

# Preoperative NSAIDs, non-acute onset and long-standing symptoms predict inferior outcome at long-term follow-up after rotator cuff repair

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Received: 15 June 2015 / Accepted: 22 October 2015 / Published online: 31 October 2015  
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## Abstract

**Purpose** To evaluate mid- to long-term results after arthroscopic rotator cuff repair and to explore possible predictors of inferior outcome.

**Methods** Patients treated for full-thickness supraspinatus and/or infraspinatus tears from 2004 to 2008, using a uniform single-row arthroscopic technique, were included in the study. Pre- and post-operative *QuickDASH* were used as the primary outcome measure, and VAS of pain, function and satisfaction were also collected. An additional questionnaire explored demographic and preoperative factors like onset and duration of symptoms, preoperative treatment and smoking habits.

**Results** One hundred and forty-seven patients (82 %) were available at 6–9 years after surgery. All outcomes improved significantly from the preoperative values. A total of 8 % of patients had undergone additional surgery to the same shoulder during the follow-up period. Long-standing symptoms (>12 months) ( $P < 0.01$ ), non-acute onset of symptoms ( $P < 0.01$ ) and preoperative use of NSAIDs ( $P = 0.01$ ) were correlated with inferior outcome at follow-up. No other factors investigated (i.e. gender, age, smoking and steroid injections) were found to affect the primary outcome (*QuickDASH*).

**Conclusion** The current study is one of few reports of mid- to long-term outcomes after arthroscopic single-row

repair of full-thickness rotator cuff tears. Global improvement in symptoms and function was found between the preoperative and the 6–9 years evaluation, and the technique therefore seems like a viable approach for treating tears of the supra- and the infraspinatus tendon. Several predictors of inferior long-term outcome after rotator cuff repair were, however, identified: preoperative use of NSAIDs, long-standing symptoms before surgery and non-acute onset of shoulder symptoms. In light of the current findings, accurate diagnosis and prompt treatment seem important in optimizing outcomes after rotator cuff surgery.

*Level of evidence* IV.

**Keywords** Rotator cuff repair · Arthroscopic rotator cuff repair · Long-term outcome · Single-row

## Introduction

Conditions related to the rotator cuff tendons are a major cause of disabling shoulder problems in the adult population [7, 28, 30]. For some patients, a non-operative treatment regime that may include NSAIDs, steroid injections and non-operative rehabilitation will reduce pain and improve function sufficiently [1, 4, 5, 20, 31]. Other patients need surgical intervention to regain proper shoulder function. An ongoing debate has yet to resolve what patient characteristics predict better outcomes for the different treatment options [6, 20, 22, 29]. Patient's age, smoking status, tear size, localization and chronicity of the tear are amongst the factors that may be important for decisions about the type of treatment [21, 24, 26, 34, 39].

Arthroscopic rotator cuff repair has become one of the most common surgical procedures performed by orthopaedic surgeons. A study from NHS (National Health Service,

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UK) showed an increase in such repairs from approximately 4–40 patients per 100,000 over the last decade [16]. In the same time period, the USA has seen a similar rise, by about 141 % from 1996 to 2006 [10]. The surgical treatment comes with substantial costs as well as an increased risk of complications related to the surgery (as opposed to a non-operative treatment)—therefore, critical evaluation of the surgical approach seems warranted. The majority of published studies evaluate the patients' short- to midterm outcome after treatment—there is therefore a substantial need for more long-term results to find the true effect after intervention in patients with rotator cuff tear [38].

Thus, the aim of the present study was to evaluate the mid- to long-term results after arthroscopic rotator cuff repair. Further, we wanted to explore for preoperative factors that could predict inferior result at the outcome evaluation. The hypotheses were (1) that surgical repair would improve function and provide good long-term outcome and (2) that patient demographics and preoperative history would make it possible identify a subset of patients with inferior outcome.

## Materials and methods

All patients treated surgically—by suture anchors in single row—for a symptomatic, repairable, transverse full-thickness rotator cuff tear of the supraspinatus and/or infraspinatus tendon in the period from 2004 to 2008 at our institution were eligible for inclusion in the study. Tears requiring side-to-side sutures and/or a margin convergence technique were not included, and all revision surgery was also excluded. All surgeries were performed as day-case procedures by the senior author.

At the time of surgery, the patients reported, on a standardized questionnaire, what type of preoperative treatment they had received (non-operative rehabilitation or exercises, drugs or other treatment modalities), their current work status, sick leave (and duration of such), smoking status, duration of symptoms and characteristics of their initial symptoms (acute or insidious debut). At the follow-up evaluation, patients were again asked to report on their work status.

## Outcome measures

The primary outcome measure was the disabilities of the arm, shoulder and hand outcome measure (DASH). Data were collected at the time of surgery and at the time of follow-up. The *QuickDASH* 11-item disability/symptom subset was used [3]. Each answer was graded from 0 to 4. The component total score, from 0 to 100, was calculated by multiplying the average score by 25. A higher score

indicates greater disability. Outcome by *QuickDASH* was rated as excellent (<20 points), good (20–39 points), fair (40–60 points) or poor (>60 points) [32].

VAS of pain (0 = no pain, 100 = worst possible pain) and VAS of function (0 = useless, 100 = perfect function) were included as secondary outcomes at both times of evaluation [33]. In addition, a VAS of satisfaction with the result of the treatment (0 = very dissatisfied, 100 = very satisfied) was included at the final follow-up evaluation [18, 29, 37].

## Surgical technique

Except for a few patients with an acute onset and severe symptoms, all patients were required to undergo a minimum of 3 months of physiotherapy and a home exercise programme before being considered for surgery. All surgeries were done arthroscopically assisted with a posterior approach for visualization and additional lateral and anterior portals as needed for instrumentation. A diagnostic glenohumeral arthroscopy was performed before switching into the subacromial space. The subacromial bursa was debrided using a soft tissue resector and a radiofrequency probe—and the rotator cuff was inspected. Thereafter, a wedge-shaped moderate acromioplasty was performed to relieve the rotator cuff of any mechanical symptoms.

A debridement of the footprint on the tuberculum majus was performed to facilitate tendon healing. The mobility of the ruptured tendon(s) was assessed prior to repairing the rotator cuff. The repair was performed with one-to-four titanium screw anchors (Fastin RC, Depuy Synthes, Raynham, USA), depending on the size of the tear. Post-operatively patients used a sling for 6 weeks. They were instructed in passive range of motion exercises and moved on to active exercises after 6 weeks guided by a physiotherapist. The Ethical Committee at our institution reviewed and approved of the study (Teres Bergen ID 2010-0110). All patients gave their informed consent prior to their inclusion in the study.

## Statistical analysis

All data handling and statistical analysis were performed in SPSS 21.0.0.0 (SPSS Inc., Chicago, IL, USA). The a priori significance level was set to 0.05. Due to a skewness of the outcome data BCa bootstrap confidence intervals based on 10,000 bootstrap replications were used to estimate mean group differences. Further, independent samples *t* test was used when testing for inter-group differences in *QuickDASH* sorted by; gender, smoking status, above/below 60 years of age, acute onset of symptoms, preoperative NSAID treatment and preoperative cortisone injections. ANOVA testing was used for examination of differences in duration of symptoms before surgery and function stratified by the preoperative *QuickDASH* score. A post hoc power

**Table 1** Demographic data of the study group

	<i>n</i> = 147
Female gender (%)	39.7
Right shoulder treated (%)	72.1
Mean age at surgery (years)	58.4
Mean length of symptoms at surgery (months)	34.1
Available at follow-up evaluation (%)	82.1
Acute onset of symptoms leading to surgery (%)	43.8

**Table 2** Functional assessment before surgery and at 6–9 years after the cuff repair

	Preoperative assessment	Follow-up evaluation	<i>P</i> value <sup>a</sup>
Mean <i>QuickDASH</i> score	50.9 (SD 19.8)	14.4 (SD 18.5)	0.00
Mean VAS function	33.0 (SD 23.7)	83.5 (SD 21.4)	0.00
Mean VAS pain	64.8 (SD 22.0)	14.7 (SD 22.1)	0.00
Mean VAS satisfaction		86.1 (SD 21.3)	

All tests used bootstrapping with 10,000 samples and a stratified sampling mode

<sup>a</sup> Paired samples *t* test

**Table 3** Post-operative *QuickDASH* scores related to preoperative treatment

	Received	Not received	<i>P</i> value <sup>a</sup>
Steroid injections	18 (SD 21)	13 (SD 17)	n.s.
NSAIDs	19 (SD 19)	6 (SD 17)	0.01

All tests used bootstrapping with 10,000 samples and a stratified sampling mode

<sup>a</sup> Paired samples *t* test

calculation showed that with a total sample size of 147 patients, using a significance level of 0.05 and a SD of 20, the statistical power for detecting a minimal difference of 10 points in *QuickDASH* was 87 %.

## Results

Of the 180 patients included in the study, 147 (82 %) were available for follow-up and were therefore evaluated at a mean of 7.5 (SD 1.1) years after the surgery. Demographic data are presented in Table 1. The length of the rotator cuff tear was found to be less than 1.5 cm in 9 % of patients, 1.5–2.5 cm in 68 % of patients and larger than 2.5 cm in 23 % of patients. One suture anchor was used for the repair in 77 % of patients and two or more in 23 %.

## Secondary operations and complications

Twelve patients (8 %) underwent a new arthroscopic procedure to the same shoulder during the observation period

due to a poor result. In eight cases, the rotator cuff tear was not healed (or a new tear had occurred); six of these had a new repair performed whereas two were considered irreparable. In three cases capsular release was performed to treat a long-standing post-operative frozen shoulder. In the last patient an acromioplasty was undertaken. Twenty-two patients (15 %) reported having experienced transient post-operative stiffness; four patients (2 %) had been treated for a superficial infection, while none had been treated for a deep infection.

## Clinical outcomes

All outcome variables were found to improve significantly from preoperative evaluation to the long-term follow-up (Table 2). The mean *QuickDASH* did improve from 51 (SD = 20) to 14 (SD = 19, *P* = 0.001), the mean VAS function improved from 33 (SD = 24) to 84 (SD = 21, *P* = 0.001) and the mean VAS pain improved from 65 (SD = 22) to 15 (SD = 22, *P* = 0.001).

## Predictors of long-term outcome

When comparing mean *QuickDASH* scores, neither gender, age above or below 60 years at time of surgery (49 % above 60), nor smoking habits (23 % smokers) were found to have any statistical significant differences (n.s.). Forty-four per cent of the patients reported to have an acute onset of their shoulder-related symptoms. This group was found to have significant better post-operative *QuickDASH*, mean 9 (SD 14) versus 18 (SD 20, *P* = 0.008), as compared to those with gradual onset of symptoms.

Outcomes (as reported in *QuickDASH* scores) related to preoperative use of steroids or NSAIDs are reported in Table 3. There was no difference (n.s.) in symptom's duration between patients who received NSAIDs and those who did not. Neither was there any such difference (n.s.) between patients who had received steroids or not.

When analysing the post-operative *QuickDASH* dependent on the duration of symptoms before surgery, there was a clear trend towards worse outcomes in groups with long-standing symptoms (12–24 months and above 25 months)

**Table 4** Function and outcome related to symptom duration at time of surgery (months)

	0–6 (27 %)	7–12 (21 %)	13–24 (21 %)	25 + (31 %)	P value <sup>a</sup>
Preoperative median DASH	50.3	50.0	48.0	55.1	n.s.
Post-operative mean DASH	8.0	10.5	13.0	25.2	0.000

All tests used bootstrapping with 10,000 samples and a simple sampling mode

<sup>a</sup> Analysis of variance (ANOVA)

**Table 5** Outcome at follow-up related to *QuickDASH* at time of surger

	Excellent (8 %)	Good (19 %)	Fair (33 %)	Poor (40 %)	P value <sup>a</sup>
Post-operative mean DASH	2.5	6.3	15.3	20.7	0.002

All tests used bootstrapping with 10,000 samples and a simple sampling mode

*Poor* if 61 or above, *fair* if 41–60, *good* if 21–40, *excellent* if 20 or below

<sup>a</sup> Analysis of variance (ANOVA)

(Table 4). When comparing the post-operative results to preoperative function graded by *QuickDASH* as poor, fair, good or excellent (Table 5), those with a poor preoperative score (61 and above) had the worse outcome.

## Discussion

The most important finding of the current study was the overall improvement in *QuickDASH*, VAS of pain and VAS of function from the preoperative evaluation to the long-term follow-up. Gradual onset, long history of symptoms and the use of NSAIDs predicted worse outcome in the patient population. Other potential preoperative predictors—like smoking, gender, age above/below 60 or preoperative steroid injections—were not found to correlate with an inferior outcome at the final evaluation.

There are relatively few long-term evaluations reporting on results after single-row rotator cuff repair, and to the best of our knowledge, the current study includes the largest number of patients to date. In a recent paper by Spennacchio et al. [37], a comprehensive review of 10 studies evaluating rotator cuff repair including a total of 483 patients was performed. The follow-up time spanned from a mean of 60–162 months, and the number of patients ranged from 26 to 115. Most patients were treated with a single-row technique, as in the current study, but some also had a mix of single- and double-row or other techniques. The type of rotator cuff lesions were heterogeneous, spanning from less severe PASTA lesions to full-thickness tears

including subscapularis tendon tears. Evaluation was performed by a variety of outcome measures [i.e. American Shoulder and Elbow score (ASEAS), University of California, Los Angeles Score (UCLA), SF-36 (Short-Form version 36) and visual analogue score (VAS)]. Two of the studies evaluated the patency of the rotator cuff repair by means of ultrasound (US) [17, 27].

Of the studies included in the review, only the one by Gulotta et al. [17, 27] seems to have a patient population comparable to that in the present study. The healing rate was reported to be 81 % as seen on the ultrasound investigation. Unfortunately, comparison across the studies is hard since none of the other outcome parameters were alike those used on the current patient population. As summarized in the review by Spennacchio, only 16 of 483 patients (3.3 %) had undergone new surgery to the same shoulder. This is less than the 12 out of 148 (8 %) who had performed new surgery in the present patient population. Aside from difference in follow-up time, variations in the policy of re-operations, socioeconomic factors (i.e. cost of health care and accessibility of non-operative treatment) and surgeons experience with re-operations might influence such differences. The heterogeneity of patient groups and differences in methods of evaluation make direct comparison across studies difficult—there is certainly a need for more patient evaluations reporting on the “true outcome” after rotator cuff repair.

A recent systematic review by Fermont et al. [12] pointed out four categories of prognostic factors that are viable in predicting patient outcomes after rotator cuff surgery. Along with demographic factors (older age, female gender) and concomitant diseases (diabetes mellitus, obesity and reduced level of activity)—morphological factors (bigger rotator cuff tears, high level of fatty infiltration) and concomitant surgical intervention of the biceps tendon or the acromioclavicular joint would be related to an inferior outcome. The current finding of inferior outcome in patients with long-standing symptoms and non-acute onset of their symptoms has, to our knowledge, rarely been reported. It is, however, well established that the ruptured supra- or infraspinatus tendon does degenerate with time and that fatty tissue will replace viable muscle [14, 23]. Although it has been found that proper surgical repair can partially reverse muscular atrophy and fatty infiltration, it is likely that there will be some irreversibility with advanced

degeneration [40]. The current finding of inferior results with chronicity of symptoms is therefore not surprising.

Another highly notable result from the current population is the significant (in all outcome variables) lower post-operative score in patients who have used NSAIDs prior to the surgery. One could think that the severity of the disease—expressed by pain and symptoms prior to surgery—and thereof use of NSAIDs could be a possible confounding factor. When examining for such a relation, we were not able to find any difference in preoperative DASH score, VAS of pain and VAS of function. Neither was there any difference in duration of symptom in patients that received preoperative NSAIDs compared to the group that did not. Thus, the use of anti-inflammatory drugs probably did not delay any surgical treatment.

According to a review by Chen et al. [8], there are currently no patient-level studies investigating the effect of NSAIDs on soft tissue to bone healing. Former research has been performed in experimental rat models with a focus on the effect on tendon-to bone healing in the post-operative period [9, 11, 13]. The only study investigating rotator cuff healing was performed by Cohen et al. [9] on 180 rats that were examined at 2, 4 and 8 weeks after rotator cuff repair. There was significantly less organized collagen and lower load-to-failure at 4 and 8 weeks after the repair. The interpretation of such experimental results, as, stated by Chen, is that NSAIDs should be used prudently until more human clinical trial are performed [8].

In the present study, *QuickDASH* and VAS of function, VAS of pain and VAS of satisfaction has been used as outcome measures. The visual analogue scale is conventionally used in post-operative evaluations, also including rotator cuff repair [2, 15, 19, 36]. It has been validated for measuring chronic and experimental pain and has its ease in the quick and straight forward administration [33]. *QuickDASH* is an 11-item shortened and validated version of the more comprehensive DASH [3]. As compared to DASH, the condensed version has been found to have good reliability in evaluating shoulder-related diseases [25]. There are, however, only a handful of studies involving shoulder surgery, and only one involving rotator cuff repair that have utilized the score [35]. In 170 patients undergoing repair with or without acromioplasty Razmjou et al. found a preoperative mean *QuickDASH* of 44.6 and 6 months post-operative mean score of 19. The findings are not unlike those of the current study (50.9 preoperative and 14.4 at median 7-year follow-up). Although the follow-up time is non-comparable, it is interesting to see that a major improvement in the subjective score is observed within the initial 6 months after surgery—and perhaps less so after that time. A cohort of patients evaluated at constant intervals after surgery would have given a more profound insight into the convalescence after rotator cuff repair.

There are several limitations to the current study. First, if a control group receiving non-operative treatment had been included that would have revealed any potential difference in outcome between the operative and non-operative treatment modalities. Secondly, a more comprehensive evaluation of outcome would include radiological and clinical evaluation—including evaluation of range of motion and muscular function. When such evaluation has not been performed, there is a risk that some patients are “adapters” in the sense that they accept their reduced level of function and therefore report a more satisfying result than would objectively be found. A third limitation is the lack of reporting on patients who did not receive surgical treatment for their rotator cuff tear. The current study presents results from the largest follow-up evaluation of rotator cuff suture yet published. Other strengths include a uniform surgical technique and a good follow-up rate of over 80 % of the included patients, which is rare in clinical studies with extended follow-up evaluations.

## Conclusion

An overall improvement was seen in the outcomes at 6–9 years after single-row arthroscopic rotator cuff repair of full-thickness rotator cuff tears—indicating a good clinical effectiveness over time. Gradual onset, long history of symptoms and the use of NSAIDs predicted worse outcome in the rotator cuff repair group, whereas age, gender and smoking status do not seem to be of importance for the outcome. The current study adds to the debate of NSAIDs usage in some certain shoulder-related diseases.

## Compliance with ethical standards

**Conflict of interest** No conflict of interest reported from any of the authors.

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