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# Shoulder arthroplasty for atraumatic osteonecrosis of the humeral head

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**Background:** Osteonecrosis (ON) of the humeral head represents <5% of the shoulder arthroplasty population. Depending on the stage of disease, surgeons must decide between hemiarthroplasty (HA) and total shoulder arthroplasty (TSA). To date, the peer-reviewed literature offers minimal insight into the best form of treatment of this population of patients.

**Methods:** Between August 1973 and November 2010, 141 shoulder arthroplasties were performed for operatively confirmed ON of the humeral head; 67 HAs and 71 TSAs were observed for at least 2 years (mean, 9.3 years) or until reoperation. Indications for surgery included imaging-confirmed ON in a patient who had failed to respond to conservative treatment modalities.

**Results:** Shoulder arthroplasty provided significant improvements in pain scores ($P < .001$), elevation ($P < .01$), and external rotation ($P < .01$) for both the HA and TSA populations. Both groups showed similar patient-reported satisfaction (>75%) and excellent/satisfactory Neer ratings (>65%). Eleven percent of HAs had moderate to severe glenoid erosion at follow-up, and 25% of glenoid components were radiographically at risk. Eight HAs and 11 TSAs underwent reoperation. The most common cause for reoperation was painful glenoid arthrosis in the HA group (7) and aseptic loosening (4) in the TSA group. The estimated 20-year survivorship of HA and TSA was 87% and 79%, respectively.

**Conclusions:** In patients with atraumatic ON of the humeral head, both HA and TSA can be expected to provide lasting pain relief and improved range of motion, with HA having longer follow-up. HA should be strongly considered in patients with atraumatic ON of the humeral head and preserved glenoid cartilage.

**Level of evidence:** Level IV, Case Series, Treatment Study.



**Keywords:** Total shoulder arthroplasty; hemiarthroplasty; atraumatic osteonecrosis

Advanced osteonecrosis (ON) of the humeral head is a well-recognized indication for shoulder arthroplasty. However, within the shoulder arthroplasty population, ON represents the preoperative diagnosis in <5% of cases.[9] ON can be due to either post-traumatic or atraumatic causes, leading to compromised blood supply to the humeral head, bone necrosis, fracture, and collapse with subsequent glenohumeral arthritis.[14] Atraumatic ON is most commonly secondary to systemic treatment with corticosteroids. Other causes include chemotherapy, irradiation, alcohol abuse,

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hematologic diseases, and caisson disease.[14] Unlike osteoarthritis, ON affects patients of all age groups. Early in the disease process, glenoid changes are minimal. This allows close observation or joint preservation techniques, such as core decompression, to be attempted. However, once the disease has progressed in terms of pain with fracture and collapse of the humeral head, prosthetic arthroplasty becomes the strongest option. Depending on the timing of surgery, these patients may have relatively preserved glenoid cartilage at the time of arthroplasty. In such cases, many surgeons select hemiarthroplasty (HA). However, concern remains, given that patients with secondary osteoarthritis may have inferior pain relief, function, and survivorship with HA compared with total shoulder arthroplasty (TSA).[2] A trend toward dissatisfaction with HA has also been shown in a mixed atraumatic/post-traumatic ON population.[8] However, previous studies have shown post-traumatic shoulders to progress more rapidly to arthropathy and shoulder arthroplasty.[7] There are limited reports with a sufficient number of shoulders comparing the longer term results of HA and TSA in atraumatic ON of the humeral head. Previously, our institution has reported on 31 cases of steroid-induced ON, with nearly half of patients reporting unsatisfactory outcomes.[16] However, this limited population fails to capture the full spectrum of atraumatic ON and lacks sufficient numbers for meaningful conclusions to be drawn. This study aims to expand on our previous group to assess pain relief, range of motion (ROM), and survivorship of shoulder arthroplasty for atraumatic humeral head ON and to assess risk factors for failure.

## Methods

Between August 1973 and November 2010, 141 shoulders with atraumatic ON of the humeral head underwent shoulder arthroplasty after failing conservative treatment measures; 68 were treated with HA, and 73 were treated with TSA. This represented <1% of the HAs and TSAs performed during that same period at our institution. All shoulders were included in the survival analysis; shoulders with a minimum 2-year follow-up or follow-up until reoperation were included in the clinical study group. Three shoulders (1 HA, 2 TSAs) were lost to follow-up before 2 years and were thus excluded from clinical follow-up analysis, with the study group representing 98.6% of patients eligible for follow-up.

Of the 141 arthroplasties performed and included in survival analysis, 23 were performed in patients undergoing bilateral shoulder arthroplasty. Thirteen patients underwent bilateral HA and 10 underwent bilateral TSA. Previous corticosteroid use was the most common etiology of ON in both groups. Full details of each group are demonstrated in Table I. Eighty shoulders (36% of patients) undergoing arthroplasty had multiple joints affected by ON. Patients with multiple joints affected were significantly more likely to undergo TSA vs. HA (39% vs. 28%; $P = .04$).

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

| | HA | TSA |
|---|---|---|
| | n = 67 | n = 71 |
| Male/female | 26/42 | 15/58 |
| Age at arthroplasty (years) | 48 (13.6) | 64 (9.0) |
| Follow-up (years) | 11.4 (7.8) | 7.7 (4.7) |
| Etiology | | |
| Steroid | 39 | 40 |
| Idiopathic | 14 | 24 |
| XRT | 3 | 5 |
| EtOH | 6 | 0 |
| Sickle cell | 3 | 0 |
| Caisson | 1 | 1 |
| Gaucher | 1 | 0 |
| Hb S thalassemia | 0 | 1 |

*HA*, hemiarthroplasty; *TSA*, total shoulder arthroplasty; *XRT*, external beam radiation, *EtOH*, alcohol abuse; *Hb*, hemoglobin.

Of the 138 operations included in the clinical study group, 67 HAs were performed at an average age of 48 years (range, 25-82 years), with a mean follow-up of 11.4 years (range, 2-30 years). Fourteen shoulders were followed up for <5 years (1 shoulder required reoperation within 5 years of index arthroplasty); 20 shoulders, for 5 to 10 years; and 33 shoulders, for >10 years. Patients undergoing HA were younger than the TSA group (n = 71); the mean age was 64 years (range, 40-85 years; $P < .001$). Average follow-up for the TSA group was also shorter than for the HA group, with a mean of 7.7 years (range, 0.6-25 years; $P = .001$). Twenty-one shoulders were followed up for <5 years (8 shoulders required reoperation within 5 years of index arthroplasty); 28 shoulders, for 5 to 10 years; and 22 shoulders, for >10 years. Three shoulders (4%) with HA and 8 shoulders (11%) with TSA had undergone a previous surgery ($P = .15$).

### Operative techniques

Arthroplasties were performed through a standard deltopectoral approach in 125 of the 138 shoulders evaluated clinically. In 12 cases in which a thin anterior deltoid or the need to repair a posterosuperior rotator cuff was identified, an anteromedial approach was used, releasing the origin of the anterior deltoid. One shoulder was approached posteriorly. The subscapularis was tenotomized, or it was removed from bone when passive external rotation was <30°. The glenoid was assessed visually, and when four fifths or more of the surface was covered with cartilage, HA was performed. When a larger amount of the glenoid surface was exposed bone, the humeral head subluxated into the deficient area on the glenoid surface, and TSA was selected instead of HA. However, during this long time, there were 7 shoulders with more advanced glenoid