JSES International 4 (2020) 85–90

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Associations between shoulder symptoms and concomitant pathology in patients with traumatic supraspinatus tears

Birgitte H. Kjær, PhD, PT [a,b,*], Birgit Juul-Kristensen, PhD, PT [b], Susan Warming, PhD, PT [a], S. Peter Magnusson, PhD, PT [a,c,d], Michael R. Krogsgaard, PhD, MD [e], Eleanor Boyle, PhD [b], Marius Henriksen, PhD, PT [a,f]

[a] Department of Physical and Occupational Therapy, Copenhagen University Hospital, Bispebjerg and Frederiksberg, Copenhagen, Denmark
[b] Department of Sports Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark
[c] Department of Orthopaedic Surgery, Institute of Sports Medicine, Copenhagen University Hospital, Bispebjerg and Frederiksberg, Copenhagen, Denmark
[d] Center for Healthy Aging, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark
[e] Section for Sports Traumatology, Department of Orthopaedic Surgery, Copenhagen University Hospital, Bispebjerg and Frederiksberg, Copenhagen, Denmark
[f] The Parker Institute, Copenhagen University Hospital, Bispebjerg and Frederiksberg, Frederiksberg, Denmark

ARTICLE INFO

Keywords:
Rotator cuff pathology
supraspinatus tears
concomitant pathology
shoulder injuries
surgical rotator cuff repair
shoulder pain and disability
Western Ontario Rotator Cuff Index
numeric pain rating scale

Level of evidence: Level III; Cross-Sectional Design; Epidemiology Study

Background: The association between concomitant pathologic characteristics and preoperative symptoms in patients identified as eligible for surgical rotator cuff repair has been sparsely evaluated. The purpose was to explore the associations between preoperative shoulder symptoms and additional structural pathology or injuries identified during surgery in patients with traumatic supraspinatus tears.
Methods: This was a cross-sectional study including patients with traumatic supraspinatus tears. Preoperatively, patients reported pain and disability using a numeric pain rating scale from 0 to 10 and the Western Ontario Rotator Cuff Index. During surgery, the presence of prespecified structural injuries and pathologies including a full-thickness or partial supraspinatus tear, infraspinatus tear, subscapularis tear, hooked acromion, acromioclavicular joint osteoarthritis, biceps tendon pathology, labral tear, and cartilage lesion was recorded. Linear regression and analysis of covariance were used to assess associations.
Results: A total of 87 patients (52 male patients, 60%) were included (mean age, 60 years; standard deviation, 9.2 years). Of these patients, 69 (79%) had a full-thickness supraspinatus tear and 18 (21%) had a partial-thickness tear. Concomitant structural pathology was found in 79 patients (91%). No association was found between the number of structural shoulder pathologies and preoperative numeric pain rating scale or Western Ontario Rotator Cuff Index score, and no particular concomitant pathology was associated with worse patient-reported symptoms.
Conclusion: Pathology of the infraspinatus and subscapularis and other structural joint pathologies concomitant with supraspinatus tears were not correlated with preoperative self-reported pain and disability in patients scheduled to undergo rotator cuff surgery, suggesting that concomitant pathology adds little to the symptoms in patients with a traumatic supraspinatus tear.

Traumatic rotator cuff (RC) tears, including supraspinatus tears, are a common condition associated with significant physical disability, pain, and reduced shoulder muscle strength.[6,10,20] RC tears typically occur owing to an extrinsic trauma in relation to sports or physical activity[10] or because of degenerative changes.[30] A traumatic or acute tear is defined as a tear occurring as a result of a clearly identified traumatic incident, leading to a sudden onset of symptoms, together with verified findings on clinical examination, imaging, and arthroscopy.[14] Current clinical guidelines recommend surgery followed by supervised rehabilitation for patients with full-thickness traumatic RC tears.[3,15] However, precise identification of patients eligible for surgical RC repair is challenging because the clinical presentation of RC tears varies.

The Health Research Ethics Committee for the Capital Region of Denmark (no. H-16033995) and the Danish Data Protection Agency (no. 2012-58-0004) approved the randomized controlled trial on which this secondary analysis was based.

* Corresponding author: Birgitte H. Kjær, PhD, PT, Department of Physical and Occupational Therapy, Copenhagen University Hospital, Bispebjerg and Frederiksberg, Bispebjerg Bakke 23, DK-2400 Copenhagen, NV, Denmark.
E-mail address: birgitte.hougs.kjaer@regionh.dk (B.H. Kjær).

https://doi.org/10.1016/j.jses.2019.11.001

To identify whether symptoms originate from the RC tear, clinicians often rely on clinical tests (painful arc, Jobe test, Neer test, Hawkins test, and so on) that have poor to fair clinimetric properties[12] and insufficient diagnostic precision.[11] Therefore, the diagnosis of a RC tear is often supplemented with imaging techniques (magnetic resonance imaging [MRI] or ultrasound [US]) with sensitivity and specificity above 90%.[29] The use of US or MRI examinations coupled with observations made during surgery has shown that several injuries and/or pathologies commonly coexist.[27,32] In traumatic RC tears, structural injuries may include biceps pathology (eg, superior labrum anterior-posterior lesion), labral tears, and cartilage lesions, and pathologies may include a hooked acromion or acromioclavicular (AC) joint pathology.[7,9] However, to which extent these concomitant injuries and pathologies influence symptoms is unclear.[23]

Previous studies on both traumatic and nontraumatic RC tears have shown partly opposing results, as some studies found associations between symptoms and tear size, biceps pathology, and fatty degeneration[26,34] whereas others did not find associations between symptoms and tear size, biceps pathology, and the presence of bursitis.[2,8,19] No studies have included concomitant pathologies and injuries, such as acromial, AC joint, labral, or cartilage lesions. Therefore, the overall purpose of this study was to explore the associations between shoulder symptoms in the form of preoperative shoulder pain and disability and the extent of structural pathology identified during surgery in patients undergoing arthroscopic repair of anticipated traumatic full-thickness supraspinatus tears. It was hypothesized that supraspinatus tears and concomitant structural pathologies would be positively associated with worse preoperative shoulder pain and disability.

Materials and methods

Study design and participants

This was a secondary analysis of data collected during an ongoing randomized controlled trial (RCT).[18] Data were collected from participants who met the preoperative inclusion and exclusion criteria in the parent RCT evaluating the effect of progressive and early rehabilitation after surgical RC repair (https://clinicaltrials.gov/ct2/show/NCT02969135).[18] The inclusion criteria in the present study were as follows: patients aged 18 years or older, patients with a clinical and paraclinical (MRI or US) diagnosis of traumatic supraspinatus tear (the injury mechanisms included falling on outstretched arms from a standing height, direct shoulder trauma from falling from a standing height or above, traumatic shoulder dislocations, and passive traction forces) without previous shoulder symptoms, and patients scheduled to undergo surgical RC repair. The exclusion criteria were nontraumatic supraspinatus tears; prior shoulder surgery; or a clinical diagnosis of glenohumeral osteoarthritis, rheumatoid arthritis, or periarthrosis of the shoulder. The recruitment period was the first 20 months of inclusion for the RCT.

Participants were recruited from 2 hospitals in Copenhagen, Denmark: Copenhagen University Hospital, Bispebjerg and Frederiksberg (Section for Sports Traumatology, Department of Orthopaedic Surgery), and Copenhagen University Hospital, Herlev and Gentofte (Shoulder-Elbow Unit). Informed consent was collected from all included participants, and the study was conducted in accordance with Danish law and the principles and ethical standards of the 1964 Declaration of Helsinki.[33]

Data collection

Baseline characteristics, patient-reported shoulder pain and disability, and information from surgery reports[18] were collected using the Procordo Research Platform (Procordo, Copenhagen, Denmark), which is an electronic online data trial management system (www.procordo.com).

Patient-reported pain and disability

Patients reported information about pain and disability using questionnaires in a Web-based survey form between 1 and 14 days before surgery. Shoulder pain was assessed using the question "How do you perceive your worst/maximum pain during the past 24 hours?" Participants answered by marking a numeric pain rating scale from 0 to 10,[4,25] with anchors of "no pain" (0) and "worst imaginable pain" (10).

As a measure of shoulder disability, we used the physical symptoms subscale of the Western Ontario Rotator Cuff Index (WORC).[17] The WORC is a self-administered questionnaire developed to measure health-related quality of life in patients with RC disorders. It consists of 21 items distributed in 5 domains: physical symptoms (6 items), sports and recreation (4 items), work (4 items), lifestyle (4 items), and emotions (3 items). Each item is scored on a 100-mm visual analog scale; the item scores are then summed to determine the score for each domain, with a higher raw score indicating poorer condition. The physical symptoms subdomain score was calculated by inverting the raw score and converting it into a percentage score ranging from 0% (worst possible) to 100% (best possible).[17,21] The other 4 subdomains—sports and recreation, work, lifestyle, and emotions—are not reported in this study. We used a translated and cross-culturally adapted Danish version that has been found valid in a general shoulder patient population, including RC patients.[1]

Structural pathologies identified during arthroscopy

The surgeons identified and then used a prespecified list of common pathologies of the shoulder to describe the surgical findings. The list included a partial supraspinatus tear, full-thickness supraspinatus tear, infraspinatus tear, subscapularis tear, hooked acromion (type 3), AC joint osteoarthritis, biceps tendon pathology (tear of the long head of the biceps, partial tear, or tendinosis), labral tear, and cartilage lesion.

Statistical analysis

The study population was described with the mean, minimum, maximum, and standard deviation for continuous data. Full- and partial-thickness supraspinatus tears were merged into 1 supraspinatus tear variable (dependent variable). To analyze whether the total number of concomitant structural pathologies (count, as a continuous variable) was associated with preoperative patient-reported measures, a standardized linear regression analysis was performed with the patient-reported measures (numeric pain rating scale score and WORC physical symptoms subscale score) as dependent variables and the number of concomitant pathologies as the predictor and/or independent variable (analysis 1). We grouped the participants according to the extent of concomitant pathologies into 3 categories defined a priori: isolated supraspinatus tear (ie, no concomitant pathology), supraspinatus tear with 1 concomitant pathology, or supraspinatus tear with 2 or more concomitant pathologies. Differences in patient symptoms between these groups of participants were analyzed using analysis of covariance adjusted

Table I
Demographic and pathologic characteristics of participants with supraspinatus tears (N = 87)

Characteristic	Mean or n (%)	SD	Minimum	Maximum
Age, yr	60	9.2	39	79
Male	52 (60)			
Height, cm	174	10	149	190
Weight, kg	82	18.8	48	148
BMI, kg/m^2	27	4.6	18	41
Dominant side affected	58 (67)			
WORC physical symptoms subscale score, %	50.1	22.0		
Pain intensity (NPRS from 0-10)	6.95	2.5		
Structural pathology found at arthroscopy				
Full supraspinatus tear	69 (79)			
Partial supraspinatus tear	18 (21)			
Infraspinatus tear	26 (30)			
Subscapularis tear	15 (17)			
Hooked acromion	58 (67)			
AC joint arthrosis	15 (17)			
Biceps tendon pathology	27 (31)			
Cartilage lesions	3 (3)			
Labral pathology	2 (2)			
No. of concomitant pathologies in addition to supraspinatus tear				
0	8 (9.2)			
1	32 (36.8)			
2	30 (34.5)			
3	15 (17.2)			
4	1 (1.1)			
5	1 (1.1)			

SD, standard deviation; *BMI*, body mass index; *WORC*, Western Ontario Rotator Cuff Index; *NPRS*, numeric pain rating scale (worst pain past 24 hours); *AC*, acromioclavicular.

for age, sex, body mass index (BMI), and hand dominance with post hoc Bonferroni comparisons (analysis 2). To analyze whether 1 particular pathology in combination with the supraspinatus tear (total or partial) was associated with patient symptoms, linear regression analyses were performed with patient symptoms as dependent variables and the presence of each of the structural pathologies as predictors. We tested the association between patient symptoms and supraspinatus tears by adding each of the structural pathologic variables stepwise to the full model (all variables). General patient characteristics (eg, age, sex, BMI, and hand dominance)[24] were considered covariates, and the analyses were repeated with adjustment for these.

No sample size calculation was conducted because of the exploratory nature of the study. The level of significance was set at 5% ($P = .05$), and all analyses were performed using IBM SPSS Statistics software (version 25; IBM, Armonk, NY, USA).

Results

In total, 87 participants were included in the study. The average age was 60 years (range, 39-79 years), and 60% of the participants were men. Of the participants, 79% had a full-thickness supraspinatus tear whereas 21% had a partial-thickness supraspinatus tear (Table I). The prevalence of concomitant structural pathology was 91% (Table I). The participants most frequently had 1 concomitant pathology (32 participants, 36.8%) or 2 concomitant pathologies (30 participants, 34.5%) (Table I). The most frequent concomitant structural pathologies were a hooked acromion (type 3) (67%) and biceps pathology (31%), and the most frequent additional tendon pathology was an infraspinatus tear (30%) (Table I). The most common combination of concomitant pathologies was a hooked acromion (type 3) (67%) with an infraspinatus tear (28% of the 67%). As the prevalence of cartilage and labral pathologies was only 3% and 2%, respectively, these pathologies were not included in the linear regression analyses.

No statistically significant association was found between the number of structural shoulder pathologies and preoperative patient symptoms in the standardized linear regression analysis (Table II). Neither did analysis of covariance adjusted for age, sex, BMI, and hand dominance yield any association between the number of structural shoulder pathologies (3-level category) and preoperative patient symptoms (Table III).

We found that no single pathology in combination with the supraspinatus tear was associated with worse patient symptoms except for a possible association of infraspinatus involvement and increased disability on both univariate and multiple regression analyses. However, the association was not statistically significant when we adjusted for possible confounders (Table IV).

Discussion

This study found no association between concomitant structural shoulder pathologies in conjunction with supraspinatus tears and symptoms (patient-reported pain and disability), in terms of either the number of pathologies or the type of pathology. This finding indicates that the physical disability and pain perceived by patients with traumatic supraspinatus tears is unrelated to specific structures.

Recent studies have increased the awareness of concomitant shoulder pathologies in patients with RC tears because it is common to regard the occurrence of such pathologies as an indicator of the severity of the condition in surgical decision making.[9,32] Our results are in line with earlier findings of no association between tear size and symptoms[5,8] or between tear size and patient-reported pain and disability in patients with RC tears undergoing operative and nonoperative treatment.[2] It is anticipated that other factors such as mental health, sex, and age may be even more associated with pain and function in these patients.[2] Conversely, in longitudinal studies, symptoms correlated with tear size,[16,22] which

Table II
Association (crude and adjusted) of total number of concomitant structural pathologies with patient-reported symptoms (WORC physical dimension and NPRS for pain intensity) for supraspinatus tears (analysis 1)

Symptoms	No. of structural pathologies					
	Crude B estimate			Adjusted B estimate*		
	Partial R^2	B (95% CI)	*P* value	Partial R^2	B (95% CI)	*P* value
Physical symptoms (WORC)	0.003	−1.134 (−5.956 to 3.687)	.641	0.027	−0.813 (−6.040 to 4.414)	.847
Pain intensity (NPRS)	0.001	−0.076 (−0.615 to 0.464)	.781	0.086	−0.198 (−0.766 to 0.369)	.251

WORC, Western Ontario Rotator Cuff Index; *NPRS*, numeric pain rating scale (worst pain last 24 hours); *B*, regression coefficient; *CI*, confidence interval.
* Adjusted for age, sex, body mass index, and hand dominance.

Table III
Influence of group characteristics on patient-reported symptoms (WORC physical dimension and NPRS for pain intensity) with 3-level category scale for supraspinatus tears (analysis 2)

Symptoms	No. of structural pathologies, mean (95% CI)*			*P* value
	Isolated supraspinatus tear, n = 8	Supraspinatus tear with 1 concomitant pathology, n = 32	Supraspinatus tear with ≥2 concomitant pathologies, n = 47	
Physical symptoms (WORC)	55.4 (37.6-73.2)	49.0 (40.2-57.9)	47.6 (40.9-54.4)	.721
Pain intensity (NPRS)	7.9 (5.9-9.8)	6.8 (5.8-7.7)	6.9 (6.2-7.6)	.588

WORC, Western Ontario Rotator Cuff Index; *NPRS*, numeric pain rating scale (worst pain past 24 hours); *CI*, confidence interval.
* Adjusted for age, sex, body mass index, and hand dominance.

was further confirmed narratively by a recent comprehensive systematic review examining the relationship between imaging features and shoulder symptoms.[32] However, inconsistent results have been reported regarding the relationship between individual imaging-detected shoulder pathologies and symptoms in patients with RC tears.[32]

A possible explanation for the lack of association found in our study is that several factors other than the supraspinatus tear and the concomitant structural pathology investigated in this study may influence shoulder pain and disability. For example, the presence of subacromial bursitis has been found to significantly increase shoulder pain,[19] as nociceptors in the bursa may be activated as a result of tissue damage and inflammation in patients with supraspinatus tears.[13] In addition, increased pressure on the coracoacromial ligament due to anterosuperior migration of the humeral head may induce pain.[20] Pain may also be related to labral pathology or cartilage lesions caused by trauma[9,28]; however, in our study, the prevalence of these pathologies was too low to be included in the analysis.

Moreover, the explanation for no association could be that the pain perceptions from different structures may merge and give a uniform pain experience, and consequently, it simply may not be possible to distinguish between the symptoms from different pathologies. The complexity in symptoms and the unclear relationship with structural involvement have been investigated in other patient groups. For instance, no relevant association was found between structural knee pathology and self-reported pain and function prior to arthroscopic meniscal surgery.[31]

Limitations

Although our study is not longitudinal, it provides cross-sectional evidence that the structural characteristics of RC tears and the most frequent concomitant structural pathologies are not associated with pain and disability. The cross-sectional study design also means that prognostic factors are not taken into consideration; on the other hand, we adjusted for possible confounders such as age, sex, BMI, and hand dominance. The fact that no sample size calculation was conducted may have resulted in the study being underpowered to determine associations that may exist. A larger sample would also have allowed the subclassification of partial- or full-thickness infraspinatus and subscapularis tears, which could have affected associations with pain and disability. Furthermore, the size of the supraspinatus tear and whether the tear was partial or full thickness may have been confounding variables, and ideally, partial- and full-thickness supraspinatus tears would have been evaluated separately. Only 8 patients had no concomitant pathology, which precluded any meaningful subgroup analyses; however, this illustrates that traumatic events often result in impairment and/or damage of several structures of the shoulder.

Some of the concomitant pathologies are likely to be prevalent at the time of injury (eg, a hooked acromion or AC joint osteoarthritis), but these do not seem to contribute to the symptoms related to the traumatic supraspinatus tear as patients with previous shoulder symptoms were not included. In addition, we cannot rule out that the RC tears were acute-on-chronic tears (ie, progression of asymptomatic pre-existing tears) in this population

Table IV
Linear regression (crude and adjusted) of each concomitant structural pathology with patient-reported symptoms (WORC physical dimension and NPRS for pain intensity) for supraspinatus tears (analysis 3)

Pathology	Crude univariate models			Multivariate model			Adjusted multivariate model*		
	Partial R^2	B (95% CI)	*P* value	R^2	B (95% CI)	*P* value	R^2	B (95% CI)	*P* value
Physical symptoms (WORC)				0.080			0.098		
Infraspinatus tear	0.047	−10.406 (−20.460 to −0.353)	.043		−10.58 (−20.786 to −0.376)	.042		−9.165 (−20.524 to 2.194)	.112
Subscapularis tear	0.019	7.148 (−3.851 to 18.147)	.200		9.348 (−2.136 to 20.832)	.109		9.298 (−2.913 to 21.508)	.133
Hooked acromion	0.001	1.540 (−8.456 to 11.537)	.760		0.923 (−9.247 to 11.093)	.857		0.597 (−10.848 to 12.043)	.917
AC joint arthrosis	0.004	3.483 (−8.977 to 15.942)	.580		2.974 (−9.684 to 15.632)	.641		3.852 (−10.803 to 18.507)	.602
Biceps tendon pathology	0.001	−1.572 (−11.758 to 8.614)	.760		−3.570 (−14.105 to 6.965)	.502		−3.738 (−15.348 to 7.872)	.523
Pain intensity (NPRS)				0.017			0.105		
Infraspinatus tear	0.005	−0.373 (−1.522 to 0.776)	.520		−0.404 (−1.583 to 0.775)	.497		−0.355 (−1.623 to 0.914)	.579
Subscapularis tear	0.006	0.433 (−0.806 to 1.671)	.489		0.555 (−0.771 to 1.882)	.407		0.588 (−0.775 to 1.952)	.392
Hooked acromion	0.001	−0.172 (−1.290 to 0.945)	.760		−0.217 (−1.392 to 0.958)	.714		−0.028 (−1.307 to 1.250)	.965
AC joint arthrosis	0.000	0.136 (−1.340 to 0.937)	.847		0.178 (−1.284 to 1.641)	.809		−0.448 (−2.085 to 1.188)	.586
Biceps tendon pathology	0.001	−0.202 (−1.340 to 0.937)	.725		−0.363 (−1.581 to 0.854)	.554		−0.662 (−1.958 to 0.634)	.312

WORC, Western Ontario Rotator Cuff Index; *NPRS*, numeric pain rating scale (worst pain past 24 hours); *B*, regression coefficient; *CI*, confidence interval; *AC*, acromioclavicular.
* Adjusted for age, sex, body mass index, and hand dominance.

with an average age of 60 years. Owing to the pragmatic nature of this study, 9 different surgeons described the specific pathology identified during surgery, which may lead to different classification of pathology despite guidelines.

Strengths

One strength of this study is the uniform group of traumatic supraspinatus tear patients. Another is the use of patient-reported measures with reliable and valid psychometric properties. In addition, the recording of pathologies was performed during surgery, which is considered the gold standard for diagnostics and superior to imaging such as MRI and US.

Conclusion

Pathology of the infraspinatus and subscapularis and other structural joint pathologies concomitant with supraspinatus tears were not correlated with preoperative self-reported pain and disability in patients scheduled to undergo RC surgery, suggesting that concomitant pathology adds little to the symptoms in patients with a traumatic supraspinatus tear.

Acknowledgments

We acknowledge the efforts of all participating patients. We thank the orthopedic surgeons, nurses, and other clinical staff at the Section for Sports Traumatology, Copenhagen University Hospital, Bispebjerg and Frederiksberg, in addition to the Shoulder-Elbow Unit, Department of Orthopaedic Surgery, Copenhagen University Hospital, Herlev and Gentofte, for their assistance with patient recruitment, data collection, and cooperation.

Disclaimer

Funding was provided by the Department of Physical and Occupational Therapy, Bispebjerg and Frederiksberg Hospital; the Danish Physiotherapy Association; the Faculty of Health Sciences at University of Southern Denmark; the Danish Rheumatism Association; The Jascha Foundation; and The Gangsted Foundation.

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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