

## Research Article

# Functional Changes during Wait Times in Patients with Rotator Cuff Tears

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## Abstract

**Background:** Rotator cuff tears are common problems that often require surgery. In Canada, there are often wait times for orthopaedic consultation and surgery. The purpose of this study is to evaluate functional changes during the wait times on patients with rotator cuff tears.

**Methods:** Between January 2003 and April 2008, 135 patients with rotator cuff disorders were recruited from a surgical consultation list. Participants were assessed shoulder external rotation strength and self-reported upper extremity disability questionnaires at baseline and 1, 2, 3, 4, 5, 6, 12 months follow-up till they received surgery. Generalized estimating equations (GEE) were used to model functional changes that occurred during wait-times.

**Results:** A total of 135 patients (average age=65 year) with rotator cuff disorders were recruited from a surgical consultation list and followed prospectively while waiting for surgery. Participants were assessed for range of motion, shoulder strength, patient-reported pain and disability, as well as health status at baseline and 1, 2, 3, 4, 5, 6, 12 months follow-up till they received surgery. Functional changes in patient-reported outcomes and strength were analyzed. The average wait times of patients to receive surgery was 154 days. Patients with severe injury were more likely to undergo surgery before 3 months. The length of time waiting wait times had a minor impact on self-reported disabilities as long as strength.

**Conclusions:** Surgeons are triaging patients with more severe problems to receive treatment earlier. We observed patients had small further declines in functions occurring during a six-month surgical wait time. Further studies are needed to explore earlier stage in the clinical course.

**Keywords:** Rotator Cuff; Time to Surgery; Functional Changes.

## Introduction

Rotator cuff tears are a common shoulder problem in general population with the incidence between 5% to 40%, most from aging and degeneration [1-3]. However, this rate might be under-

estimated as the presentation can be subclinical [4,5], Although mild and chronic tears can be treated conservatively, significant numbers of patients need to undergo surgery eventually. It is reported that nearly 300,000 rotator cuff operations are performed in the United States annually, and the number is increasing as the population is aging [6]. In Canada, although the length of wait

times for rotator cuff tears can vary across the provinces depends on the urgency of surgery and availability of resources, some Canadian have to wait more than 15 months to receive the surgery [7]. Wait times can occur at several transitions throughout the healthcare system including the time between patients experiencing symptoms and treatment from their family physician, the time when patients are being managed by family physicians or physical therapists for conservative management of rotator cuff tears, the time waiting for surgical consultation and the time waiting for rotator cuff surgery. It can be difficult to determine the impact of this trajectory on outcomes. Despite multiple studies examining the impact of wait times on surgical outcomes [8-10], few studies have addressed how patients functional change during this waiting period. The aim of this study is to evaluate self-reported and objective physical functional changes during the wait time interval between surgical consultation and surgery on patients with rotator cuff tears.

## Methods

### Study Design And Setting

We conducted a prospective cohort study between January 2003 and April 2008 at the Hand and Upper Limb Centre (HULC), London, Ontario. Ethics approval for the study was provided by the Western's Research Ethics Boards.

### Participants/Study Subjects

Patients met following inclusion and exclusion criteria were approached by research assistant at their first visit to HULC: Inclusion criteria: (1) Referrals to the HULC with a suspected or proven rotator cuff tear; (2) Age between 18-70 years old. Exclusion criteria: (1) Previous surgical intervention to the affected shoulder; (2) Inability to complete testing and questionnaires; (3) Major medical illness, psychiatric disorders, cognitive impairment, or other health condition which precludes initial and follow-up assessment; (4) Refusal to attend the study.

### Baseline Assessment

The patient's age, gender, occupation, dominant hand, causes of rotator cuff tears, self-reported medical history and length of time referral to HULC were recorded. Occupation was defined based on the patient's reported job for the previous 6 months.

### Clinical Assessment:

Once participants consented to the study, measurements of shoulder flexion/abduction/extension and rotation range-of-motion (ROM) were assessed by a trained research assistant using standard goniometry [11]. Strength measures on external rotation were taken with a LIDO Active Isokinetic Multi-Joint Dynamometer by Loredan Biomedical (West Sacramento, CA). This system has been proven to be a valid and reliable to test ROM [12,13]. Both

arms were tested. The deficit of flexion/abduction/external rotation ROM and external rotation strength impairment were calculated as a ratio using the ROM/strength on the affected arm divided by unaffected arm to adjust the heterogeneity across individuals.

### Instruments:

Upper extremity disability (Disability, Arm Shoulder and Hand (DASH) [14,15], rotator cuff specific quality-of-life measured by the Western Ontario Rotator Cuff scale (WORC) [16] and general health status (SF-12) [17] were self-reported by the patient. The WORC is specific to rotator cuff disease and has high levels of reliability, validity and responsiveness [18-22]. The more generic regional disability measure, the DASH [18-20,23] has been validated in comparison to the WORC, and the SF-12 have been previously reported for this population [24,25].

The DASH questionnaire is a 30-item questionnaire designed to measure physical function and symptom in upper limb. A single total score is computed, ranging from 0 to 100. The higher score reflects more severe disability. Reliability and validity are well documented [26-28]. The scale has been used in patients with rotator cuff disorders [18].

The WORC questionnaire is a 21-item quality-of-life scale that focuses on rotator cuff pathology. The items are scored on a visual analog scale and are presented in 5 subscales that focus on physical symptoms, work, recreation/sports, lifestyle, and emotional context. The total score, ranges from 0-2100, is computed by adding up five individual subscales. Similar to the DASH, higher scores on the WORC reflect more severe dysfunction. The reliability and validity and implementation have also been published [16,29]. The SF-12 is a 12-item, Likert-scaled generic health status questionnaire that is a short form of the SF-36 that can provide physical and mental health summary scores [17] The SF-12 is expected to be less responsive than upper extremity measures but may provide better understanding of general health status not directly addressed by upper extremity scales [30,31].

### Follow-Up

Patients were re-examined at regular intervals while waiting for surgery and re-measured for external rotation strength assessment and subjective questionnaires. These were repeated every month for first 6 months and 12 months after initial evaluation. Wait times was defined as the time between first time visited HULC for consultation and the time until the date of surgery was executed. The visiting and surgery date was retrieved from electronic medical record.

### Data Analysis

Descriptive statistics were obtained on all variables. ANOVA was performed for DASH, WORC and ratio of external rotation strength to examine differences over time. We employed General-

ized Estimating Equations (GEE) [32] to examine the potential factors influencing objective and subjective functional changes (ratio of external rotation strength, DASH, and WORC ) over 12-month wait times. We identified predictor variables prior to the data collection that we believed those are associated with our outcomes of interest based on theoretical frameworks and clinical experience [19,33] The following independent variables were included GEE models: age(continuous variable), gender (male vs. female), dominated affected arm (yes/ no), rotator cuff teas by injury (yes/ no), length of waiting (days), and SF-12 physical health at baseline, which serves as a surrogate of physical health status. We used SAS (version 9.3, SAS Institute Inc, Cary, NC, USA) for analysis.

## Results

The study included 135 participants with average age 65.12 (SD: 9.99) years; approximately 2/3 were male. Forty percent of the sample was employed at the time of consultation. The average time from family physician referral to surgery consultation at HULC was 163 (SD: 112) days and wait times from surgical consultation on until surgery was an additional 154 (SD: 71) days. Sixty-six participants (49%) received physical therapy before their initial surgical consultation assessment. Detailed description of demographics can be found in (Table 1).

Characteristics	N (%)
<b>Age</b>	
37-50	10 (7.4)
51-60	30 (22.2)
61-70	58 (43.0)
71-80	26 (19.3)
81-90	11 (0.8)
Gender (male)	89 (65)
<b>Affected arm is dominant</b>	83 (62)

<b>Rotator cuff tears by injury</b>	82 (61)
<b>Employment</b>	
Full time/par time employed	53 (39.3)
Unable to work because of rotator cuff injury	9 (7%)
Homemaker/retired	39 (28.9%)
Missing	34 (25.2%)
<b>Highest education level</b>	
High school	29 (21.5)
College	33 (24.4)
University and above	33 (24.4)
Missing	40 (29.6)
<b>Wait times (mean, SD)</b>	
First surgery consultation at HULC (mean,SD)	163 (112) days
Surgery executed (mean,SD)	154 (71) days

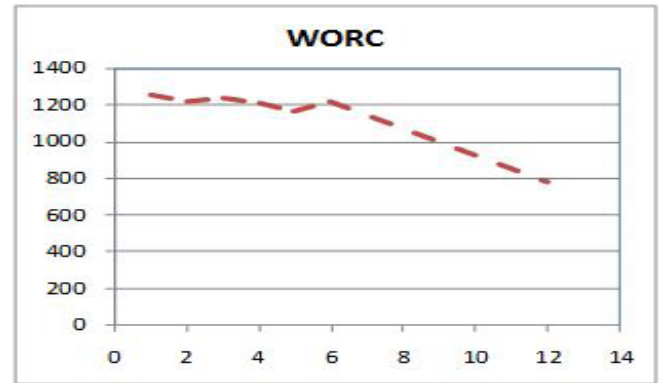
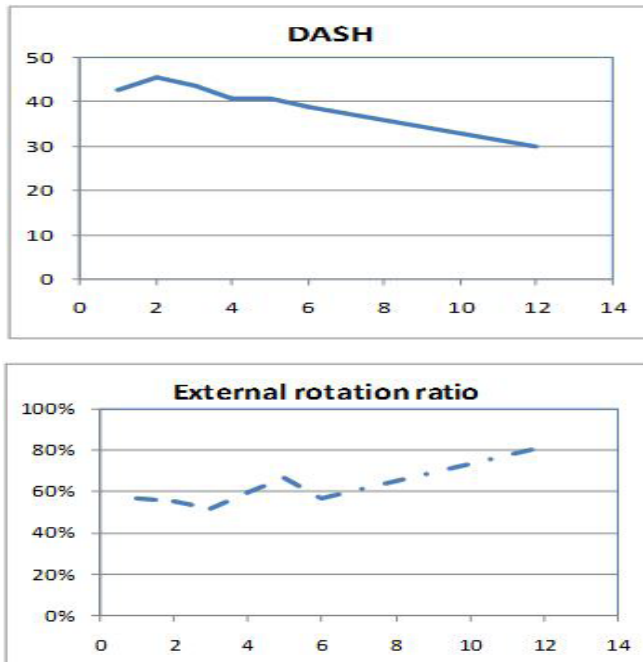
**Table 1:** Characteristics of 135participants

The number of participates evaluated decreased over time as participants proceeded to surgery: from the 135 participants, 82 completed subjective and objective assessments at the 2- month visit, 45 at the 4-month, 15 at the 6-months and 12 at 12- month visits.

Overall, participants in our sample demonstrated moderate self-reported functional impairment and severe objective physical dysfunction. The average of baseline DASH and WORC were 41.23 out of 100 and 1248.7 out of 2100 respectively. The flexion, abduction and external rotation ROM ratio were 76%, 73% and 72% whereas the external rotation strength was about one half of normal range (56%). The functional changes during 12 months were represented in (Table 2).

	Baseline	Months							P value
		1	2	3	4	5	6	12	
DASH	DASH		41.23	42.84	45.51	43.84	40.79	40.84	38.95 (14.64)
	(21.34)	(20.59)	(21.34)	(20.59)	(23.28)	(18.84)	(19.78)	(22.92)	
WORC	WORC		1248.7	1256.9	1219.6	1238.9	1212.7	1168.5	1214.6 (243.0)
	(496.8)	(481.1)	(496.8)	(481.1)	(518.9)	(533.9)	(567.7)	(539.4)	
External rotation ratio Strength	External rotation ratio Strength		56.22	57.03	55.00	51.55	59.77	66.48	57.10
	(34.17)	(35.24)	(37.95)	(34.90)	(37.63)	(36.03)	(31.97)	(15.65)	

**Table 2:** Comparison of DASH, WORC and external rotation ratiochanges in 12 months



**Figure 1:** Comparison of DASH and WORC score and external rotation ratio changes in 12 months.

Identification of determinants of self-reported dysfunction and poorer external rotation strength relative to the other side were evaluated using multivariate (adjusted) GEE models as presented in (Table 3).

	DASH			WORC			External rotation ratio strength		
	Adjusted $\beta$ (95% CI)	P vale		Adjusted OR (95% CI)	P vale		Adjusted OR (95% CI)	P vale	
<b>Age</b>	0.7	(0.18, 0.37)	0.001*	0.49	(-0.80, 1.77)	0.46	-0.01	(-0.02, 0.002)	0.14
<b>Gender (female)</b>	0.54	(-1.51, 12.39)	0.13	6.48	(-14.55, 27.50)	0.55	0.08	(-0.09, 0.25)	0.38
<b>Affected arm is dominated</b>	7.94	(0.74, 15.15)	0.03*	7.78	(-12.28, 27.86)	0.48	0.001	(-0.15, 0.15)	0.99
<b>Caused by injury</b>	4.34	(-2.30, 10.99)	0.2	17.98	(-0.35, 36.31)	0.06	-0.21	(-0.36, -0.07)	0.004*
<b>Wait times</b>	0.04	(0.03, 0.05)	0.001*	0.08	(0.04, 0.12)	0.001*	-0.03	(-0.08, 0.08)	0.94
<b>SF-12</b>	-0.58	(-0.86, -0.28)	0.001*	-1.28	(-2.08, -0.47)	0.002*	-0.002	(-0.007, 0.004)	0.59

**Table 3:** Multivariate analyses of DASH, WORC and external rotation ratio strength.

Poorer patient reported function measured by the DASH was associated with older age, dominance of the affected arm, longer wait times and poor baseline general health. Less favorable WORC scores were associated with longer wait times and poor baseline general health. On the other hand, external rotation strength deficit was only associated with the nature of the tear being traumatic rather than a gradual onset factor. Wait times were significantly associated with self-reported functional changes by 0.04/per day on the 100-point DASH (95%CI: 0.03, 0.05) and 0.08/per day on the 2100-point WORC (95% CI: 0.04, 0.12). The clinical relevance of these changes cannot be determined. No relationship was identified between wait times and external rotation deficit in this study.

## Discussion

This longitudinal study found that with appropriate prioritization of surgical priority by surgeons, the length of wait times had no deleterious effects on patient’s self-perceived function. No consistent impact on impairments in strength was observed. In our study, the average wait time was 5 months which accounted for approximately 6 points degradation (6%) of DASH score and 12 points (0.05%) on the WORC. These deficits were not evident when looking at the raw data, graphs or analysis of variance because of the selective withdrawal of more severe patients earlier for surgery. This indicates the value of using GEE to study wait

times. Our data suggests that appropriate triaging of patients for surgery is currently in place despite a lack of clear mechanisms for this to occur. We expect that the expertise of specialized upper extremity surgeons contributed to appropriate triaging.

Although we were able to identify degradation of scores after controlling for sociodemographic variables and initial severity, we are unable to determine the clinical significance of this. In some studies clinically important differences are used to establish treatment effectiveness, but it is unclear whether these parameters are useful benchmarks for monitoring decline when treatment is not taking place [34]. Our findings are similar to those reported in a systematic review – included 788 hip and 858 knee patients, which suggested small amounts of change in pain and function while waiting for surgery if the wait times less than 6 months [35].

Few studies have examined the impact of waiting for rotator cuff surgery. Although the importance of waiting for surgery has been acknowledged and prioritized, most studies and efforts have targeted hip and knee replacement [36,37]. Our study provides evidence that some progression of disability can be anticipated during a six-month wait for shoulder surgery; but is unable to determine the clinical importance of this decline. Further since patients were not evaluated earlier in their disease process when being managed by family physicians or physiotherapists, it is unclear how much decline had occurred prior to their consultation with an orthopedic surgeon. We only examined the wait time between the surgical consultation and surgery, not the other components of wait time that could occur due to delays in seeking consultation with family physicians, during the conservative management process, or while processing consultations.

Given that strength declines rapidly with disuse [38], it is likely that much of the impairment and strength loss would have occurred prior to surgical consultation and the lack of further decline may be because patients had reached a stable state of disability. The fact that strength and motion were substantially impaired supports this hypothesis. Although we are confident that we missed a critical time where early management might have benefited patients, it is also important for surgeons who receive referrals to know that they are appropriate triaging and that only mild progression of rotator cuff tears can be expected between surgical consultation and surgery date within six months. We acknowledge that our data is unstable because of the smaller numbers at later time points, but this limited data does suggest that more substantial decline can be expected after this time point. This would require further investigation with larger samples.

We observed both DASH and WORC scores improved after three months, which we attribute to appropriate selection of more severely disabled patients as being a higher priority for early sur-

gery. This would suggest that surgical practice correctly prioritizes available resources and that any improvement in management should be directed at decreasing wait times rather than changing current prioritization processes. Similarly, we found that the external rotation strength did not change in first 6 months, which again was attributed to early selection of patients with more substantial loss of motion; and that impairments in motion and strength may have occurred earlier in the clinical course. We chose to analyze strength scores rather than motions scores to avoid creating too many models, and assuming that the larger strengths deficits and more direct relationship to musculotendinous function made the strength deficits a more important impairment to focus on.

We found that elderly patients were more likely to have higher levels of pain and disability while waiting for surgery. This finding is supported by both basic and clinical research [39-41]. Degeneration of d muscle or tendon as part of the aging process, may contribute to less capacity for healing and recovery in older individuals [42]. Some of our findings suggest potential avenues to mitigate disability in patients waiting for cuff repair. Firstly, although failure of conservative management is typically considered an indication for surgery, less than half of our sample reported having a physical therapy rehabilitation program prior to their surgical consultation. Thus, it is unclear if these patients would have either benefited from rehabilitation sufficiently to avoid surgery, or benefit from exercise programs that would have mitigated loss of strength, motion and function while waiting for surgery (pre-rehab). Since patients presented with substantial loss of strength, motion and functional impairment; and since physical therapy has been shown to be effective in patients with rotator cuff tears [43] the lack of a preoperative course of physical therapy may represent a practice or health service accessibility gap that could be targeted for improving outcomes.

We found that arm dominance of the injured side was associated with poorer health outcomes suggesting that the impact of the injury on the ability to use the dominant hand is an important consideration. Some of the patients in our study may have presented with partial tears, where continued use of the impaired arm could result in potential increases to the size of the tear patients if personal or work duties were not appropriately modified. Patients with partial tears are more likely to be managed conservatively or by family physicians for a period of time prior to surgical consultation and interventions that would improve patient's knowledge about appropriate personal and work activities; as well as appropriate exercise program may mitigate both functional decline and risk of advancement of the tear. Since we did not directly study the progression of tear size, our hypotheses about the nature of partial tear progression in working and nonworking patient should be explored in future research. While the extent of worsening that

occurred while between surgical consultation was relatively small, it is important to consider the amount of burden present at baseline. Patients presented with moderate levels of disability that did not improve and a substantial number were unable to work. Substantial impairments in range of motion and strength were present by the time patients presented for surgical consultation. Thus, the lack of adequate rehabilitation and the surgical wait-times meant that patients were held in a disabled state for substantial periods of time. The personal suffering and economic losses due to inability to work during this wait interval would be substantial. Factors such as anxiety about surgery and lost quality of life while waiting can substantially influence surgical outcomes [44,45]. When considering these factors together, the total economic cost of wait times are substantial [46].

Our data suggests patients face waits of 5 months to see specialist for initial consultation and then further same amount of time for the surgery. Therefore, early screening of surgical wait-lists to re-direct patients who have not had an appropriate trials of conservative management may reduce burden and overall wait time. As changes in access to funded physical therapy have declined in Canada over the past decade, this may account for the higher than anticipated number of patients who presented for surgery having not completed a course of conservative management. There are several limitations worth noting. (1) We did not measure, or control for, tear size. However we expect that our functional measures provided some indication of severity as the association between severity of functional complaints and tear size has been documented. (2) We had a small sample that made it to 12 months, because the majority had already progressed to surgery. Thus the confidence in our results declines over time and we are unable to make definitive conclusions about what happened at 12 months. However, despite these limitations the key conclusions that surgeons are appropriately triaging patients based on functional impact, that there is substantial pain, disability and impacts on health status during the wait time; and that there are small declines in functional status during the wait time between surgical consultations and receiving surgery are robust and important findings.

## Conclusions

Our study suggests surgeons are triaging patients with more severe problems to receive surgical intervention earlier. We observed patients had small further declines in functions occurring during a six-month surgical wait time. Further studies are needed to explore earlier stage in the clinical course.

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