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ORIGINAL ARTICLE

Glenosphere size in reverse shoulder arthroplasty: is larger better for external rotation and abduction strength?

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Background: The role of glenosphere size in reverse shoulder arthroplasty (RSA) may be important in prosthetic stability, joint kinematics, rotator cuff tension and excursion, scapular impingement, humeral lateralization, deltoid wrap, and the occurrence of "notching." This study compared short- and midterm clinical and radiographic outcomes for 2 different glenosphere sizes of a single RSA type with respect to implant positioning, glenoid size, and morphology.

Methods: This retrospective analysis included 68 RSA procedures that were prospectively documented in a local register during a 5-year postoperative period. Two glenosphere diameter sizes of 36 mm (n = 33) and 44 mm (n = 35) were used. Standard radiographs were made preoperatively (ie, baseline) and at 6, 12, 24, and 60 months after surgery. Range of motion, strength, the Constant-Murley score, and the Shoulder Pain and Disability Index were also assessed at all follow-up visits. The effect of glenosphere size on measured outcomes was adjusted for baseline values, patient gender, and humeral head diameter.

Results: No significant differences were found in the functional scores between treatment groups at all follow-up assessments. At the 12-month follow-up, patients with a 44-mm glenosphere had greater external rotation in adduction (mean difference, 12°; $P = .001$) and abduction strength (mean difference, 1.4 kg; $P = .026$) compared with those with the smaller implant. These differences remained at 60 months. Scapular notching was observed in 38% of all patients, without any relevant difference between the groups.

Conclusion: An increase in glenosphere diameter leads to a clinically moderate but significant increase in external rotation in adduction and abduction strength at midterm follow-up.

[1]These authors contributed equally to this work and share first coauthorship. The Kantonale Ethikkommission Zürich (Cantonal Ethics Committee of Zurich) approved the analyses of the local clinical register (KEK-ZH Nr. 2014-0483: Clinical and subjective long term outcome after an implantation of a shoulder arthroplasty) on January 23, 2015.

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The use of reverse shoulder arthroplasty (RSA) has dramatically increased during the last decades[16] and proven successful in the treatment of rotator cuff tear arthropathy,[2] irreparable rotator cuff tears,[23] revisions of failed shoulder replacements,[21] and proximal humeral fractures[29] as well as their sequelae[13] in elderly patients. Despite increasing knowledge about appropriate implantation techniques, humeral component impingement against the glenoid neck remains a concern.[24] This mechanism may limit range of motion.[11] Scapular abutment of the humeral cup in adduction may also become radiographically apparent as bone loss at the scapular neck,[32] a condition referred to as "scapular notching." Numerous reports have linked scapular notching with decreased long-term shoulder function, increased polyethylene wear, and decreased implant stability.[20,26,31]

Some patient-related risk factors favor humeral cup impingement against the scapula such as glenoid neck morphology[25] and rotator cuff status.[20] Yet other risk factors seem to be related to glenosphere positioning and design. In particular, an increase in glenosphere size has recently shown its effectiveness in ex vivo studies.[19] The clinical effectiveness of this approach, however, has so far only been reported in 2 clinical studies. Mollon et al[22] demonstrated increased active shoulder abduction and forward flexion angles with a 42-mm glenosphere vs. its 38-mm counterpart; this effect was more pronounced in female patients. Torrens et al[33] demonstrated a significant decrease in scapular notching with the use of larger glenosphere components and no difference in functional outcome scores. Neither study accounted for size and morphology of the glenohumeral joint at the time of implantation, even though the effect of glenosphere sizes in relation to the native glenoid may be altered. In addition, these studies were limited to a 2-year follow-up period.

Therefore, the goal of this study was to assess the effect of glenosphere size on postoperative range of motion, scapular notching, and clinical outcome scores while considering factors of implant positioning, glenoid size, and morphology up to 5 years after surgery.

Materials and methods

Patient selection

Since May 2006, all patients receiving a shoulder arthroplasty have been prospectively documented in a local register.[17,30] From this database, rotator cuff arthropathy patients treated with a SMR Reverse Shoulder system (Lima Switzerland SA, Rotkreuz, Switzerland) and a glenosphere with a diameter of 36 mm or 44 mm were retrospectively included in this study. Only data from patients with complete baseline and at least 24-month clinical examinations were selected and analyzed; in the case of bilateral arthroplasty patients, only data from the first arthroplasty procedure were included.

Surgical technique and postoperative protocol

A deltopectoral approach was used with patients under general anesthesia in a beach chair position. Tenotomy or tenodesis of the long head of the biceps was performed for all patients identified with an intact biceps tendon. The remaining subscapularis was tenotomized, and refixation was performed at the end of the procedure, whenever possible. All humeral stems were uncemented and positioned in 5° to 10° retroversion. The humeral component has a standard neck shaft angle of 155°. The baseplate was placed such that the inferior border was flush with the inferior rim of the glenoid and then secured with a central peg and 2 supplementary screws that were proximally and distally placed, respectively. In our clinic, the eccentric glenosphere is preferred over the concentric type to reduce the risk of inferior notching. The decision to use the 36-mm or 44-mm glenosphere was made based on preoperative templating and intraoperative probing to minimize notching and improve stability with adequate soft tissue tensioning. After surgery, the patient was required to keep the arm immobilized only during the night for 4 weeks while following a standardized physical therapy program involving passive and active-assisted mobilization from postoperative day 1.

Radiographic baseline parameters and follow-up

Baseline and postoperative radiographs included standard anteroposterior (AP) views in internal and external rotation as well as an axial view. Scaled baseline radiographs were assessed for the acromiohumeral distance based on the calculation of Brox et al[6]; humeral head diameter (D) according to the best fitting circle on the humeral head; glenoid height (AB) as the distance from the most superior (A) to the most inferior (B) aspects of the glenoid surface (if there was a prominent medial glenoid tubercule, this was referenced as point B); scapular neck length (BC) as the distance between point B and the starting point of the lateral column of the scapula [C] (Fig. 1, *A*).

The first available qualitative AP radiographs, which are routinely taken at the 6-month postoperative follow-up were assessed for the parameters of inferior glenosphere overhang (O) adapted from Bigorre et al,[5] which is the distance between two parallel lines passing through the most inferior point of the glenoid (F) and the most inferior part of the glenosphere (G), both drawn perpendicular to the plane EF of the glenoid baseplate (this measurement was only made for patients with a 36-mm glenosphere because the 44-mm glenosphere made of polyethylene could not be seen on the radiographs); and prosthesis scapular neck angle as described by Simovitch et al,[31] which is equivalent to the angle between EF and the line FH joining F and a point 1 cm medial to point F along the glenoid rim or scapular neck (H) (Fig. 1, *B*). Further assessments of postoperative radiographs were done to