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Shoulder arthroplasty for post-traumatic osteonecrosis of the humeral head

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Background: Osteonecrosis (ON) of the humeral head is a known complication of proximal humeral trauma. Prosthetic replacement may be the last option to treat the associated pain. Depending on the condition of the glenoid, hemiarthroplasty (HA) or total shoulder arthroplasty (TSA) can be considered. To date, the peer reviewed literature offers limited direction on the better treatment for this population.

Methods: Between 1973 and 2010, 93 arthroplasties were performed for post-traumatic ON of the humeral head after conservative treatments failed. Of these, 37 HAs and 46 TSAs were monitored for a minimum of 2 years (mean, 8.9 years) or until reoperation.

Results: The HA and TSA groups showed improvements in pain ($P < .001$), elevation ($P < .01$), and external rotation ($P < .01$). The TSA group had less pain at follow-up than the HA group (2.1 vs 3.0, $P = .001$). TSA led to better satisfaction (70% vs 56%) and more excellent/satisfactory Neer ratings (57% vs 41%) compared with HA. Nine HA patients and 5 TSA patients underwent reoperation. The most common causes for reoperation were painful glenoid arthrosis (n = 8) in HA and rotator cuff failure (n = 4) in TSA. The estimated 15-year survivorship was 79.5% for HA and 83% for TSA.

Discussion: In patients with post-traumatic ON of the humeral head, shoulder arthroplasty provides improvements in range of motion. However, TSA provides superior pain relief, with better patient-reported satisfaction. TSA should be strongly considered in patients with post-traumatic ON of the humeral head with damage to the glenoid cartilage.

Level of evidence: Level III, Retrospective Cohort Design, Treatment Study.

Keywords: Total shoulder arthroplasty; hemiarthroplasty; post-traumatic avascular necrosis

Osteonecrosis (ON) of the humeral head is a known complication after trauma to the proximal humerus. Traumatic injuries to the shoulder girdle can compromise the blood supply to the humeral head, causing bone necrosis, fracture, and collapse, with subsequent glenohumeral arthritis.[8] After proximal humerus fractures, ON has been reported to occur in up to 75% of displaced 4-part fractures and with a lower incidence in more minor fracture patterns.[9] Early in the disease, conservative treatment or humeral head decompression, or both, can be considered. As the disease progresses, humeral head congruity is lost, and degenerative

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changes can escalate on both sides of the shoulder joint. With a greater percentage of the humeral head involved, functional Constant scores decrease.[9] Compared with atraumatic ON, the post-traumatic ON population has also been shown to progress more rapidly to symptomatic arthritis.[6] Eventually, prosthetic shoulder arthroplasty becomes the strongest option for this population.

Authors have proposed hemiarthroplasty (HA), total shoulder arthroplasty (TSA), reverse shoulder arthroplasty when the rotator cuff is deficient, or nonprosthetic glenoid arthroplasty as means for treating glenohumeral arthrosis. With an intact or repairable rotator cuff and sufficient glenoid bone stock, most surgeons consider TSA or HA, depending on patient factors and the condition of the glenoid cartilage at the time of the operative intervention. The osteoarthritis literature shows HA provides inferior pain relief, function, and survivorship compared with TSA.[1] Previous studies of ON have supported this trend toward dissatisfaction with HA when evaluating a combined population of atraumatic and post-traumatic ON shoulders treated with arthroplasty.[5] However, the atraumatic and post-traumatic populations remain separate entities and may not act in the same manner.

There are limited large studies examining the longer-term results of HA and TSA in post-traumatic ON of the humeral head. Those studies isolating the post-traumatic population remain small in numbers, limiting the ability to draw meaningful conclusions. This study assessed pain relief, function, and survivorship of humeral head replacement alone and TSA for post-traumatic humeral head ON and assessed risk factors for failure.

Materials and methods

Between August 1973 and November 2010, 93 consecutive shoulders (41 HA, 52 TSA) with post-traumatic ON of the humeral head were treated with shoulder arthroplasty. The study excluded 5 shoulders (2 HA, 3 TSA) due to tuberosity nonunion or a malunion requiring osteotomy because these shoulders require altered rehabilitation and likely have different goals after arthroplasty. All shoulders were required to fail nonoperative treatment before prosthetic replacement.

A diagnosis of post-traumatic ON of the humeral head accounted for <1% of all shoulder arthroplasties performed at our institution during the same period. The clinical follow-up analysis excluded 5 shoulders (2 HA, 3 TSA) that were lost to follow-up before 2 years, leaving 37 HA and 46 TSA in the clinical study group. Shoulders with <2 years of follow-up were included in the survival analysis until the point of their last clinical contact. Included were 95% of patients eligible for follow-up. Demographic data for the cohort are provided in Table I.

Table I Patient demographics for shoulders with a minimum 2-year follow-up or until reoperation

Variable	HA (n = 37)	TSA (n = 46)	*P* value
Age, mean (range) y	55 (17-79)	65 (44-83)	<.001
Sex, No.			
Male	10	3	.016
Female	27	43	
Follow-up, mean (range) y	10.9 (2-35)	7.3 (2-20)	.03
Prior surgery, No.	16	20	1.0

HA, hemiarthroplasty; *TSA*, total shoulder arthroplasty.

Operative techniques

Shoulders were approached through the deltopectoral interval in 58 of the 83 shoulders evaluated clinically. In 25 shoulders, the origin of the anterior deltoid was detached due to a thin deltoid or the need to access the posterosuperior rotator cuff. The subscapularis was released from bone if passive external rotation was <30°, otherwise a tenotomy was used. The glenoid was inspected, and the decision to proceed with hemiarthroplasty was made when four-fifths or more of the cartilage surface remained. Four patients elected to have a HA preoperatively, despite documented cartilage wear, due to the desire to avoid activity restrictions. When trauma-induced contractures were present, thickened capsule was incised and often partially excised to create joint flexibility and allow component placement, be it HA or TSA. Cement fixation was used in 14 of the 37 HA humeral components and in 43 glenoids and 8 humeri in the 46 TSAs. The rest were placed in an uncemented fashion.

The shoulder was immobilized for 1 week after surgery. From 1 week to 1 month, a sling was used during the day and an immobilizer at night. Passive range of motion (ROM) was initiated in the hospital, as defined by intraoperative findings, and progressed to active assisted ROM at 6 weeks. Pulley exercises and gentle strengthening were initiated between 2 and 3 months.

Clinical evaluation

Clinical records were reviewed for all shoulders with a diagnosis of post-traumatic ON of the humeral head, as identified by our intuition's total joint database. Patients are asked to return at routine intervals, depending on surgeon preference. In addition, a validated questionnaire is sent to all joint replacement patients at intervals for those patients unable to return for an in-person evaluation.[11] Pain was assessed on a 5-point scale, where 1 denoted no pain and 5 denoted severe pain.[7] Satisfaction was scored on a scale of 1 to 4, representing patient responses of "much better," "better," "the same," or "worse" compared with before surgery. Active elevation and external rotation were measured clinically or by the validated shoulder questionnaire described above. Active internal rotation was measured as the most cephalad vertebral segment reached by the thumb. Pain, ROM, and patient satisfaction were used to determine the modified Neer ratings for each shoulder.[3,7]

Radiographic evaluation

Standardized preoperative and postoperative radiographs were reviewed and included 40° posterior oblique views of the humerus (internal and external rotation) and an axillary view. Two