

Cementless Hemiarthroplasty for Complex Fractures of the Proximal Humerus

a report by

Francis X Mendoza

Chief, Shoulder and Elbow Section, Orthopaedic Surgery, Lenox Hill Hospital, New York



Francis X Mendoza is an orthopaedic surgeon and Chief of the Shoulder and Elbow Section, Department of Orthopaedic Surgery, Lenox Hill Hospital, New York. He is also a Consultant at the Nicholas Institute of Sports Medicine and Athletic Trauma, Lenox Hill Hospital. Dr Mendoza has been in private practice at Lenox Hill Hospital since the completion of his fellowship with Dr Charles S Neer II in 1982. He has over 25 years of clinical and surgical experience with total shoulder replacements. Dr Mendoza is a member of numerous professional associations, including the American Shoulder and Elbow Surgeons Society, American Academy of Orthopaedic Surgeons, and American Medical Association.

Hemiarthroplasty of the proximal humerus is indicated in older patients for the treatment of most four-part and head split fractures, and selected three-part fractures with moderate comminution or osteoporosis.

Most orthopaedic surgeons agree that the surgical treatment of these severe fractures generally offers good pain relief, but the functional results are variable. Current thinking is that anatomical healing of the tuberosities around an anatomically restored humeral head is a necessary prerequisite to optimise functional results.

Since the original Neer monoblock designs the last 10 to 20 years have seen the emergence of modular hemiarthroplasty. These newer second- and third-generation designs offer anatomically designed humeral heads and varying degrees of humeral head adjustability for version, offset and inclination. These features allow the orthopaedic surgeon to more precisely control the three-dimensional (3-D) placement of the anatomically sized humeral head around which the tuberosities are anatomically reconstructed. Second-generation prosthetic modular designs consist of a stem-neck-collar implant with fixed inclination and different size humeral heads with variable offsets. They all depend upon cement for humeral stem fixation. Once the cement cures, these designs are unforgiving with respect to any changes in restored humeral length, humeral head version or inclination. Any final adjustments prior to tuberosity fixation depend upon varying head size and offset. Third-generation modular hemiarthroplasty systems also use cement for humeral stem fixation; nonetheless, they are more forgiving. The availability of different humeral head sizes with variable version, offset and inclination features assist the surgeon to anatomically restore the position of the prosthetic head more easily than with previous generations. These newer second- and third-generation prostheses use assorted surgical jigs or guides to restore native humeral length prior to cementing the stem.

The PROMOS® Shoulder System

This fourth-generation anatomical arthroplasty was

introduced in 2003 for the treatment of both arthritic conditions and complex proximal humerus fractures (see *Figure 1*). The system features cementless stem fixation and *in situ* adjustability to adapt the anatomically-designed humeral head and glenoid components to the surgical anatomy. The dual tapered stem, designed after the Zweymüller hip stem, provides secure, cementless endosteal fixation in both osteoporotic and normal quality bone. An adjustable body with an adjustable inclination set are used to couple the anatomically-positioned humeral head to the fixed, cementless stem. No special surgical guides or jigs are used during arthritic or fracture reconstructions. When used for fracture reconstructions, the orthopaedic surgeon can change the restored humeral length or humeral head position (version, offset or inclination) or head size at any time prior to tuberosity fixation. The tuberosities are individually secured and circumferentially strapped with bone graft around the uniquely shaped, adjustable body component, which acts as an endoskeleton to maintain their anatomical alignment during rehabilitation and osteosynthesis.

Surgical Technique

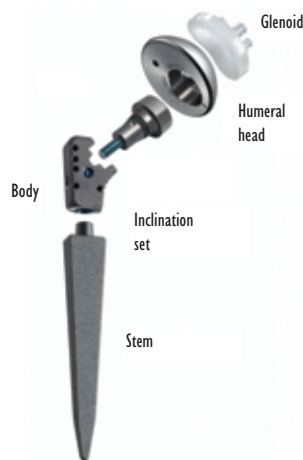
Radiographic templating of both humeri should be used pre-operatively to estimate the native humeral head size and the stem size. A standard deltopectoral incision is recommended. The long head of the biceps tendon is identified and, if possible, preserved. The lesser and greater tuberosities are defined. Three No. 5 (non-absorbable) sutures are placed around the lesser tuberosity and through the subscapularis tendon. Similarly, the greater tuberosity fragments are tagged with three No. 5 sutures around the tuberosity and through the attached tendons. The fractured humeral head and fragments are removed and pieced together. The trial humeral head that closely approximates the diameter of the fractured head is chosen. The fractured proximal humeral shaft is delivered into the wound: broach with 20–30° of retroversion. The medullary canal is prepared to the stem size determined pre-operatively with the humeral stem template that allows contact of the endosteal cortex while resting 1–2cm below the native medial calcar. The trial stem

is inserted into the medullary canal at the selected retroversion with gentle impaction until firm endosteal engagement is achieved. Normally, the top of the chosen trial stem should rest 1–2cm below the level of the native medial calcar. This will serve as a solid foundation on which to anatomically restore the length of the humerus.

The smallest trial body that clears the native medial calcar is placed on top of the trial stem, aligned and securely fixed. Normally, the final trial body size is determined after optimal head position is achieved. If necessary, adjusting the body position relative to the fixed stem will allow changing the version up to $\pm 15^\circ$. The shortest trial inclination set that allows clearance of the trunnion beyond the native medial calcar is selected. It is tightly screwed into the body with the saddle in neutral (inclination angle of 132.5°) and its axis of rotation pointing in a vertical direction. If necessary, this saddle position will allow changing the version up to $\pm 12^\circ$ while maintaining the same inclination of 132.5° . The trial head is placed onto the trunnion of the trial inclination set. Optimal head position is achieved when it is rotated posteriorly to re-establish the normal, anatomical medial calcar–humeral head relationship while resting 1cm or less above the body. This will allow for greater tuberosity fixation a few millimetres below the anatomically positioned humeral head while restoring anatomical posterior offset. The trial humeral head is impacted. The trial head is then reduced onto the glenoid fossa with the long head of the biceps tendon lying anteriorly and the tuberosities loosely reduced around the head.

Humeral head version and myofascial sleeve tension are evaluated with the arm placed at the side and in neutral rotation. The humeral head should point towards the centre of the glenoid fossa, revealing the true anatomical version. In this position, the newly tensioned myofascial sleeve should allow up to 40–50% of humeral head diameter translation in the inferior and posterior directions. A trial reduction of the tuberosities onto the body should allow for their anatomical repair without undue tension of the rotator cuff. The trial components are removed. The head and inclination set are removed separately, while the stem and the body can be removed as a unit with the extractor/impactor. The definitive stem is inserted at the initially chosen $20\text{--}30^\circ$ of retroversion. After solid fixation is confirmed with no evidence of subsidence during impaction, the final stem height below the native medial calcar is determined. If essentially unchanged from the trial stem height, then proceed with insertion of the definitive body, inclination set and humeral head. Otherwise, a different combination of bodies and inclination sets may be required for an anatomical reconstruction. Once the definitive stem is

Figure 1: PROMOS modular components



fixed, it will serve as the *in situ* foundation on which to assemble the definitive body, inclination set and humeral head. Any additional *in situ* (version, inclination or even height) adjustments that the surgeon feels are necessary to achieve optimal head position can be implemented as the definitive body and inclination set are fixed onto the stem.

Secure individual, anatomic tuberosity fixation to the lateral body holes is achieved using the three previously placed No. 5 sutures around each tuberosity. Fixation is further supplemented with two circumferential heavy (No. 5 Mersilene or Dacron) tapes. One tape is placed through the large medial hole of the body and then around the upper half of each tuberosity. A second tape is placed through the same medial hole and then passed around the lower half of each tuberosity.

To enhance healing of the tuberosities to the humeral shaft and to each other, a sliver of primarily cancellous humeral head bone is fashioned to each side of the body and fixed by wedging it into the medullary cavity. First, the greater tuberosity is anatomically reduced onto the body a few millimetres below the superior aspect of the humeral head while overlapping a few millimetres onto the humeral shaft inferiorly. Secure fixation is achieved by tying the three No. 5 sutures. Next, the lesser tuberosity is reduced in a similar fashion and fixed with the three No. 5 sutures. The upper tape is then tied beneath the biceps tendon, circumferentially strapping both tuberosities to each other and to the body. The lower tape is then tied over the biceps tendon, further strapping both tuberosities and tenodesing the biceps tendon. The most lateral aspect of the rotator interval is anatomically closed with No. 2 non-absorbable sutures completing the anatomical reconstruction. ■

A longer version of this article containing references can be found in the Reference Section on the website supporting this briefing (www.touchbriefings.com).