Systematic review of rotator cuff tears in workers’ compensation patients


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Background
The burden imposed by workplace rotator cuff (RC) injuries has been reasonably defined. However, literature associated with the demographic characteristics and ‘best practices’ to manage such injuries among workers’ compensation (WC) patients is scant.

Aims
To consolidate the existing literature on full-thickness RC tears among WC patients. Subject, shoulder and injury characteristics were examined to determine if and how WC recipients may differ from their non-compensable counterparts.

Methods
A systematic search (databases, clinical practice guideline web resources, conference proceedings and reference lists) revealed 450 abstracts. Two blinded reviewers independently assessed abstracts for inclusion. Sixty abstracts were subsequently included in a blinded full manuscript review. Seventeen of these manuscripts (3.8% of sample; 11 intervention and 6 determinant) were included in the present review.

Results
Previous studies demonstrate that operative interventions are appropriate for full-thickness RC tears as substantial gains in range of motion, strength and quality of life were witnessed within the first post-operative year. Non-operative interventions, including workplace-based work hardening, physical therapy and the use of an early referral system, were shown to improve outcomes. Conflicting results exist with respect to determinants such as age and sex. Importantly, WC patients had consistently poorer outcomes than non-WC patients.

Conclusions
Our results show that although WC patients experience substantial benefits from various treatments for full-thickness RC tears, disparities exist between them and their non-WC counterparts. The lack of WC-specific literature limited our results. Larger studies, particularly ones comparing WC patients with their non-compensable counterparts, are crucial to allow for future evidence-based recommendations.

Key words
Evidence-based practice; musculoskeletal; occupational rehabilitation; physiotherapy; quality of life; rehabilitation; upper limb disorder.

Introduction
Disorders of the rotator cuff (RC) include a broad spectrum of pathological conditions, including bursitis, tendinitis, tendonosis, partial thickness tears and full-thickness tears [1]. Given the daily demands that are placed upon the RC, it is not surprising that RC tears are the most common source of shoulder pain, disability and discomfort [2,3]. In fact, RC disease is the most common cause of shoulder pain seen by physicians. Based upon magnetic resonance imaging, ~4% of individuals under 40 years of age may have an asymptomatic RC tear (partial or full thickness). This figure climbs to >50% among individuals >60 years old [4]. Although these tears are classified as asymptomatic, previous literature has shown that pain develops within 5 years in approximately half of these individuals [5]. As the current population is aging, increasingly active and perhaps less willing to accept functional limitations, the incidence of symptomatic RC disease is expected to grow in future years.
As RC pathology ranks second only to back and neck pain in frequency of occurrence in the workplace [6], work productivity is substantially affected as indicated by high claims rates and costs attributed to workplace RC injuries [6–8]. RC injuries are also the second most common reason for lost time from work in manual workers [4–6]. Although the scope of burden imposed by workplace RC injuries has been reasonably defined, literature associated with the demographic characteristics and ‘best practices’ to manage such injuries among workers’ compensation (WC) cases is scant at best. When compared to non-WC patients, several studies have demonstrated the lower recovery (i.e. physical measures, quality of life), patient satisfaction and longer time periods to return to employment or full activities following RC injury experienced by WC claimants [9–12]. Very few studies, however, have expanded upon this in order to investigate whether this differential recovery following RC injury in WC patients can be explained by patient, shoulder, injury or occupational characteristics.

Therefore, the main goal of this review was to consolidate the existing literature on the management of RC injuries focusing on patients insured by WC. In addition, subject, shoulder and injury characteristics were examined to determine if and how WC recipients with a RC tear may differ from those non-compensation subjects with RC tears.

The specific research questions which we aimed to address were:

(a) In WC patients with full-thickness RC tears, what operative or non-operative interventions are effective in restoring function, reducing pain and allowing return to pre-injury work?

(b) Are WC RC patients different from non-WC patients in terms of the following patient characteristics:
   (i) demographics (e.g. age, gender, smoking status),
   (ii) shoulder characteristics [e.g. pain, strength, range of motion (ROM)],
   (iii) general health status and
   (iv) type of employment (e.g. demands, number of hours worked)?

(c) Are WC RC patients different from non-WC patients in terms of injury characteristics:
   (i) mechanism of injury (e.g. traumatic, overuse, degenerative),
   (ii) tear characteristics (e.g. size, location, muscle(s) torn)?

Through the provision of such evidence, our goal was to shed light on areas where research has found conclusive results, as well as to highlight areas in need of further research.

**Methods**

To identify potential articles, systematic searches of MEDLINE, Cochrane Library, EMBASE, CINAHL, SCOPUS, Sport Discus, PEDRO, BIOSIS Previews, TRIP, Clinical Evidence, StatRef, OCLC Papers First and Proceedings First, Dissertation Abstracts and Web of Science databases were performed up to December 2008. A further search of ‘grey literature’, including clinical practice guideline web resources, conference proceedings and reference lists of key manuscripts, was also performed. Medline, EMBASE and CINAHL were searched using a combination of thesaurus terms and text words (see Figure 1, available as Supplementary data at *Occupational Medicine* Online), while a simple text word search (rotator cuff and [Workers compensation OR WCB]) was conducted on the other databases.

Only studies containing data that were collected from 1990 to present day were included in this review to represent current medical and rehabilitative practices. In order to ensure the inclusion of recent manuscripts (those published following our initial literature search), a final scan of the MEDLINE database was performed immediately prior to this final report. The target population was adult patients (aged $\geq 18$ years) who were receiving WC benefits related to full-thickness RC tears. As such, our review is limited to countries/jurisdictions where formal WC programs are available. Studies which included this target population as a subset (i.e. articles not exclusively containing WC patients) were included if data pertaining to WC patients could be extracted. Our investigation, however, was limited to literature concerning interventions and determinants associated with full-thickness RC tears only. Any sources of literature encompassing the broad definition of ‘tendinopathy’ were not included, unless an explicit reference to ‘full-thickness RC tear’ was present. Interventions included both operative and non-operative (i.e. physical therapy, medication, steroid injection) management. Outcomes included objective (ROM, strength and return to work), patient reported (pain scales and health-related quality of life questionnaires) and economic (length/cost of WC claim) measures. Our eligibility criteria spanned numerous study designs, including randomized trials, cohort, case–control, retrospective reviews, comprehensive reviews and meta-analyses. Determinant studies that described or compared characteristics of subjects and allowed comparison of patient-/work-related characteristics between WC and non-WC subjects were included.

For potentially eligible abstracts, two blinded reviewers independently assessed studies for inclusion/exclusion according to standardized criteria regarding patient populations, interventions, outcomes and study design (Figure 2, available as Supplementary data at *Occupational Medicine* Online). For the evaluation of determinant studies (i.e. non-interventional evaluations), a comprehensive list of demographic and potentially modifiable risk factors was developed (Figure 3, available as Supplementary data at *Occupational Medicine* Online).
Based on the a priori criteria, each reviewer was asked to determine if each abstract should be included or excluded for full manuscript review. Following the initial abstract evaluation, the corresponding full-text manuscript was retrieved for each remaining abstract. The same two reviewers independently assessed each full-text article for eligibility using standardized criteria as described above. In cases where consensus was not obtained, the reviewers reviewed the article in question and a decision with respect to inclusion was made.

Following study selection, the included articles were divided among the two reviewers. Each reviewer independently assessed one half of the total articles. Data regarding study population, design, interventions and outcomes were extracted and transcribed onto standardized data collection sheets. Once each reviewer completed data extraction for their respective articles, the reviewers exchanged articles and verified the other’s data extraction. The internal validity of each intervention article was assessed by the same two reviewers using a modified version of the Newcastle–Ottawa Scale [13]. Studies were rated as ‘high quality’ if they met at least 80% of criteria, ‘good’ if they met 70–79% of criteria, ‘fair’ if they met 60–69% of criteria and ‘poor’ if they met <60% of standard criteria. A flowchart of manuscript selection and evaluation is provided in Figure 1.

**Results**

Four hundred and fifty potentially eligible abstracts were assessed, of which 390 abstracts were excluded as they did not answer our predetermined research questions. The reviewers were in agreement in 82% (n = 369) of the 450 cases. The corresponding kappa statistic was $k = 0.45$, indicating moderate agreement [14]. Following full-text assessment, the reviewers excluded a further 43 manuscripts and the reviewers were in agreement in 72% (n = 43) of the remaining 60 cases. The corresponding kappa statistic was $k = 0.39$, indicating fair agreement [14]. Therefore, a total of 17 manuscripts (11 intervention and 6 determinant) were included in the present review.

The methodological details of intervention studies (n = 11), including author and year published, study design, sample size, mean age, gender, number and proportion of WC patients, interventions, outcomes assessed and follow-up periods are provided in Table 1 (available as Supplementary data at Occupational Medicine Online). The details of the determinant studies (n = 7) are provided in Table 2 (available as Supplementary data at Occupational Medicine Online).

Of the 11 intervention studies retrieved, 8 focused on surgical interventions [10,15–22]. Of these eight surgical studies, seven examined outcomes relating to RC repair, either alone or in combination with other procedures (subacromial decompression, acromioplasty and biceps repair), while the remaining study examined outcomes associated with subacromial decompression performed in isolation. Patient follow-up periods ranged from 12 months to 10 years. With respect to the study quality, three were rated as ‘high quality’, five were rated as ‘good’ and the remaining three were rated ‘fair’. Due to the small number of studies retrieved, we have chosen to present comprehensive results, as opposed to ones stratified according to study quality.

The complete list of results from intervention studies is provided in Table 1. Generally, these previous studies demonstrated that operative interventions are an appropriate treatment for dealing with full-thickness RC tears as subjects had substantial gains in ROM, strength and various measures of quality of life post-operatively. Gains in ROM, strength and function were primarily witnessed within the first post-operative year. Although one study demonstrated that patient satisfaction and the patient’s subjective disability rating may improve from 2 to 10 years post-operatively, it should be noted that only one WC patient was included at the 10-year post-surgery mark [16]. Therefore, these results should be interpreted with caution. Among the remaining studies, which included follow-up beyond the 1-year post-operative mark, patients...
did typically experience modest but non-significant gains [10,15,17–20].

Only four studies directly compared WC patients to those not receiving any form of compensation. Studies that directly compared WC patients to those not receiving any form of compensation reported that WC patients experienced lower outcomes at each assessment period [10,15,18,19]. Additionally, WC patients typically experienced less post-operative satisfaction, and a lower proportion of WC patients returned to their similar pre-operative work when compared to a non-WC population [10,18,19]. In instances where these patients did return to work/activities, it was often at a slower rate than non-WC patients.

Two of the remaining studies examined non-operative interventions associated with RC tears [23,24]. These included the role of clinical versus workplace work-hardening programs [23] and physical therapy [24]. Both reported short-term results (within 1 year) of treatment. It was shown that in instances of clinical versus workplace-based work-hardening programs, those involved in workplace-based work hardening had better shoulder function and return-to-work rates upon program completion. Additionally, physical therapy, by way of patient education and manual therapy, was shown to be beneficial, regardless of compensation status.

The final interventional study examined the use of an early referral system in the surgical management of RC tears. An important finding was that the use of an early referral system, as opposed to a traditional ‘gatekeeper’ system, resulted in significant cost reductions (physician), experience greater pain, lower quality-of-life (as shown via subjective questionnaires) and have poorer function pre- and post-operatively. WC claimants consistently reported that outcomes for WC recipients were of lower magnitude than their non-WC counterparts. WC patients experienced slower objective gains, had longer time-to-treatment (3.9 months in early referral versus 10.1 in ‘gatekeeper’ system) and time off work (6.6 versus 17.1 months).

The complete results of the six determinant studies are provided in Table 2. These studies examined a wide variety of determinants associated with outcomes relating to RC injury. The most frequently examined demographic determinants included age, sex and compensation status, which were examined in all six studies [12,25–29].

Other demographic determinants included smoking status (n = 3) [26,27,29] and hand dominance (n = 2) [25,29].

Determinants relating to shoulder status included RC tear size (n = 4) [25,26,28,29], pain severity [25], biceps deformity [25], supraspinatus atrophy (in millimeters) [25], presence of a drop-arm sign [25] and the number of RC tendons involved [29]. With respect to general health status/medical determinants, those examined included time-to-treatment (n = 6) [12,25–29], injury type (n = 4) [12,25–27], cortisone injection use (n = 3) [25,26,29], presence of co-morbid health conditions (n = 2) [27,29], surgical technique used (n = 2) [26,27], previous shoulder surgery (n = 2) [12,29] and sleep interruption [25]. Time off work was the only determinant assessing the impact of shoulder injury and management on employment [25].

From a demographic perspective, the most significant findings were observed for age and sex. It was generally found that age did not significantly impact patient outcomes, although one study found that WC patients were significantly younger when compared to their non-compensable counterparts [26]. It was also found that patients under the age of 55 years were significantly more likely to be displeased with surgical results and were less likely to have additional surgery [12].

There also appeared to be sex-based differences among patient outcomes. Women may experience more post-operative pain than their male counterparts [28]. In addition, although women expressed slightly greater satisfaction with their RC treatments, they had a reduced ability to perform certain shoulder tasks, including placing objects on a high shelf, tucking in a shirt, placing their hand behind their head and tossing a ball underhand [12]. However, given that the sample in each of these studies was only partially comprised of WC patients, these findings may not necessarily apply to the WC population.

Most importantly, studies reported that patients with active WC claims do experience poorer outcomes, both pre- and post-operatively. WC claimants consistently experience greater pain, lower quality-of-life (as shown via subjective questionnaires) and have poorer function (by way of ROM or strength). Given that tear size and muscle involvement (number of tendons torn) did not appear to be associated with compensation status, this suggests that other mechanisms may be at play.

Discussion

Overall, it was seen that both operative and non-operative interventions are beneficial for WC recipients who have a full-thickness RC tear. Although there were only a small number of studies available, 70% of these studies were considered to be of at least good quality. In all studies, both WC and non-WC subjects made substantial gains in both objective (ROM and strength) and subjective (pain and health-related quality of life) symptoms in the first year following treatment.

For operative interventions, these benefits appear to be maintained over time. In light of the magnitude of RC pathology in the working population, these results must be viewed as encouraging. However, studies also consistently reported that outcomes for WC recipients were of lower magnitude than their non-WC counterparts. WC patients experienced slower objective gains, had longer...
periods for return to work/activities and perhaps most importantly experienced greater post-operative dissatisfaction. The reasons for these differential outcomes remain unclear as the current body of evidence is primarily comprised of retrospective, single surgeon, heterogeneous (WC and non-WC patients in same sample) designs or studies lacking appropriate risk-adjustments. Studies examining exclusively WC patients (100% of sample) or studies that are large enough to do WC subject sub-analyses are especially needed.

Indeed, there may be great variability among WC recipients themselves. Traditionally, previous research has simply categorized patients based upon their WC status alone. Such efforts combine construction workers with repetitive above-head tasks with those who have a shoulder injury, but work at a desk job. Given this heterogeneity within the WC population itself, further research is necessary to determine how job demands may affect patients’ expectations and outcomes.

Perhaps, the most interesting findings were related to the use of an early referral system in the surgical management of RC tears. The results of this study, particularly the 10-fold decrease in medical costs and the 60% decrease in time spent waiting for surgery and time off work, demonstrate that there is much improvement to be made in this area. Further research advocating a proactive approach in the management of RC tears among WC claimants would not only benefit patients and their employers but may also result in significant cost reductions among health care systems. Such benefits may also have a greater societal impact.

From our results, it was also shown that females and younger patients particularly those under the age of 55 years may experience less promising outcomes and/or more post-operative dissatisfaction. Although this may be the product of a ‘survivor effect’, we feel that this is primarily due to differences in the nature of the work demands placed upon younger patients and their older counterparts. Further research is also necessary in order to further clarify the potential reasons for this.

The results of the present study are limited by the lack of literature regarding WC recipients. In many cases, WC claimants are excluded from research studies. Even in cases where WC recipients have been included within research, stratified or risk-adjusted analyses were either not performed or WC responses could not be separated from non-WC responses. The current evidence should also be interpreted with caution as in many cases, these studies did not include long-term results or were retrospective in nature. Few studies looked at outcomes beyond the first year of intervention and few measured the ability of the subject to return to work or unrestricted activities.

Although the majority of studies included in this review were of sufficient quality, in most cases, WC patients were represented by only a small subset of each study sample. The present study highlights that comparisons of WC patients to their non-compensable counterparts is scarce within the current literature. As such, evidence-based ‘best practices’ in the treatment and assessment of RC outcomes among WC patients are lacking. In addition, due to the heterogeneity of WC patients, results from these studies may not apply to all WC patients with full-thickness RC tears as there was generally little consideration for the varying nature of occupational demands.

A wide variety of measures were used to assess outcomes including ‘objective measures’ (e.g. ROM, strength), ‘patient-reported questionnaires’ (e.g. Constant score, American Shoulder and Elbow Score; Western Ontario Rotator Cuff) and ‘length of time to return to work/activities’. These included items relating to activities of daily living, functional limitations, work-related disability and post-operative function. In many cases, these were simply generic items developed for a particular study by the investigators. Furthermore, despite the magnitude of the problem in the working population, cost-related data were only reported in a single study. The heterogeneity of outcomes, interventions, assessment tools and assessment periods used in previous studies make it very difficult for clinicians and decision makers to make cross-comparisons among studies, much less determine if the findings are meaningful to the subpopulation of WC patients.

The existing body of literature does not provide clinicians with clear guidance in the treatment of full-thickness RC tears in WC patients. Because of the lack of consensus in the literature and the extremely limited body of well-conducted research, it is impossible to extract any variety of meta-analytic data related to the treatment of these injuries. As such, this review cannot provide evidence-based recommendations and there remains considerable debate as to the most appropriate practices in the management of these tears in the WC population.

Although limited, the results of the present investigation highlight the disparity in outcomes between WC claimants and their non-WC counterparts. There is evidence to suggest that the WC population with full-thickness RC tears start and finish below their non-WC counterparts, especially with respect to quality of life. Preliminary data suggest that significant benefits may come from an accelerated model of care, which expedites the management of such cases. However, despite the cost savings associated with accelerated care, outcomes of treatment in the WC population remain below those of the non-WC population. Thus, accelerated care in isolation does not provide a complete solution to the management question, despite considerable cost savings. Further research examining compensation status, patient characteristics and the nature of employment as primary outcomes is necessary in order to clarify the mechanisms responsible for the inferior outcomes. Despite the lack of evidence in previous literature, outcome, medical cost and quality of life data indicate that if managed in an
appropriate fashion, WC patients are capable of returning to productive employment. What remains unclear, however, are the associated best practices to be employed in the management of such injuries, which would further enhance the outcomes that may be associated with expedited care.

Key points
- Both operative and non-operative interventions are beneficial for workers’ compensation recipients who have a full-thickness rotator cuff tear.
- Despite this, studies consistently reported that outcomes for workers’ compensation recipients were of lower magnitude than their non-workers’ compensation counterparts.
- The associated best practices to be employed in the management of such injuries remain unclear.

Funding
Workers Compensation Board of Alberta.

Acknowledgements
L.A.B. is a Population Health Investigator who receives salary support from Alberta Innovates-Health Solutions (formerly Alberta Heritage Foundation for Medical Research).

Conflicts of interest
None declared.

References


