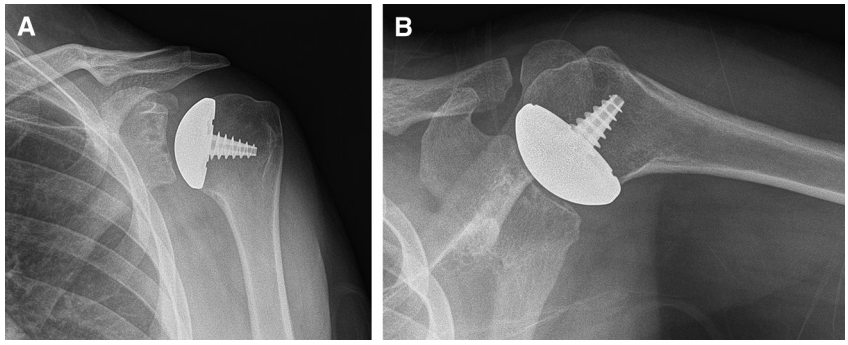

Figure 2 Immediate postoperative anteroposterior (**A**) and axillary (**B**) radiographs showing restored joint space.

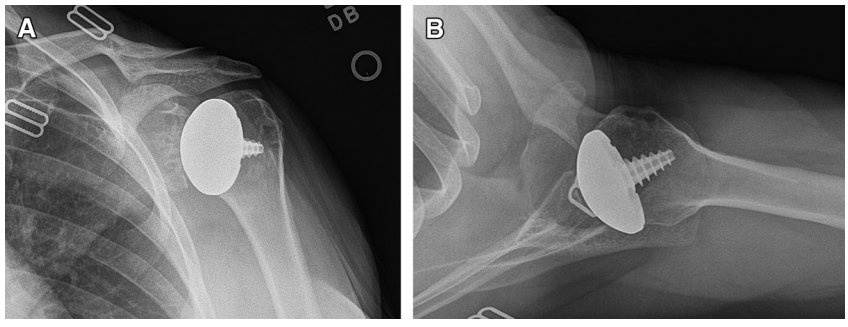

Figure 3 Anteroposterior (**A**) and axillary (**B**) radiographic evidence of loss of joint space 53 months postoperatively.

3 patients (8.3%) electing to undergo revision to TSA with a cemented polyethylene glenoid component.

A more recent study by Elhassan et al[9] was not able to reproduce such favorable results. Thirteen patients (mean age, 34 years) underwent humeral head arthroplasty with soft tissue glenoid resurfacing (Achilles allograft, fascia lata autograft, or anterior shoulder joint capsule), and 12 patients reported very poor results, with 10 (76.9%) undergoing revision to TSA at a mean of 16 months. The authors noted dissolution of all glenoid grafts at the time of revision surgery. Our results, though not uniformly poor, are similar to those reported by Elhassan et al, although our revision rate of 38% was not as high (as compared with 76.9% at 16 months). On the basis of our results, we believe that the discrepancy in age between the cohorts studied by Burkhead and Hutton[5] and Elhassan et al[9] may account for some of this difference. The mean age of our patients was 36.1 years, and it is possible that the high functional demands of this age group make satisfaction after joint resurfacing or replacement difficult to achieve.

Biologic resurfacing of the arthritic shoulder remains an active area of research interest and clinical need. One proposed resurfacing technique not investigated in this study involves the use of lateral meniscal allograft to cover a diseased glenoid surface. This technique was first proposed by Ball et al,[1] and Nicholson et al[15] reported favorable short-term results using lateral meniscal allograft, with an overall 94% patient satisfaction rating. Radiographic

Table III Outcome comparisons

	Mean age (y)	Mean follow-up (mo)	No. of patients	VAS pain score		AFE (°)		AER (°)		Rate of revision to TSA (%)
				Pre	Post	Pre	Post	Pre	Post	
Current study	36.1	60	16	8.1	5.8	128.1	134.4	27.5	31.6	38
Burkhead and Hutton[5]	48	28	6	NR	NR	81	138	5	50	0
Krishnan et al[11]	51	84	36	7.7	2.1	70	140	5	50	8.3
Elhassan et al[9]	34	48	13	8	6	NR	NR	NR	NR	76.9

AER, Active external rotation; *AFE*, active forward elevation; *NR*, not reported; *Post*, postoperative; *Pre*, preoperative.

analysis of the cohort at 1 year showed no significant decrease in glenohumeral joint space and no erosion of the glenoid. More recently, Wirth[21] reported on 27 patients with a mean of 3 years of follow-up and found positive results in all patients in terms of pain relief and improved function. However, there was concern about the durability of the graft because progressive joint space narrowing was noted. Another treatment option for young patients with advanced glenohumeral arthritis is biologic resurfacing with osteochondral allograft. This procedure has been described using both open and arthroscopic techniques.[10,12,13,18] Although outcomes data are limited at this time, it is currently our preference to recommend this type of procedure to young patients with advanced shoulder arthritis, rather than to use an interposition graft.

Limitations of this study include those associated with the retrospective and multicenter design, as well as our small cohort size. However, the size of our cohort is similar to cohort sizes of previous authors, and the uncommon use of this procedure makes a multicenter design necessary. Given the conflicting data in the published literature to date, we believe that our results provide additional valuable data to surgeons considering using this procedure.

Conclusions

Our experience using humeral head resurfacing with soft tissue resurfacing of the glenoid to treat young patients with shoulder arthritis has been disappointing because both pain and function are only modestly improved. Given the limited improvement in patient outcomes and the relatively high revision rate, this is no longer our primary treatment option for young patients and should be used with caution.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

References

1. Ball C, Galatz L, Yamaguchi K. Meniscal allograft interposition arthroplasty for the arthritic shoulder: description of a new surgical technique. Tech Shoulder Elbow Surg 2001;2:247-54.
2. Bartelt R, Sperling JW, Schleck CD, Cofield RH. Shoulder arthroplasty in patients aged fifty-five years or younger with osteoarthritis. J Shoulder Elbow Surg 2011;20:123-30. http://dx.doi.org/10.1016/j.jse.2010.05.006
3. Baumgarten KM, Lashgari CJ, Yamaguchi K. Glenoid resurfacing in shoulder arthroplasty: indications and contraindications. Instr Course Lect 2004;53:3-11.
4. Bohsali KI, Wirth MA, Rockwood CA Jr. Complications of total shoulder arthroplasty. J Bone Joint Surg Am 2006;88:2279-92. http://dx.doi.org/10.2106/JBJS.F.00125
5. Burkhead WZ Jr, Hutton KS. Biologic resurfacing of the glenoid with hemiarthroplasty of the shoulder. J Shoulder Elbow Surg 1995;4:263-70.
6. Burkhead WZ Jr, Krishnan SG, Lin KC. Biologic resurfacing of the arthritic glenohumeral joint: historical review and current applications. J Shoulder Elbow Surg 2007;16:S248-53. http://dx.doi.org/10.1016/j.jse.2007.03.006
7. Chong PY, Srikumaran U, Kuye IO, Warner JJ. Glenohumeral arthritis in the young patient. J Shoulder Elbow Surg 2011;20:S30-40. http://dx.doi.org/10.1016/j.jse.2010.11.014
8. Edwards TB, Kadakia NR, Boulahia A, Kempf JF, Boileau P, Nemoz C, et al. A comparison of hemiarthroplasty and total shoulder arthroplasty in the treatment of primary glenohumeral osteoarthritis: results of a multicenter study. J Shoulder Elbow Surg 2003;12:207-13. http://dx.doi.org/10.1016/mse.2003.S1058274602868045
9. Elhassan B, Ozbaydar M, Diller D, Higgins LD, Warner JJ. Soft-tissue resurfacing of the glenoid in the treatment of glenohumeral arthritis in active patients less than fifty years old. J Bone Joint Surg Am 2009;91:419-24. http://dx.doi.org/10.2106/JBJS.H.00318
10. Gobezie R, Lenarz CJ, Wanner JP, Streit JJ. All-arthroscopic biologic total shoulder resurfacing. Arthroscopy 2011;27:1588-93. http://dx.doi.org/10.1016/j.arthro.2011.07.008
11. Krishnan SG, Nowinski RJ, Harrison D, Burkhead WZ. Humeral hemiarthroplasty with biologic resurfacing of the glenoid for glenohumeral arthritis. Two to fifteen-year outcomes. J Bone Joint Surg Am 2007;89:727-34. http://dx.doi.org/10.2106/JBJS.E.01291
12. Kropf EJ, Sekiya JK. Osteoarticular allograft transplantation for large humeral head defects in glenohumeral instability. Arthroscopy 2007;23:322.e1-e5. http://dx.doi.org/10.1016/j.arthro.2006.07.032
13. McCarty LP III, Cole BJ. Reconstruction of the glenohumeral joint using a lateral meniscal allograft to the glenoid and osteoarticular humeral head allograft after bipolar chondrolysis. J Shoulder Elbow Surg 2007;16:e20-4. http://dx.doi.org/10.1016/j.jse.2006.10.018
14. Namdari S, Alosh H, Baldwin K, Glaser D, Kelly JD. Biological glenoid resurfacing for glenohumeral osteoarthritis: a systematic

review. J Shoulder Elbow Surg 2011;20:1184-90. http://dx.doi.org/10.1016/j.jse.2011.04.031

15. Nicholson GP, Goldstein JL, Romeo AA, Cole BJ, Hayden JK, Twigg SL, et al. Lateral meniscus allograft biologic glenoid arthroplasty in total shoulder arthroplasty for young shoulders with degenerative joint disease. J Shoulder Elbow Surg 2007;16:S261-6. http://dx.doi.org/10.1016/j.jse.2007.03.003
16. Radnay CS, Setter KJ, Chambers L, Levine WN, Bigliani LU, Ahmad CS. Total shoulder replacement compared with humeral head replacement for the treatment of primary glenohumeral osteoarthritis: a systematic review. J Shoulder Elbow Surg 2007;16:396-402. http://dx.doi.org/10.1016/j.jse.2006.10.017
17. Savoie FH III, Brislin KJ, Argo D. Arthroscopic glenoid resurfacing as a surgical treatment for glenohumeral arthritis in the young patient: midterm results. Arthroscopy 2009;25:864-71. http://dx.doi.org/10.1016/j.arthro.2009.02.018
18. Skendzel JG, Sekiya JK. Arthroscopic glenoid osteochondral allograft reconstruction without subscapularis takedown: technique and literature review. Arthroscopy 2011;27:129-35. http://dx.doi.org/10.1016/j.arthro.2010.09.012
19. Sperling JW, Cofield RH, Rowland CM. Minimum fifteen-year follow-up of Neer hemiarthroplasty and total shoulder arthroplasty in patients aged fifty years or younger. J Shoulder Elbow Surg 2004;13:604-13. http://dx.doi.org/10.1016/S1058274604001296
20. Sperling JW, Cofield RH, Rowland CM. Neer hemiarthroplasty and Neer total shoulder arthroplasty in patients fifty years old or less. Long-term results. J Bone Joint Surg Am 1998;80:464-73.
21. Wirth MA. Humeral head arthroplasty and meniscal allograft resurfacing of the glenoid. J Bone Joint Surg Am 2009;91:1109-19. http://dx.doi.org/10.2106/JBJS.H.00677
22. Wright RW, Baumgarten KM. Shoulder outcomes measures. J Am Acad Orthop Surg 2010;18:436-44.