J Shoulder Elbow Surg (2017) ■■, ■■–■■

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ORIGINAL ARTICLE

# Sonographic assessment of the subscapularis after reverse shoulder arthroplasty: impact of tendon integrity on shoulder function

**Nicolas J. Dedy, MD, PhD[a,*], Conor J. Gouk, MB BCh[b], Fraser J. Taylor, MBChB, FRACS[b], Michael Thomas, MB ChB, FRCS, FRACS[b], S.L. Ezekiel Tan, MB ChB, FRACS[b]**

[a]*Department of Plastic, Hand and Reconstructive Surgery, Krankenhaus Barmherzige Brüder Regensburg, Regensburg, Germany*

[b]*Department of Orthopaedic Surgery, Gold Coast University Hospital, Southport, QLD, Australia*

**Background:** The deltopectoral approach for reverse shoulder arthroplasty (RSA) requires subscapularis tenotomy or lesser tuberosity osteotomy. Whether the subscapularis should be repaired at the conclusion of the procedure remains controversial. The present study sonographically assessed the subscapularis after RSA and evaluated the effect of tendon integrity on functional outcome.

**Methods:** All patients who had undergone RSA in the Gold Coast University Hospital between 2005 and 2016 were included. Sonography was performed by a blinded examiner. Function was assessed using the Disabilities of the Arm, Shoulder and Hand, the Constant-Murley, and Oxford Shoulder scores. Internal rotation ability was recorded on a 6-point scale.

**Results:** The study included 43 patients (48 shoulders). Median length of follow-up was 19 months (range, 4-132 months). On sonography, the subscapularis was graded intact in 6 shoulders (13%), intact with mild attenuation in 16 (33%), severely attenuated in 15 (31%), and not intact or absent in 11 (23%). Differences in Disabilities of the Arm, Shoulder and Hand, Constant-Murley, or Oxford Shoulder scores between intact and attenuated or absent subscapularis shoulders were not significant. Internal rotation scores were significantly higher in the intact and mildly attenuated tendon group than in the absent tendon group ($U = 1.0$, $P = .001$ and $U = 28.5$, $P = .007$, respectively).

**Conclusions:** The present work is the first long-term outcome study of RSA using sonography to assess the subscapularis. Subscapularis integrity did not appear to have a measurable effect on patient outcome as measured by standard scores but was important for internal rotation ability after RSA.

**Level of evidence:** Level III; Retrospective Cohort Design; Treatment Study



**Keywords:** Shoulder; arthroplasty; reverse; subscapularis; internal rotation; sonography

Reverse total shoulder arthroplasty (RSA) is an established procedure for patients with rotator cuff tear arthropathy. Indications for RSA have recently been expanded to include irreparable rotator cuff tears with pseudoparalysis, comminuted proximal humeral fractures and fracture sequelae, and revision surgery. Despite good short-term and medium-term

The Gold Coast Health Service District Human Research Ethics Committee approved this study (HREC/15/QGC/301).

*Reprint requests: Nicolas J. Dedy, MD, PhD, Klinik für Plastische, Hand- und wiederherstellende Chirurgie, Krankenhaus Barmherzige Brüder Regensburg, Prüfeninger Str. 86, D-93049, Regensburg, Germany.

E-mail address: Nicolas.dedy@gmx.de (N.J. Dedy).

1058-2746/$ - see front matter © 2017 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
https://doi.org/10.1016/j.jse.2017.12.008

results of RSA, the risk of intraoperative and postoperative complications remains higher than that of anatomic shoulder arthroplasty, and the functional outcome is inferior to that of anatomic total shoulder replacement.[5]

The most common surgical approach for RSA uses the deltopectoral interval requiring subscapularis tenotomy or osteotomy of the lesser tuberosity. Whether the subscapularis tendon should be repaired at the conclusion of RSA implantation remains controversial. An argument in favor of subscapularis repair is its role in shoulder internal rotation, which is critical for many activities of daily living, such as tucking in a shirt in the back of the pants.[14]

A further reason to repair the subscapularis after RSA is a potential role in stability of the arthroplasty. Instability and dislocation are among the most common early postoperative complications and have been reported to occur in an average of 4% of cases.[4,5,8] Conversely, Clark et al[5] could not find an effect of subscapularis repair on dislocation risk, range of motion, or pain. A recent study of RSA outcomes comparing shoulders with and without subscapularis repair by Friedman et al[9] demonstrated significantly higher scores on a variety of outcome measures in the subscapularis repair group.

A major limitation of all clinical studies examining the role of subscapularis in RSA is the lack of an objective measure of tendon integrity. Previous studies relied on operative notes to determine whether the subscapularis tendon was repaired at the conclusion of the procedure.[5,8,9] Sonography has been used as an objective method to assess subscapularis integrity after anatomic shoulder arthroplasty.[2,3,12,17] Thus, the purpose of the present study was to assess subscapularis integrity after RSA using sonography and to evaluate the effect of tendon integrity on shoulder function and patient outcome.

## Materials and methods

### Recruitment

We used a database to identify 67 consecutive patients who had undergone RSA at Gold Coast University Hospital between 2005 and 2016. An a priori sample size calculation was performed using the G*Power 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to detect a difference of 10 points in the Constant score between patients with intact and deficient subscapularis tendons. For a power of $1 - \beta = 0.8$, a level of significance of $\alpha = 0.05$, and with an estimated standard deviation of 10, the required sample size was calculated as 17 in each group. The available cohort was thus deemed sufficient to examine the research question while accounting for nonresponders and dropouts. All patients signed informed consent upon enrollment.

### Inclusion and exclusion criteria

All patients who had undergone RSA in the observation period were eligible for inclusion, except patients who received RSA for fracture treatment. Patients with severe disabilities that precluded the completion of the physical examination were excluded after identification from the database.

### Clinical examination

Patient outcome was assessed by the Disabilities of the Arm, Shoulder and Hand (DASH),[11] Constant-Murley,[6] and Oxford Shoulder scores.[7] Internal rotation ability was scored on a 6-point ordinal scale based on the Constant-Murley score, with 1 being the lowest score (hand positioned at lateral thigh) and 6 the highest score (hand placed behind back at interscapular level).[6] Similarly, external rotation ability, lateral elevation, and forward flexion were assessed using the ordinal scales provided by the Constant-Murley scoring system.[6]

### Implants and surgical technique

Operative notes, when available, were screened for the approach used to take down the subscapularis, implant type, and method of refixation if the subscapularis was repaired at the conclusion of the procedure.

### Sonography

Ultrasound examinations were conducted with a variable frequency linear transducer by a single experienced examiner who was blinded to the results of the clinical examination. The bicipital groove was used as an anatomic landmark to identify the subscapularis tendon. Dynamic examinations were performed in internal and external rotation and included visualization of the subscapularis in the transverse and longitudinal planes to assess tendon integrity. Integrity was graded as intact, attenuated, or absent, as previously described.[3,17] The attenuated group was further subdivided into mild attenuation (ie, tendons with minimal or no thinning but a hypoechoic signal) and severe attenuation (ie, thinning of >50% compared with a normal rotator cuff tendon).[3] A ruptured tendon was defined as a tendon that could not be visualized with dynamic examination or had a visible defect with retraction of the proximal tendon or muscle belly.[16]

### Statistics

Data were analyzed using IBM SPSS Statistics 20 software (IBM Corporation, Armonk, NY, USA). Data were tested for normality of the distribution by the Shapiro-Wilk test. The level of significance for a 2-tailed test was defined as $\alpha = 0.05$. Data are reported as medians and interquartile ranges unless stated otherwise.

## Results

Of the 67 patients that were eligible for inclusion in the study, 9 had died and 15 were unable to come for follow-up for other reasons, mainly because of having relocated to another state or country. In 1 patient with bilateral RSA, 1 shoulder was excluded because the respective upper extremity was paralyzed secondary to a stroke. Overall, 43 patients (48 shoulders) were included in the analysis. There were 28 women (58%) and 32 right shoulders (67%). The average patient age at the time of the study was 78 years (range, 66-88 years).