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The effect of workers' compensation on outcome measurement methods after upper extremity surgery: A systematic review and meta-analysis

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Abstract

Background—Patients who receive workers' compensation (WC) often display worse surgical result such as prolonged pain or reduced functional ability. The outcomes of surgery can be assessed using a variety of surveys, assessments, and measurements. It is unknown if the confounding effect differs based on how results are measured. The aim of this study is to determine if these variations exist.

Methods—A search of full-length articles published between January 1, 1995 and December 31, 2015 was conducted using PubMed, Embase, and CINAHL. We performed a systematic review and meta-analysis using unique inclusion criteria for each.

Results—A total of 101 articles were included in the systematic review; 62 of those were retained for the meta-analysis. In the systematic review, 70% of studies found that patients receiving WC had significantly worse postoperative results than uncompensated patients, whereas only 42% of studies that measured pre- vs postoperative improvement were influenced by WC. The meta-analysis found that uncompensated patients were more likely to experience improvement after surgery than patients receiving WC (summary OR 3.17; 95% CI 2.47–4.08). A subgroup analysis demonstrated that functional measures, such as grip strength or nonunion, were least affected by WC, compared with other outcome measures such as patient-reported outcomes questionnaires or time off work. The specific disorder or the country of study did not change the effect of WC on results.

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Supplemental Digital Content 1. Appendix A: Studies included in the systematic review, [INSERT LINK HERE](#).

Conclusion—Potential bias introduced by WC can be mitigated by evaluating surgical treatment of work-related upper extremity disorders using pre- vs postoperative improvement or functional measures.

Keywords

workers' compensation; outcome measurement method; upper extremity disorder; systematic review

Introduction

Workers' compensation (WC) has long been recognized as a confounding variable when evaluating work-related diseases, conditions, and injuries.(1, 2) Patients receiving WC for upper extremity conditions and injuries often take longer to return to work, report more pain, and score lower on patient-reported outcomes measures (PROs) than their uncompensated counterparts.(3–9) There is evidence, however, that the effect of WC may not be uniform across types of outcomes measurements. For example, Fulton et al. found that after ulnar shortening osteotomy, compensated patients reported more pain and worse Disabilities of the Arm, Shoulder and Hand (DASH) scores than patients without WC. There were no such differences in wrist arc of motion (AOM) or grip strength, however.(10) Similarly, Duralde et al. reported that postoperative American Shoulder and Elbow Surgeons scores (ASES) were significantly worse for patients receiving WC than for uncompensated patients after surgery, whereas this difference was not observed in postoperative shoulder range of motion. (5)

Although several recent meta-analyses observed an association between receiving WC and poor results following general surgery or orthopedic surgery, an analysis focused on hand surgery does not exist.(11–15) Furthermore, these analyses did not test for possible relationships between outcomes types and receipt of WC. For instance, is the association stronger when results are measured using PROs, such as DASH or the SF-36, than when results are measured with physical findings like grip strength or pain? Quantifying these differences can provide crucial information to guide the selection of outcomes for future studies involving work-related conditions or injuries.(16–19) The primary aim of clinical research using PROs, functional measures, or other ways of quantifying results is to identify, compare, and verify the effectiveness of interventions. With this in mind, the importance of understanding and minimizing bias in data collection and interpretation cannot be understated. In this study we report a systematic review and meta-analysis to determine which outcomes measurement methods are most affected by receiving WC.

Materials & Methods

Search Strategy

We performed a manual systematic literature search following a predefined protocol and in accordance with the Meta-Analysis of Observational Studies in Epidemiology checklist.(20) Two authors independently reviewed studies published from January 1, 1995 to December 31, 2015 using PubMed, Embase, and CINAHL Plus. The search terms were: (hand OR

finger OR wrist OR forearm OR arm OR digit OR thumb OR carpal OR scaphoid OR pisiform OR phalan* OR metacarpal OR median OR ulnar OR radial OR radius OR ulna OR elbow OR cubital OR tennis OR shoulder OR humer* OR biceps OR triceps OR epicondyle OR rotator cuff OR brachial plexus OR thoracic outlet OR upper) AND (surgery OR surgical OR operation OR operative) AND (compensat* OR insurance OR litigat*). The bibliographies of relevant articles were also investigated using Scopus to identify additional eligible studies. Table 1 shows the inclusion and exclusion criteria for the systematic review and the meta-analysis. The criteria differed between the two analyses. The outcome of interest in the systematic review was whether an outcomes measurement method was significantly affected by WC or if it was not affected by WC. For this reason we need studies to have sufficient power to detect significance. To this end, we set the sample size to at least 10 WC and at least 10 non-WC patients. The meta-analysis uses statistical methods to weigh each study's results so lack of power is corrected for in the analysis. For this reason, we are able to use less stringent inclusion criteria. More inclusive criteria also allowed us to keep more studies, which is important because many studies were rejected because they did not include binary outcomes.

Data Extraction and Analysis

Two investigators (Y. F and M.L.) independently abstracted data from eligible studies using predetermined selection criteria. A plan was created to resolve discrepancies by discussion with a third investigator (M.J.S.), but this was ultimately not necessary as there were no discrepancies.

We selected the most commonly used outcome measurement methods presented in the included studies, with a focus on including both the patient-reported and objective measurements. We classified outcome measurement methods into 7 categories: satisfaction, pain, PRO instruments, functional measures, instruments combining PROs and functional measures, return to work/activity, and adverse events. (Table 2) We did not attempt to analyze within group differences (i.e. DASH vs BCTQ) because there were too few studies in each category to create a statistically sound subgroup analysis. We also grouped conditions and injuries into 3 categories: joint disorders, tendon disorders, and nerve disorders. Institution, country, year of publication, disorder/injury studied, study design, and sample size were abstracted from each article. Because we extracted data from each outcome category in our systematic review, we may have obtained data in multiple outcome categories from a single study. If postoperative results were measured several times in one study, we included only the latest follow-up time point. If the authors used several outcome measurement methods from the same category (this was especially common with PROs) we selected the instrument that included the greatest number of questions. If the same outcomes were reported from the same facility in multiple manuscripts, we included only the most recent study. If a study reported both the number of patients and the number of treated limbs (e.g. number of patients vs number of hands in a carpal tunnel syndrome study), we used the number of treated limbs. If we could abstract data from several result categories, we used the data in the following order of preference: region-specific PROs, (e.g. Boston Carpal Tunnel Questionnaire (BCTQ), Western Ontario Osteoarthritis of the Shoulder (WOOS)), general

upper extremity PROs (e.g. DASH, ASES), general health PROs (e.g. SF-36), patient satisfaction, pain, functional measures, return to work/activity, and adverse events.

To perform the systematic review, we collected both postoperative data and improvement data (a comparison of pre- and postoperative results). For the meta-analysis, we used methodology similar to that used by Harris et al.(12) We managed the heterogeneity of the collected data by simplifying the reported results from each study into a binary variable: satisfactory or unsatisfactory. Satisfactory results include improvement of PRO scores, satisfaction, nerve conduction, grip strength, sensation, or AOM or reduced pain. Unsatisfactory results include no change or worsening symptoms. When results were reported on a Likert scale, we recognized “excellent” and “good” as a satisfactory result, whereas “fair” and “poor” were unsatisfactory.

We calculated the odds ratios (ORs) for binary variables. A higher odds ratio means a bigger difference in the rate of satisfactory result between non-WC versus WC. We did not analyze studies with continuous variables. Subgroup analysis was performed based on the country of study origin and condition/injury category. We examined results for heterogeneity by examining the forest plot, comparing the summary ORs using random-effects models, and using I^2 statistical tests for heterogeneity. To evaluate for publication bias, we used funnel plots. R statistical software was used.

Results

Our search identified a total of 4,935 articles. We excluded 897 duplicate articles. A subsequent title and abstract search narrowed our focus to 131 articles. The manuscript search yielded 101 articles that met our inclusion criteria for the comprehensive review and 62 articles for meta-analysis (Figure 1, See Supplemental Digital Content 1, Appendix A, Studies included in the systematic review, **INSERT LINK HERE**). Twenty-six studies were performed prospectively (6 retained for meta-analysis), 73 retrospectively (54 retained), and 2 studies were performed as randomized control trials (both retained), although neither randomly assigned patients to be compensated. We did not find any additional articles to include by performing a search of included articles’ citation lists. High heterogeneity was observed in the main analysis. Upon subgroup analyses highest heterogeneity was observed in the included studies for tendon disorders, pain, adverse events, and return to work/activity. (Figure 2, Tables 3, 4)

Comprehensive Results

In the comprehensive review, 69 studies evaluating postoperative results found that patients receiving WC had significantly worse results than uncompensated patients, regardless of what outcomes were measured. Similarly, studies comparing pre- vs postoperative change, regardless of the specific outcome being measured, identified that in 5 out of 12 studies, patients receiving WC demonstrated significantly less improvement after surgery than uncompensated patients. Our meta-analysis supported these findings and indicated that uncompensated patients were 3 times more likely to experience improvement after surgery than patients receiving WC (summary OR 3.17; 95% CI 2.47–4.08) (Figure 3). No significant publication bias was detected ($P=0.11$) (Figure 4).

Outcome Measurement Methods

When examined separately, the effect of WC varied based on which outcomes were measured. In the systematic review, studies that measured results via pain, time to return to work/activity, via PRO instruments, or measures that combined PROs and functional assessments were more likely to be affected as a result of WC. In other words, in these studies, results were worse among patients receiving WC than among those who were not compensated (Table 5). Studies measuring results using functional measures, patient satisfaction, or via the presence or absence of adverse events were less likely to be affected. Additionally, studies assessing pre- vs postoperative change were less affected in all outcome categories. In the meta-analysis, studies using outcomes such as return to work/activity or functional measures had the lowest ORs, meaning the results were least likely to be biased by receipt of WC (Figure 2). Return to work/activity was unaffected in the meta-analysis, but it was affected in the systematic review. This is likely due to characteristics of the subset of studies retained from the comprehensive review for the meta-analysis.

Disorder/Injury

Studies of nerve disorders/injuries were less likely to be affected by WC than those of joint or tendon disorders/injuries according to the systematic review (Table 6). However, in the meta-analysis, the summary ORs in nerve disorder studies were higher than the others, meaning they were most likely to be affected by WC (Table 4). As above, this may be because of the retained studies used in the meta-analysis.

Country of study

The majority of the studies included in our comprehensive review were conducted in the US (71%), followed by Canada (14%), France (6%), and Australia (4%). The remaining 5% of studies were reported from Germany, Japan, Switzerland, Taiwan, and the United Kingdom. These countries vary in their social insurance programs as well as in their healthcare systems. Though we were concerned this may influence the results of this study, our result indicated that this is not the case. (Table 4) Although payment for work-related illnesses and injuries varies as a factor of the varying healthcare systems, the total benefits provided for workers' compensation schemes did not differ greatly.

Discussion

In this systematic review and meta-analysis, we found that patients receiving WC had worse postsurgical results after upper extremity surgery and demonstrated less pre- vs postoperative improvement than uncompensated patients regardless of which outcomes were measured. However, this effect was not uniform among different types of outcomes. Functional measures, such as AOM or grip strength, were least likely to demonstrate a significant difference between compensated and uncompensated patients. The same was true in studies that measured pre- vs postoperative improvement rather than only assess patient postoperatively.

Previous studies have evaluated the relationship between WC and surgical results. Similar to our study, Murgatroyd et al. hypothesized that the effect of receiving WC differed depending

on the type of outcome, such as physical function, psychological function, and pain.(14) In their systematic review, they concluded that WC was associated with poorer psychological and physical function results and more pain. However, they were unable to compare outcome types because they did not perform a meta-analysis. They extracted several results from one study, as we did in our systematic review, and categorized each outcome. To obtain more comprehensive results, evaluation with meta-analysis is useful. Our results regarding country of study and type of condition/injury were supported by 2 previous studies examining orthopedic surgery procedures that found no variation of the effect of WC in subgroups based on country, compensation type, study type, injury, procedure, or follow-up period.(11, 12) This reveals that the effect of WC on surgical outcome is not solely an issue of malingering Americans. Compensation systems that do not incentivise feigning impairment, also observe worse outcomes associated with WC. Rather, this may indicate that increased impairment among workers receiving WC may be a result of psychological effects on patients caused by a sense of victimization or injustice.

Understanding the characteristics of WC can be a great help for investigators, because it often contributes to confounding bias in clinical studies. From our study, we can postulate several methods to reduce this. First, measuring results via pre- vs postoperative change can protect against bias introduced by WC. If this is not possible, our study indicates that functional measures are the outcome least affected by WC. It is important to note that we are not advocating against the use of PROs. They are frequently, and appropriately, used because they provide a more complete appraisal of a patient's condition, often including quality of life factors. However, as we have shown, they are also more likely to be biased by the receipt of WC. This must be taken into account when interpreting the results of studies involving WC and PROs.

This study has several limitations. First, a total of 131 studies met our original inclusion criteria for the meta-analysis, however we could include only 62 studies. PRO use is common, yet the results rarely lend themselves to translation into binary variables. At least one previous study evaluated both continuous and binary variables.(11) However, they needed to analyze these two types of outcomes separately and the number of continuous variables available for the analysis was limited. We performed two analyses, a systematic review and a meta-analysis, to include the maximum number of studies and obtain comprehensive results. The two analyses did not always agree, however. For instance, the comprehensive review showed that return to work is highly influenced by WC, whereas the meta-analysis revealed the opposite: return to work is less likely to be influenced by WC. In these cases, we were simply unable to draw a conclusion, as reflected by our interpretation of the results.

Another possible limitation is the inclusion of return to work or activities as an outcomes measure. Return to work/activities is often eliminated as an outcome measure because it is determined by a multitude of personal, societal, and systematic factors.(21–23) However, we included this outcome measurement because health in general is determined by these same factors. We also did not evaluate the pre- vs postoperative improvement in the meta-analysis, because in the majority of studies this outcome was reported as a continuous variable which could not be transformed into a binary variable. We could not include patient age or study

follow-up period in our analysis because they were not always reported thoroughly. Furthermore, follow-up time was not considered an influential factor in previous meta-analyses.⁽¹⁾ Finally, some of the factors in our meta-analysis had relatively high heterogeneity, which may reduce the reliability of our study. We took this into account in our interpretation of the results by confirming the correctness of the conclusion that functional measures were less affected by WC.

Bias introduced by patient receiving WC is a common hurdle in hand surgery research, in which work-related conditions and injuries are commonplace. Including compensated patients can result in artificial reduction of the therapeutic effect which may lead to incorrect conclusions. Our study confirmed, once again, that WC was associated with worse postoperative results. However we also identified variations in this effect depending on the outcome measurement methods used. To evaluate the result of work-related upper extremity surgeries appropriately in clinical studies, the choice of outcome measurement methods is critical.^(24, 25) We suggest using pre-vs postoperative change when possible or using functional measurements. Several physical measurement methods, which can be key to reducing the effect of WC on surgical outcome, that were used for disorders of the upper extremity are listed in Table 7. We have expanded upon previous research to suggest ways to mitigate the effects of WC in future studies. The findings obtained in this study can aid in analyzing precise results with less confounding bias.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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*Incorrect data: inconsistencies between data presented in the tables and in the text.

Figure 1.
Identification of studies in the primary literature search

Satisfaction

Pain

PRO instruments

Functional measures

PRO + functional instruments

Return to work or activity

Adverse event

Figure 2.

Type of outcomes in meta-analysis

PRO: Patient Reported Outcome, RT: Return To

These results suggested that authors can make use of functional measures outcomes or RT work or activity when they evaluate patients with work-related disorders because it is not as affected by the receipt of workers' compensation.

Figure 3.

Forest plot of Random-Effect Odds Ratios and 95% Confidence Intervals for each study in Meta-analysis

Overall, workers' compensation had a negative effect on outcomes after surgery.

Figure 4.

Funnel plot of the Odds Ratios for all studies in Meta-analysis.

P=0.108 from test for funnel plot asymmetry, based on linear regression method.

Statistically no publication bias was indicated in this study.

1. Harris, I., Mulford, J., Solomon, M., van Gelder, J. M., Young, J. Association between compensation status and outcome after surgery: a meta-analysis. *Jama* 2005;293:1644–1652.

Table 1

Inclusion and exclusion criteria for systematic review and meta-analysis

Analysis	Inclusion criteria	Exclusion criteria
Both systematic review and meta-analysis	<p>Studies of upper limb disorders and/or injuries</p> <p>Full-length articles including outcome data comparing patients receiving WC to patients not receiving WC</p> <p>Studies including at least 1 patient receiving WC and 1 uncompensated patient</p> <p>All patients underwent surgical treatment</p>	<p>Review articles</p> <p>Articles not written in English</p>
Systematic review	<p>Both WC and non-WC groups must include a sufficient number of patients to detect statistical significance *</p> <p>The authors must have performed statistical analysis to compare these two groups or mentioned significant differences in the abstract</p>	
Meta-analysis	<p>Presented data must be sufficient to perform a meta-analysis (i.e. sample size of each group for each result and/or ORs and SE, SD or 95% CI)</p> <p>Results were reported for WC and non-WC patients separately</p> <p>At least one outcome measured could be converted to a binary variable</p>	

WC: Workers' compensation, ORs: Odds ratios, SE: Standard error, SD: Standard deviation, CI: confidential interval

* To ensure the statistically significant, we set the inclusion criteria; Both WC and non-WC groups must include at least 10 patients.

Table 2

Categorized outcome measurement methods

Category	Representative outcome measurement methods
Satisfaction	Self-reported satisfaction, self-evaluated improvement
Pain	visual analog scale, scar tenderness, opioid use
PROs instruments	DASH, BCTQ, ASES, WORC, SST
Functional measures	Shoulder/wrist AOM, NCS, nonunion, grip strength
PRO + function instruments	Mayo wrist score, UCLA rating scale, MEPI
Return to work or activity	Return rate, time off work, time away from activity
Adverse events	Recurrence rate, reoperation, length of stay

PRO: Patient-Reported Outcome, DASH: Disabilities of the Arm, Shoulder and Hand, BCTQ: Boston Carpal Tunnel Outcomes questionnaire, ASES: American Shoulder and Elbow Surgeons shoulder score, WORC: Western Ontario Rotator Cuff Index score, SST: Simple Shoulder Test, AOM: Arc of Motion, NCS: Nerve Conduction Study, UCLA: University of California, Los Angeles, MEPI: Mayo Elbow Performance Index

Table 3

The subgroup analysis in meta-analysis of the association between compensation status and unsatisfactory outcome by study outcome.

Type of disorder	No. of studies	Odds Ratio	95% Confidence Interval	Heterogeneity I-squared (%)
Joint	24	2.81	2.27–3.48	7.3
Tendon	17	2.93	1.52–5.67	79.7
Nerve	21	3.88	2.59–5.81	55.1

The effect of worker's compensation on the outcome in nerve disorder showed higher odds ratio than the other two disorders meaning that outcomes following nerve disorders are more affected by the receipt of workers' compensation.

Table 4

The subgroup analysis in meta-analysis (n=62) of the association between compensation status and unsatisfactory outcome by reported country.

Country	No. of studies	Odds Ratio	95% Confidence Interval	Heterogeneity I-squared (%)
USA	51	3.29	2.57–4.22	55.6
Western *	10	2.68	1.05–6.82	86.8
France	3	1.19	0.05–31.16	95.9
Australia	2	3.81	2.35–6.18	0
Canada	2	3.18	0.74–13.73	0
Taiwan	1	1.96	0.39–11.81	-

PRO: Patient Reported Outcome, RT: Return To,

* "Western countries" is a combined group of studies from Australia, Canada, France, Norway, Switzerland, and UK.

There was no significant difference in the effect of receipt of workers' compensation based on country of study. Due to the similarity of results we will include studies from all countries in our analyses.

Table 5

Type of outcome in systematic review

Type of outcome measurement methods	Postoperative only		Pre- vs postoperative	
	Significant n(%)	Not significant n(%)	Significant n(%)	Not significant n(%)
Satisfaction	13(50)	13(50)	-	-
Pain	16(73)	6(27)	4(67)	2(33)
PROs instruments	31(82)	7(18)	5(42)	7(58)
PROs + function instruments	15(79)	4(21)	1(33)	2(67)
Functional measures	7(37)	12(63)	1(17)	5(83)
RT work or activity	21(70)	9(30)	-	-
Adverse event	5(50)	5(50)	-	-

Cells display the number (and percentage) of studies that used each outcome measurement method and whether results derived from that method were significantly affected by patients receiving workers' compensation.

PRO: Patient Reported Outcome, RT: Return To

These results suggested that examination of improvement in outcomes can reduce the effect of receiving workers' compensation when they evaluate patients with work-related disorders.

Table 6

Type of disorder in systematic review

Type of disorder	Postoperative only		Pre- vs postoperative	
	Significant n(%)	Not significant n(%)	Significant n(%)	Not significant n(%)
Joint	25(70)	8(30)	1(25)	3(75)
Tendon	24(89)	3(11)	2(40)	3(60)
Nerve	19(53)	17(47)	2(50)	1(50)
Others	1(50)	1(50)	-	-

Cells display the number (and percentage) of study about each type of disorder and whether the results were significantly affected by patients receiving workers' compensation.

The receipt of workers' compensation affected patients with nerve disorder less than patients with joint or tendon injuries/disorders. There was little difference among the three disorder groups regarding postoperative improvement outcomes, likely because of the limited number of studies.

Table 7

Typical physical measurement methods

Measurement methods	Evaluated disorders
Range of motion	Rotator cuff tear, impingement syndrome, ulnar wrist pain, Kienbock disease,
Grip, pinch, or other muscle strength	Chronic epicondylitis, ulnar wrist pain, rotator cuff injury, carpal tunnel syndrome, Kienbock disease
Nerve conduction study	Carpal tunnel syndrome
Bone union	Scaphoid fracture, ulnar impaction syndrome
Sensory test	Digital nerve injury