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Causes of pain and loss of function in rotator cuff disease: analysis of 1383 cases

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Abstract

Background: The New Zealand Rotator Cuff Registry is a multicentre, nationwide prospective study of rotator cuff repairs established in March 2009.
Methods: A total of 1383 rotator cuff repairs were included in this study, all with completed baseline Flex-SF scores, pain scores and standardized operative forms.
Results: Increasing tear size and tear retraction, over 4 cm, were associated with decreasing Flex-SF scores but not pain. Tear area (a composite of tear size and retraction) is increased with advancing age, male gender and a traumatic history but not with smoking. Increased pain scores were associated with supraspinatus (SS) single tears, compared to subscapularis tears, and with labral tears. SS/infraspinatus tears had lower Flex-SF scores compared to subscapularis/SS.
Conclusion: This study presents the relationship between baseline function, pain and tear characteristics in symptomatic rotator cuff tears. Increasing tear size and retraction are related to a loss of function but have minimal effect upon pain. Pain generators included labral pathology, and the involvement of SS. The intraoperative appearance of the long head of biceps pathology did not predict baseline pain and function.

Introduction

Rotator cuff disease can lead to significant pain and functional compromise, but the actual cause of pain and poor function is often multifactorial. Previous studies have focused on the relationship between intraoperative findings such as tear size, tendon quality and concurrent pathology on post-operative outcome;[1,2] however there is limited information on such tear characterises and the degree of baseline impairment. Some studies have associated larger tears with increasing pain and poorer function, but are limited by small sample sizes and the use of ultrasound to assess tear characteristics.[3–5]

Long head of biceps (LHB) pathology has been traditionally been thought to be a pain generator of rotator cuff disease,[6] but once again the majority of studies have focussed on post-operative outcomes.[7,8] Likewise, labral pathology has been linked to poor function but limited literature is available.[9]

The New Zealand Rotator Cuff Registry is a multicentre nationwide registry of rotator cuff operations. To date, it is the largest prospective study of rotator cuff repairs, and is the first registry to include both open and arthroscopic repairs.[10–12]

This aim of this study was to investigate the relationship of rotator tear characteristics and other shoulder pathology on pain and function in a large cohort of patients presenting for rotator cuff surgery.

Methods

Data were acquired from the New Zealand Rotator Cuff Registry, a registry of rotator cuff operations undertaken from 1 March 2009 to 31 December 2010. All surgeons who performed rotator cuff repairs throughout New Zealand were invited to participate in the registry. A total of 90 surgeons participated.

Patients were prospectively enrolled by the operating surgeon. At baseline, demographic questionnaires, preoperative pain scores and preoperative Flex-SF scores were recorded. A total of 1901 patients completed the baseline questionnaires, 518 patients did not proceed to surgery and were excluded leaving 1383 patients included in this study.

The Flex-SF score is a validated shoulder-specific functional assessment score,[13,14] involving a self-administered questionnaire

detailing current function and resulting in a score out of 50, with a higher score representing better function. A four-question self-administered pain questionnaire was used, with patients grading pain over the preceding month as their 'pain at the least', 'pain at worst' and 'average pain' out of 10. Patients were also asked if pain had disturbed their sleep more than once per night, once per night, a few times per week, less than once per week or never.

Rotator cuff tear characteristics were recorded intraoperatively including the number of tendons involved, tear grade (partial, full thickness partial or full thickness all of tendon) and tendon quality (poor, thin, good (some deterioration) or very good (normal thickness)). Tear size was recorded in the anterior to posterior (AP) dimension, and the extent of tear medial retraction measured was in centimetres. The measured tear size and retraction were multiplied to give the numerical tear area in cm^2. The LHB tendon position was categorized as normal position, subluxed or dislocated. LHB condition was categorized as normal, damaged or ruptured.

Data were analysed using the Sofa Statistics (version 1.4.3; Paton-Simpson & Associates Ltd, Auckland, New Zealand). Independent *t*-testing, analysis of variance and chi-square testing were used to examine statistical relationships, with *P*-values < 0.05 considered statistically significant. Pearson's correlation was used to examine linear correlations, with *P*-values < 0.05 considered statistically significant.

Results

One tendon was involved in 57% of cases, with supraspinatus (SS) being involved in the majority of cases (52% overall). Two tendon tears occurred in 32% of cases, combination of SS/infraspinatus (IS) in 17% overall and combination of SS/subscapularis (Sub) in 15% overall. Flex-SF and pain scores for certain tear characteristics are shown in Figure 1. One tendon SS tears had higher pain levels than Sub tears (4.8 versus 4.3, $P = 0.02$). SS/IS tears had lower Flex-SF scores than SS/Sub (23.3 versus 24.5, $P = 0.01$).

Table 1 presents preoperative average Flex-SF and pain scores for certain intraoperative findings. As tear size increased in the AP dimension, there was a significant trend to lower Flex-SF scores ($P = 0.04$). Tear retraction >4 cm had lower Flex-SF scores versus <1 cm (23.0 versus 24.8, $P = 0.02$). Poor or thin tendon quality was associated with significantly lower Flex-SF scores than good or very good (23.7 versus 24.5, $P = 0.02$). Presence of labral pathology has significantly higher pain scores than those without labral pathology (5.1 versus 4.7, $P = 0.03$). Dislocated LHB had significantly lower pain scores than normally positioned LHB (4.4 versus 4.8, $P = 0.04$).

Overall, the average tear area was 5.0 cm^2. Table 2 compares average tear area with demographics and intraoperative findings. There was a significant linear correlation between age and tear area (Pearson *r* statistic = 0.18, $P < 0.01$). Those aged over 65 had higher average tear area compared with those less than 65 years (6.22 cm^2 versus 4.61 cm^2, $P < 0.01$). Males had larger average tear area versus females (5.38 cm^2 versus 3.69 cm^2, $P < 0.01$) and accidental cause had large tear area versus non-accidental cause (5.13 cm^2 versus 4.03 cm^2, $P < 0.05$). There was a linear correlation with tear area and Flex-SF, with lower Flex-SF scores as tear area increased (Pearson *r* statistic = −0.08, $P = 0.04$). There was no correlation between tear area and pain (Pearson *r* statistic = −0.03, $P = 0.2$).

Discussion

In this study of 1383 patients from the New Zealand Rotator Cuff Registry with symptomatic rotator cuff repairs, increasing tear size and retraction are related to a loss of function but has minimal effect upon pain.

While tear size is commonly measured in the AP dimension, we also assessed tear retraction and overall tear area. Tear size demonstrated a statistically significant trend with increasing size associated with decreasing functional scores. Large tear retraction also has an effect on functional scores, with retraction over 4 cm having significantly lower functional scores than those with less than 1 cm retraction. Previous literature on tear size and patient symptoms has been mixed. McCabe *et al.* found tear size had no effect on baseline function in 61 patients undergoing rotator cuff repair,[15] whereas both Gazielly *et al.*[3] and Kukkonen *et al.*[10] showed lower functional scores with increasing tear size in 98 and 306 patients, respectively.

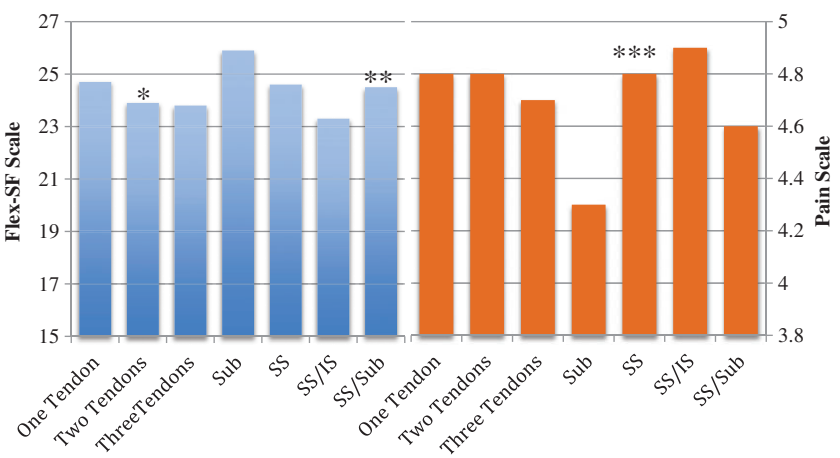

Fig. 1. Average Flex-SF (■) and pain (■) according to tendon involvement. IS, infraspinatus; SS, supraspinatus; Sub, subscapularis. *Significant difference in average Flex-SF between one and two tendons, $P < 0.05$. **Significant difference in average Flex-SF between SS/IS and SS/Sub, $P < 0.05$. ***Significant difference in average pain between Sub and SS, $P < 0.05$.

Table 1 Average Flex-SF and pain scores for certain intraoperative findings

	n	%	Flex-SF (*P*-value)	Pain score (*P*-value)
Tear size AP (cm) (*n* = 1362)				
<1 (*n* = 1347)	161	11.8	24.4	4.9
1.1–1.2	492	36.1	24.6	4.9
2.1–3	366	26.9	24.7	4.6
3.1–4	179	13.1	24.0	4.7
4.1–5	164	11.8	23.2 (ANOVA = 0.04)	4.7 (0.04)
Tear size retraction (cm) (*n* = 1299)				
<1	364	28.0	24.8	4.9
1.1–1.2	479	36.9	24.5	4.7
2.1–3	250	19.2	24.2	4.7
3.1–4	128	9.9	24.0	4.8
4.1–5	78	6.0	23.0 (0.1)	4.5 (0.5)
Labral tear (*n* = 1302)				
Yes	134	10.3	24.0 (0.5)	5.1 (0.03)
No	1168	89.7	24.4	4.7
LHB condition (*n* = 1108)				
Normal	485	43.8	24.8	4.8
Damaged	516	46.6	24.2 (0.10)	4.7 (0.14)
Ruptured	107	9.7	25.2 (0.5)	4.5 (0.07)
LHB position (*n* = 1195)				
Normal	924	77.3	24.2	4.8
Subluxed	175	14.6	24.6 (0.4)	4.6 (0.12)
Dislocated	96	8.1	24.9 (0.2)	4.4 (0.04)
Tendon quality (*n* = 1333)				
Poor or thin	165	19.9	23.7 (0.04)	4.7 (0.8)
Good or very good	1068	81.1	24.5	4.7

Tendon quality was defined as the tissue available for rotator cuff repair. Significant difference in average Flex-SF or pain score. ANOVA, analysis of variance; LHB, long head of biceps.

Table 2 Average tear area in relation to demographics

	Tear area (cm^2)	*P*-value
Age		
<50	3.73	<0.001†
50–59	4.76	
60–69	5.24	
70–79	7.44	
>80	7.48	
Male	5.53	<0.001
Female	3.87	
Ethnicity		
European	5.08	
Maori	5.18	0.9‡
Polynesian	5.04	0.8
Asian	3.30	0.13
Other	3.95	0.3
Accident		
Yes	5.17	0.02
No	4.03	
Non-smoker	5.03	0.8
Smoker	5.16	
Nil/low work demand§	5.09	0.6
High/medium work demand	4.95	
Nil/low recreational demand§	4.89	0.2
Medium/high recreational demand	5.25	
Dominant hand	5.01	0.8
Non-dominant hand	5.09	

†*P*-value represents trend of increasing tear areas with increasing age category. ‡*P*-value represents direct comparison of average tear area in European versus other ethnicity categories. §Work and recreational activity is a self-reported score of work or recreational demand, grouped into nil or low demand, versus medium or high demand.

Tear area was also recorded, using a combination of the tear size and tear retraction. Tear area matched the findings described above, with increasing tear area associated with lower functional scores. To date, no other paper has measured tear area, and in particular the relationship with function and pain.

Despite the effect on function, we found that increasing tear size, retraction and tear area were not associated with increasing pain. In fact, tear size had a weak correlation with decreasing pain. Previous authors have hypothesized that pain in rotator cuff disease is related to inflammation and subacromial bursitis rather than tear size.[16]

Functional scores were significantly lower if two tendons were involved, compared to one. The most 'painful' tendon injury was SS alone and in combination with IS. Neer introduced the concept of subacromial impingement being the main pain generator in rotator cuff disease, which may explain why SS tears are more painful than Sub tears.[16] In the two-tendon group, combined SS/IS tears had lower functional scores than combined SS/Sub tears. This loss of function may reflect IS role as the most powerful external rotator of the shoulder girdle.

Labral pathology was reported in around 10% of cases and small increase in pain scores suggests that labral pathology is a pain generator in rotator cuff disease. Previous research by Forsyth *et al.* noted lower preoperative functional scores in those with labral tears, but they did not record pain scores.[9] Our study found no significant effect upon function.

The LHB tendon was reported as damaged or ruptured in just over 600 cases (43%), and subluxed or dislocated in 271 cases (22%). Walch *et al.* reported a 16% rate of subluxed or dislocated LHB in those with rotator cuff tears.[6] Traditionally, LHB has been considered to be a pain generator in rotator cuff disease.[7,8,22] This is challenged by our current results. Aside from a small difference in pain scores in dislocated versus normally positioned LHB, there

was minimal effect of LHB condition or position on pain. Similarly, there was minimal effect of LHB on functional scores.

Tendon quality was reported by the surgeon at time of repair, and represents the thickness of the tendon available for repair. There were significantly lower preoperative functional scores in those with thin or poor tendon quality, but no relationship with pain. Tendon quality has been shown to be a weak correlate to outcome post-rotator cuff repair;[2] however, there is little prior information regarding the relationship with baseline pain and function.

Age is consistently the most important predictor of the presence of a rotator cuff tear[17–19] and our study supports this finding. Gumina *et al*. found a twofold increase in large and a threefold increase in massive tears in those over 60 years.[20] Milgrom *et al.* concluded that increasing age is a very important predictor of full thickness tears.[17] We found a significant linear relationship between age and tear size, particularly tear area. In those aged over 65 years, the average tear area was almost 2 cm^2 greater than those aged under 65 years.

Almost 90% of our demographic reported an accidental cause of rotator cuff tear, much higher than other reports of traumatic rotator cuff tears.[10,21] Traumatic tears were associated with larger tear areas compared to atraumatic. Similar to the Finnish registry, our study relied on the patient self-reporting a traumatic cause.[10] In New Zealand, medical costs related to accidental injury are covered by a government-funded agency, the Accident Compensation Corporation potentially influencing patients to report a traumatic history.

The statistically significant differences in pain and function need to be considered in context of clinical significance. Work by Cook *et al.* has estimated the clinically important difference for Flex-SF to be approximately three points.[13] This is based on comparing Flex-SF differences before and after interventions. There is no data to suggest a clinically important difference when comparing baseline function in two groups. The statistically significant differences in baseline function mentioned in the current paper need to be interpreted in context.

There are number of limitations to this study. The registry design of this study relies on collection of the operative data by the operating surgeon, and therefore represents non-standardized recruitment methods. Most of the fields were reported in over 90% of cases (repair pattern, approach, acromioplasty, bursectomy and labral tear). Some fields had lower reporting rates, for example biceps tendon intervention (74%) and LHB condition (80%). It is likely that some fields were left blank intentionally because no surgical intervention was carried out and this is a potential source of bias. Attempt was made to standardize surgical categories on the intraoperative form in order to minimize inter-observer variability. However, this registry involved 90 surgeons and some categories, for example tendon quality, are difficult to standardize. However, tear size and retraction, both important measures in this study, are more easily quantified objectively. Tear area was expressed as a numerical figure, and this was a product of tear size and tear retraction, both categorical variables. For analysis, these were converted to numerical values, and therefore could represent a source of error.

Enrolment in the registry was also reliant on the operating surgeon. The main strength of this study is the large numbers of patients involved, from multiple centres across New Zealand. However, the true number of rotator cuff procedures performed in New Zealand including patients operated on but not enrolled during the stated timeframe is unknown. The absolute indication for surgery was not recorded, but is most likely due to symptomatic disease. It is noted that 518 patients completed enrolment data but did not proceed to surgery, the reasons for this are unclear but could include improvement in patient symptoms or lack of funding for surgery. The patient and operative characteristics of this missing cohort are unknown.

Conclusion

This study presents the relationship between baseline function, pain and tear characteristics in those presenting for rotator cuff surgery. Increasing tear size and retraction are related to a loss of function but have minimal effect upon pain. Pain generators included labral pathology and the presence of SS lesions. The presence of LHB pathology was not associated with poor function or pain. This information can be used in conjunction with outcome studies to guide future surgical intervention strategies.

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