



## A BIOPOLAR SHOULDER HEMIARTHROPLASTY FOR ROTATOR CUFF DEFICIENT SHOULDERS

**INTRODUCTION:** In view of the success of the hip and knee joint replacement, it is logical to assume that shoulder replacement would be a dynamic alternative to resection arthroplasty or shoulder fusion, assuming motor function is available to mobilize the joint. From Pean's first artificial shoulder in 1893<sup>1</sup> through the modern age of shoulder replacement ushered in by Neer in 1955<sup>2</sup>, a vast array of devices have been introduced to treat the painful arthritic shoulder joint. While the results of shoulder arthroplasty have been excellent, studies involving these devices all comment on the complexities of glenohumeral motion and the problems that arise when a prosthesis fails or a rotator cuff deficient shoulder is encountered. In answer to these difficulties, a new design of salvage shoulder prosthesis is introduced. The indications and advantages of this hemiarthroplasty will be discussed and results of preliminary clinical trials will be presented.

**METHODS:** Nine patients with severe rotator cuff disease secondary to either rheumatoid arthritis, severe degenerative changes, or failed primary arthroplasty, were selected for implantation of the bipolar shoulder hemiarthroplasty. The patients ages ranged from 50 to 89 years (mean 74 years). There were eight females and one male. The dominant shoulder was involved in six, while the non-dominant was involved in three.

All surgery was performed under general anesthesia on a regular operating table in beachchair position. The patient was prepped with an iodophor preparation and draped in the usual sterile fashion. A straight deltopectoral incision was made beginning 1 cm. distal to the clavicle and continuing past the axillary fold. The coracoid process was used as the proximal landmark for this incision. In all cases the rotator cuff was markedly attenuated with large, irreparable tears or completely obliterated. A transverse osteotomy of the humerus was made using the oscillating saw and the head fragment removed. The humeral canal was sequentially reamed until there was a snug fit of the hand reamer in the canal. The correct humeral stem trial was placed into position with the appropriately sized bipolar head. A trial reduction was done and the range of motion and stability were assessed. When a satisfactory fit was achieved final components were press fit into position. If available, the biceps tendon was used to reinforce the anterior soft tissue repair. The operative extremity was then placed in a shoulder immobilizer sling.

Rehabilitation of the soft tissue through active and passive range of motion exercises was instituted immediately. The patient was cautioned against active motion above eye level during the first six weeks post-operatively. This was done to allow the remnants of the rotator cuff and anterior deltoid to heal. Activity was progressed as the patient could tolerate.

**RESULTS:** Nine patients underwent bipolar hemiarthroplasty in symptomatic, rotator cuff deficient, arthritic shoulders. The patients were followed for an average of thirty-four months (range 12 to 57 months). There were no intraoperative complications in the study group and no postoperative infections. The evaluation of the prosthesis is based on pre- and postoperative pain, function, and range of motion (Forward flexion, abduction, external rotation, and internal rotation).

Pain preoperatively was described as being from moderate with activities to severe, constant, and interfering with sleep. Postoperatively, eight of nine patients report their pain to be improved. At three month follow-up, pain was present in eight of nine but improved in all. By one year, six of nine were asymptomatic, two were markedly improved, and one had recurrent pain with activity.

Preoperative function was uniformly poor. Three of nine patients reported they were able to undertake the activities of daily living (ADL's) with the affected shoulder with moderate to severe pain. The remaining six were unable to perform any ADL's with the involved shoulder. Postoperatively, all patients reported that they were performing ADL's.

Range of motion improved for all four parameters. Forward flexion improved from an average of 41 degrees (15-80) to an average of 81 degrees (45-120). Abduction



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increased from 30 degrees (20-45) to 69 degrees. Average external and internal rotation also doubled from preoperative values of 24 degrees (0-90) and 25 degrees (0-60) to 59 degrees (40-90) and 57 degrees (30-90) respectively.

**DISCUSSION:** The forces in the gleno-humeral joint are complex and vary with arm position, weight and loads on the arm. The forces consist of several groups: 1) the weight of the arm and other external forces; 2) the abductor forces of the deltoid and supraspinatus; 3) the counterbalancing forces of the subscapularis, infraspinatus, and teres minor; which together produce a joint reaction force on the glenoid. The resultant of the first three groups is generally essentially perpendicular to the glenoid surface and act as joint stabilizers<sup>3-7</sup>.

The disruption of the rotator cuff and or its associated musculature by either severe degenerative changes, rheumatoid changes, or prior surgical intervention, disrupts the action of the adductors resulting in an inability to balance the abductor forces. The resultant force will therefore be directed superiorly causing an upward shift of the humerus and thus its impingement with the acromion.

Reconstruction of the rotator cuff, and therefore restoration of shoulder force balance, is necessary in shoulder joint arthroplasty using current, unconstrained, shoulder prostheses. If restoration of lost cuff function cannot be achieved, current shoulder designs cannot prevent impingement of the prosthesis or humerus with the acromion, and therefore do not provide a satisfactory replacement. Attempts to provide prosthetic stability lost as a result of a dysfunctional and unreconstructable cuff by use of linked, contained prostheses, have been unsuccessful due to inadequate long-term, glenoid fixation<sup>8</sup>. Experimentation with an acromial resurfacing component, likewise has been unsuccessful, due to fixation difficulties.

The salvage shoulder prosthesis, as illustrated in figures 1 and 2, is designed to provide joint replacement in the unreconstructable, unstable, adductor deficient shoulder. The fundamental concept is to provide a stable loading element that can transfer the upwardly directed resultant force vector, produced by the abductors, to the glenoid and the acromion, with a minimum of articulation between this loading element and the contacting surfaces of the shoulder.

In the salvage situation, pain relief is the primary goal while function and stability is the next priority. In eight of nine pain markedly improved while all reported being able to resume ADL's with the involved shoulder. The average range of motion improved nearly 100 percent in the parameters examined. The only patient who did not report improvement in pain, was a staged revision of an infected primary arthroplasty who did have a slight increase in postoperative range of motion. The etiology of the pain was not clear. Work-up for infection has been negative to date. The patient's case however, is involved in litigation.

The early results of this prosthesis are promising. Longer follow-up and greater numbers will be needed to confirm the role of the prosthesis a salvage device for the rotator cuff deficient shoulder.

### **REFERENCES**

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