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ORIGINAL ARTICLE

Fatty infiltration and muscle atrophy of the rotator cuff in stemless total shoulder arthroplasty: a prospective cohort study

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Background: The influence of preoperative rotator cuff fatty infiltration (FI) and muscle atrophy (MA) on the postoperative outcome of total shoulder arthroplasty (TSA) has only rarely been investigated and reported in the literature. We hypothesized that more FI and MA would be associated with a worse postoperative functional outcome.

Methods: This prospective cohort study included 63 patients (31 female and 32 male patients; mean age, 71 years [range, 53-89 years; standard deviation, 7 years]) with primary osteoarthritis of the shoulder operated on with anatomic stemless TSA. Preoperatively and at 3 months and 1 year after the operation, the functional outcome (QuickDASH [short version of Disabilities of the Arm, Shoulder and Hand questionnaire] score) and range of motion (ROM) (goniometer) and strength (dynamometer) for abduction at the scapular plane and for external rotation were measured. The degree of preoperative FI and MA was evaluated using computed tomography scans according to the Goutallier classification and Warner classification, respectively, for the supraspinatus and infraspinatus.

Results: We found clinically and statistically significant improvements in functional outcome, strength, and ROM at both 3 months and 1 year of follow-up compared with those preoperatively. The Pearson correlation coefficient (*r*) showed significant correlations between preoperative supraspinatus and infraspinatus FI and MA and preoperative and 1-year postoperative shoulder abduction and external rotation strength but not ROM. However, we found no influence of the rotator cuff FI and MA on the functional outcome after TSA.

Conclusion: We demonstrated a significant correlation between rotator cuff FI and MA and strength but not ROM of the shoulder joint.

The study was performed according to the Declaration of Helsinki, and the protocol was approved by the local ethics committee at Umeå University (2012-201-31 M).

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Anatomic total shoulder arthroplasty (TSA) is a cost-effective and successful surgical intervention for patients with shoulder osteoarthritis (OA) complaining of persistent pain and disability in the absence of rotator cuff insufficiency. The main goals of TSA are to decrease pain and improve function. Most patients are satisfied after TSA. However, about 10% to 30% of TSA patients report persistent pain and suboptimal functional outcomes at long-term follow-up.[2,24,26,27] The absolute number of dissatisfied patients is expected to rise given the increase in the annual number of TSAs performed. Therefore, every effort should be made to investigate factors that possibly influence outcomes. Age, sex, primary diagnosis, prosthetic type, comorbidities, side dominance, and preoperative functional status are some of the variables that affect the postoperative outcome.[5,17]

The rotator cuff muscles have a key role in shoulder joint movements, strength, and stability. In OA, the rotator cuff is usually involved in a variable manner. Fatty infiltration (FI) and muscle atrophy (MA) are 2 pathologies that affect muscular performance. In severe cases, rotator cuff insufficiency may result in limited abduction ability of the shoulder and reverse TSA is indicated to compensate for this. However, in mild to moderate cases in which the rotator cuff's function is completely or partially maintained, anatomic TSA can be used. The influence of preoperative rotator cuff FI and MA on postoperative outcome has only rarely been investigated and reported in the literature. Lapner et al[15] studied FI and MA of the supraspinatus and infraspinatus muscles in TSA. The study showed a negative association between these variables and 1-year functional outcomes. To our knowledge, no other studies in the literature have addressed this issue.

The aims of this prospective study conducted in a cohort with primary unilateral shoulder OA treated with anatomic TSA were (1) to evaluate any correlation between preoperative supraspinatus and infraspinatus FI and MA and preoperative and 1-year postoperative shoulder abduction and external rotation range of motion (ROM) and strength and (2) to evaluate the influence of preoperative supraspinatus and infraspinatus FI and MA on 3-month and 1-year functional outcomes. We hypothesized that more FI and MA would be associated with a worse postoperative functional outcome.

Methods

This prospective cohort study was conducted at Sundsvall Teaching Hospital in Sweden between February 2014 and April 2016. All patients with primary OA of the shoulder treated with stemless TSA were considered for inclusion. Patients with secondary OA, contralateral TSA, or previous fracture or surgery of the operated shoulder and non-Swedish speakers were excluded. Informed consent was obtained from patients.

Within 6 weeks before the operation and at 3 months and 1 year after the operation, the functional status and ROM and strength for abduction and external rotation (ER) were measured. The short version of the Disabilities of the Arm, Shoulder and Hand questionnaire (QuickDASH) was used to assess functional impairment.[1,10,14,18]

An independent research nurse measured active ROM and isometric muscle strength for abduction and ER. ROM was measured using a 360° goniometer. Active ROM was measured under the instruction that patients should move their arm as far as they could. External rotation was measured in a neutral position with the shoulder adducted, the elbow flexed at a right angle, and the forearm in a neutral supination-pronation position. Abduction was measured in the seated-in-a-chair position at the scapular plane (abduction with 20°-30° of anterior elevation), as in ER, with the trunk upright. Once active end range was achieved, the measurements were documented.

Muscle strength was assessed using an IsoForceControl dynamometer (IFC; MDS Medical Device Solutions, Oberburg, Switzerland), which is considered by many investigators to be the gold-standard method of measurement.[12,13,16]

All patients were examined using a standardized shoulder computed tomography (CT) protocol[22] obtained on a computerized radiography system (Siemens, Erlangen, Germany). CT imaging was performed with the patient in the supine position and the arms by the side with the palms facing upward (anatomic position). One independent investigator performed the radiologic measurements to ensure objectivity.

FI was assessed on CT according to the Goutallier classification.[9] This classification system is based mainly on the percentage of fatty degeneration of the involved muscle. The grading increases in severity as follows: grade 0, normal muscle; grade 1, some fatty streaks; grade 2, less than 50% fatty MA; grade 3, 50% fatty MA; and grade 4, greater than 50% fatty MA (Figs. 1 and 2).

MA was evaluated according to the Warner atrophy grade.[28] The Warner classification comprises 4 grades describing atrophy as follows: no atrophy, the muscle completely fills its fossa and the outer contour is convex; minimal atrophy, the muscle's outer contour is flat compared with its fossa; moderate atrophy, the muscle's outer contour is concave into the fossa; and severe atrophy, the muscle is barely apparent in its fossa (Fig. 3). These grades were converted to a numerical scale (1, none, to 4, severe) for the purpose of statistical analysis.

Surgical technique

Stemless Zimmer Biomet Comprehensive implants (Warsaw, IN, USA) were used. Two shoulder surgeons performed all operations using an anterosuperior approach according to Mackenzie.[19]

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