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Clinical performance of lateralized versus non-lateralized reverse shoulder arthroplasty: a prospective randomized study



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Background: Reverse shoulder arthroplasty (RSA) is an established therapeutic option in the treatment of cuff tear arthropathy (CTA). Recent studies have described a positive effect of lateralization of the center of rotation, especially on postoperative rotational function. The goal of this study is to compare the outcome of non-lateralized versus lateralized RSA with particular regard to rotational function in patients with CTA.

Methods: Thirty-four patients underwent implantation of RSA either with lateralization (n = 17) or without lateralization (n = 17) by use of a 1-cm autologous bone graft (“bony increased offset”) of the humeral head for CTA. Clinical outcomes were measured with the Constant score; the Disabilities of the Arm, Shoulder and Hand score; and the Activities of Daily Living Requiring External Rotation score, as well as measurement of external rotation and determination of the external rotation lag sign with the arm at the side and at 90° of abduction, at 1 year postoperatively and at final follow-up. Computed tomography scan evaluation was performed in all patients preoperatively and at 1 year postoperatively to assess preoperative fatty infiltration of the rotator cuff and bony integration of the graft postoperatively.

Results: At final follow-up, all patients showed significantly increased functional results. There were no significant differences in the evaluated parameters. If patients with degenerative changes of the teres minor were excluded, the lateralized group showed significantly increased external rotation. Bony integration of the graft could be verified on postoperative computed tomography scans in all patients.

Conclusion: RSA with bony lateralization shows a trend toward improved external rotation in lateralized RSA, with a statistically significant improvement in external rotation in patients with an intact teres minor.

Level of evidence: Level I, Randomized Controlled Trial, Treatment Study.

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Keywords: Reverse shoulder arthroplasty; lateralization; BIO-RSA; external rotation

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Reverse shoulder arthroplasty (RSA) represents an established therapeutic option in the treatment of cuff tear arthropathy (CTA). Improvement in shoulder function and pain reduction at 2 to 5 years' follow-up consistently has been shown by several authors.^{7,11,33} Active flexion and abduction are significantly improved

in most patients.^{7-9,12,27,28,33} However, although parts of the posterior (teres minor muscle) and/or anterior (subscapularis muscle) rotator cuff may still be intact in CTA,^{3,28} improvements of active external and internal rotation have rarely been reported in non-lateralized RSA and may even be reduced postoperatively,^{7,17,33} regardless of the preoperative or postoperative integrity of the teres minor or subscapularis.^{9,28} This occurs for several reasons. First, the external rotation moment arm of the deltoid is decreased after non-lateralized RSA.¹ Second, the number of posterior or anterior deltoid fibers contributing to external or internal rotational movements decreases as a result of the medialized center of rotation. In addition, bony impingement in internal and external rotation is dependent on glenosphere position. The maximal impingement-free rotational capacity has been shown for inferior translation, inferior tilt, and lateralization of the glenosphere.²⁴ These facts may also play a role in the differences in rotational function between non-lateralized and lateralized RSA.

Multiple activities of daily living such as combing one's hair, tucking in a shirt or blouse, bringing a full glass to the mouth, performing personal hygiene tasks, and controlling the spatial position of the arm require active rotation of the shoulder,^{3,4,28} and active rotation may even be more important for elderly persons than full forward flexion or abduction. Biomechanical studies have shown that medialization of the center of rotation of the humeral head leads to decreases in muscle pre-tensioning and the rotational capacity of the remaining rotator cuff in non-lateralized RSA.²² This alteration can be partly prevented by lateralizing the center of rotation and, therefore, preserving the rotational function of the remaining rotator cuff.¹⁷ Moreover, the external rotation moment arm of the deltoid is optimized,¹ and lateralization of the glenosphere, in addition to inferior translation and tilt, leads to maximal impingement-free rotational capacity.²⁴

In the clinical setting, lateralization can be achieved either by using specific implants with an increased offset intrinsic to the glenoid component¹¹ or by using a newly developed technique, the "bony increased offset," or BIO-RSA, technique with an autologous bone graft interposed between the glenoid and the glenosphere.⁵ Clinical studies have described a positive effect of lateralization on postoperative rotational function.^{5,11,26,30} Using an increased-offset glenoid component, Frankle et al¹³ and Mulieri et al²⁶ reported significant gains in external rotation of 29° and 24°, respectively. However, to our knowledge, there is a lack of randomized comparative studies analyzing the effect of lateralization of the center of rotation in comparison with the conventional, non-lateralized center of rotation on clinical outcome and rotational function after RSA implantation. Hence, the aim of this study is to evaluate the clinical outcome of RSA, looking at the rotational function of patients with CTA treated by an RSA with or without bony lateralization and a 1-cm autologous bone graft (BIO-RSA), by means of a prospective, randomized trial.

Methods

This is a prospective, randomized clinical study comparing the clinical outcome of lateralized and non-lateralized RSA.

Patient cohort

The inclusion criteria for the study consisted of patients aged between 65 and 100 years with CTA greater than grade 2 according to the Hamada classification,¹⁹ range of motion of active abduction and flexion less than 90°, severe pain, and failure of conservative treatment for a minimum of 6 months. The exclusion criteria included any relevant glenoid bone loss in the horizontal plane (types B2 and C according to Walch et al³¹) or vertical plane (stage E3 according to Sirveaux et al²⁹) and patients with post-traumatic conditions including humeral head necrosis or other conditions precluding harvesting of a bone graft of the humeral head. Implantation of the RSA (Aequalis Reversed Shoulder Prosthesis; Tornier, Houston, TX, USA) was performed using the standard surgical technique (STD group) or the BIO-RSA technique⁵ (BIO group) with a 1-cm autologous bone graft positioned under the baseplate to allow lateralization of the center of rotation.

Preliminary power analysis showed that a sample size of 34 patients (17 patients in each group) was needed, assuming a β error of .05 and a power of 0.80, to show a 10-point difference in the Constant score (CS) or a 10° difference in external rotation (assuming a range of motion of 100° [−35° to 65°] of active external rotation). Patients were informed about both surgical techniques, consented to take part in the study, and were blinded to the treatment. Preoperative randomization was carried out using an online tool for randomization (Research Randomizer, version 3.0 [<http://www.randomizer.org/>]; Geoffrey C. Urbaniak and Scott Plous, Middletown, CT, USA).

Radiologic evaluation

True anteroposterior and axial radiographic evaluation was performed for each patient preoperatively and at 3, 6, 12, and 24 months postoperatively. Computed tomography (CT) scan evaluation of the involved shoulder was performed preoperatively and again at 12 months postoperatively.

Fatty infiltration of the rotator cuff was classified on the preoperative CT scan according to Goutallier et al.¹⁵ For statistical analysis, grades 0, 1, and 2 (<50% fatty infiltration) and grades 3 and 4 (≥50% fatty infiltration) were grouped together as previously described.^{6,28} The teres minor integrity was classified according to Melis et al²⁵ as hypertrophic, normal, atrophic, or absent. As with the simplified version of the Goutallier classification, we grouped together hypertrophic and normal appearance of the teres minor and we grouped together atrophic and absent appearance of the teres minor.

Functional evaluation

For subjective and functional evaluation of shoulder function, the CS¹⁰; the Disabilities of the Arm, Shoulder and Hand (DASH) score (German version)¹⁴; and the Activities of Daily Living Requiring External Rotation (ADLER) score were obtained

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