



Return to work after shoulder arthroplasty: a systematic review and meta-analysis



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Background: With the rising incidence of shoulder arthroplasty, there is increasing emphasis on improving functional outcomes and ability to return to work (RTW). The purpose of this study was to determine the rate of RTW after shoulder arthroplasty.

Methods: This systematic review and meta-analysis were performed in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. A literature search of 4 electronic databases was performed from database conception through April 2018 to identify studies reporting data on RTW after shoulder arthroplasty. The primary outcome was the rate of RTW after shoulder arthroplasty. Random-effects meta-analysis was used to pool the rate of RTW across studies.

Results: Seven studies were reviewed, including 447 patients at an average follow-up of 4.4 years (range, 1.0–12.6 years). The overall rate of RTW was 63.6% (95% confidence interval, 58.8%–68.2%) at a mean 2.3 months postoperatively (range, 0.3–24.0 months). RTW was significantly lower for patients with heavy-intensity occupations vs. all intensity types (61.7% vs. 67.6%; $P = .04$). RTW did not differ between anatomic total shoulder arthroplasty (63.4%) and hemiarthroplasty (66.1%) or reverse total shoulder arthroplasty (61.5%; $P = .53$). There were no significant differences in RTW among underlying diagnoses (osteoarthritis, 64.4%; cuff tear arthropathy, 65.6%; proximal humerus fracture, 69.1%; $P = .41$) or by workers' compensation status (61.2% vs. 65.3%; $P = .41$).

Conclusions: A majority of patients return to work after shoulder arthroplasty at an average of 2.3 months postoperatively. Those with heavy-intensity occupation return at significantly lower rates, whereas no differences in RTW by arthroplasty type, underlying diagnosis, or workers' compensation were found.

Level of evidence: Level IV; Systematic Review

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Shoulder arthroplasty, an increasingly common procedure, has grown from 14,000 total operations in 2000 to 67,000 in 2011.^{20,23,36} As indications for humeral hemiarthroplasty (HHA), anatomic total shoulder arthroplasty (aTSA), or reverse total shoulder arthroplasty (rTSA)

continue to expand³⁶ and as these procedures demonstrate good clinical and functional outcomes, this growth is only expected to continue in the coming years. With increasing demand in younger patients³⁰ combined with a rising age of retirement,³³ more emphasis is likely to be placed not only on improving pain and functional outcomes but also on whether patients are able to return to work (RTW) after shoulder arthroplasty.

Several studies evaluating RTW in shoulder arthroplasty have demonstrated varying levels of RTW by arthroplasty type, diagnosis, and work intensity.^{3,15,16,19,21,24,28} Although these studies have been informative, they focus on individual populations typically undergoing one type of arthroplasty, and comparisons across different demographics, arthroplasty types, diagnoses, and work intensities have not been performed. In particular, it has been suggested that workers' compensation (WC) claims may have a significant impact on patient outcomes and RTW in individual populations.^{4,5,17,18,28,32} Whether pooling data from these various studies will demonstrate differences in RTW is unknown.

The goal of this systematic review and meta-analysis was to examine RTW after shoulder arthroplasty, with a focus on understanding the impact of WC claims on RTW. We hypothesized that RTW after shoulder arthroplasty will be high, but that those patients with WC claims will return at a lower rate than those without such claims. We further hypothesized that patients undergoing aTSA would return to work at a higher rate than those undergoing HHA or rTSA.

Materials and methods

Systematic review and meta-analysis of the available literature were performed, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.²⁶ The search was performed in the PubMed, Scopus, Embase, and Cochrane Library databases using the keywords "shoulder arthroplasty," "shoulder replacement," "shoulder hemiarthroplasty," or "humeral resurfacing" combined with "return to work." The final search was performed on April 16, 2018. In addition to these databases, a similar search was also performed in clinicaltrials.gov and Clinical Trials Registry Platform to identify any current trials relevant to our study. The references of each article were also checked manually for potential inclusion in the study.

Selection criteria

Clinical studies were evaluated and included if they were in English, had level of evidence I to IV, and reported on RTW after shoulder arthroplasty. Nonclinical studies, literature reviews, expert opinions, case reports, and those not reporting on RTW after shoulder arthroplasty were excluded. Studies were reviewed by 2 of the study authors (M.E.S. and J.N.L.), who performed title and abstract reviews separately. The full texts of articles meeting

inclusion criteria based on title and abstract were then reviewed for final inclusion in the study, with authors coming to a consensus in the case of disagreement.

Quality evaluation

No randomized trials evaluating RTW in shoulder arthroplasty were identified. Therefore, included studies were evaluated using the Methodological Index for Non-Randomized Studies (MINORS) checklist.³⁹ Studies were evaluated on 8 to 12 items, with each scored 0 (not reported), 1 (reported but poorly or inadequately done), or 2 (reported, well done and adequate), with a maximum score of 16 and 24 for noncomparative and comparative studies, respectively. Articles were each scored by 2 of the study authors (M.E.S. and J.N.L.), with the authors coming to consensus in the case of disagreement.

Data extraction and analysis

A standardized form was used for data extraction in evaluating each of the studies. This form covered characteristics of the study (design, year, and number of patients), patients' demographics (age, sex, arm dominance, whether the patient received WC, type of work, time to RTW, preoperative and postoperative level of work), type of arthroplasty (aTSA, rTSA, HHA), underlying diagnosis and clinical results at final follow-up.

The metaphor package implemented in R software version 3.1.0 (R Foundation for Statistical Computing, Vienna, Austria) and Comprehensive Meta-Analysis version 2 software (Biostat, Englewood, NJ, USA) were used for data analysis. The primary analysis was the rate of RTW after shoulder arthroplasty and the time to return. The I^2 index was used to measure the heterogeneity of the included studies. Thresholds were low for I^2 between 25% and 49%, moderate for I^2 between 50% and 74%, and high for I^2 above 75%. Because of a high level of heterogeneity, a random-effects model was used to combine RTW data by meta-analysis. As in previous work,²⁵ raw data on RTW were stabilized using the Freeman-Tukey double arcsine transformation,¹⁴ with weighted averages of these transformed values determined using random-effects DerSimonian-Laird models and finally back-transformed to determine final pooled rates.^{8,9,27} Studies with duplicate populations of patients were included in the systematic review, but duplicated population data were excluded from the pooled meta-analysis.

The rate of RTW was reported as a mean with 95% confidence interval, with rates from different studies and populations depicted in a forest plot diagram. Secondary outcomes included patient-reported outcomes and complication rates. Exploratory meta-regression was used to compare RTW by arthroplasty type, underlying diagnoses, and work intensity level; intensity level was categorized as sedentary, light, moderate, or heavy as defined by the United States Department of Labor.⁴⁰

A funnel chart was used to assess publication bias of the included studies, with study size plotted on the y-axis and estimated treatment effect on the x-axis. The point estimates should be evenly and symmetrically distributed about the real treatment effect in the event of no bias.¹⁰ A P value of $< .05$ was used to signify statistical significance in all tests.

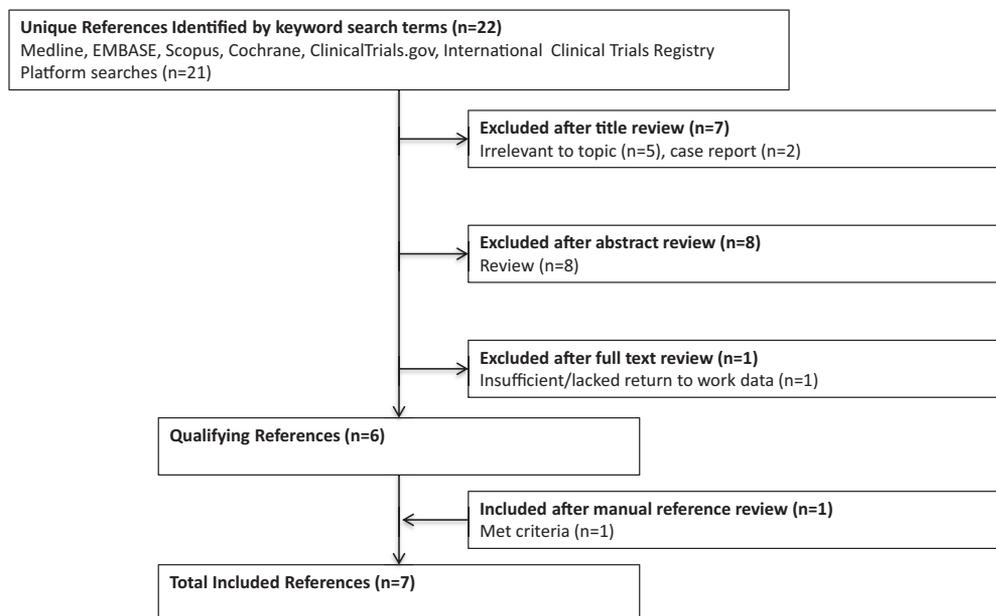


Figure 1 Flow diagram presenting the systematic review process used in this study.

Results

Study inclusion

A total of 7 studies were included in the systematic review; the selection process is summarized in [Figure 1](#).^{3,15,16,19,21,24,28} Of note, 2 additional studies reported data on RTW but were excluded because of lack of clarity with regard to presented data. Zarkadas et al,⁴⁴ for example, noted that 15 patients in their total shoulder arthroplasty (TSA) group returned to full-time or part-time work, 21 had retired, and 16 were on disability or unemployed; but it was unclear whether those who had retired had done so voluntarily, and this study was therefore not included in our analysis. In another study, Chen et al⁵ studied 70 total patients undergoing TSA or HHA but reported RTW for only 39 patients, so this study was also excluded, given the uncertainty about any potential bias reflected in this select group.

Study characteristics and quality

All 7 studies were retrospective, and 3 were comparative ([Table I](#)). In 2 of the comparative studies, WC was the basis for the comparison, with both Jawa et al²¹ and Morris et al²⁸ reporting on patients with and without WC. In 1 comparative study, Hurwit et al,¹⁹ type of arthroplasty was the basis for comparison, with 1 group undergoing rTSA and another undergoing HHA. The mean (\pm standard deviation) MINORS score was 9.3 (\pm 1.5) of 16 for non-comparative studies and 17.7 (\pm 2.1) of 24 for comparative studies. Item analysis demonstrated that 1 study²⁶

prospectively collected data, but none of the studies prospectively calculated study size. All studies had biased assessments of the study end point, and 6 of 7 had loss to follow-up of $<5\%$. Average follow-up was 4.4 years (range, 1.0-12.6 years).

Characteristics of the patients

A total of 447 patients were included in the 7 studies, including 179 men and 268 women (reported in all 7 studies); mean age was 63.6 years (range, 27.6-97.1 years), and body mass index was 28.7 kg/m² ([Table II](#)). When arm dominance was noted ($n = 6$ studies), the dominant shoulder was involved in 65.9% (286/434) of cases. Of the total population of patients, after exclusion of those who were retired or not seeking employment preoperatively, there were a total 317 patients for evaluation of RTW postoperatively. WC claims were made by 32 patients (as reported in 3 studies).

Characteristics of diagnosis and treatment

The preoperative diagnosis was reported in all 7 studies ([Table III](#)). Patients underwent shoulder arthroplasty most commonly for osteoarthritis ($n = 257$), cuff tear arthropathy ($n = 106$), proximal humerus fracture ($n = 26$), avascular necrosis ($n = 13$), massive rotator cuff tear ($n = 8$), rheumatoid arthritis ($n = 20$), post-traumatic malunion ($n = 4$), capsulorrhaphy arthropathy ($n = 2$), and failed prior arthroplasty ($n = 9$). The most commonly performed arthroplasties included aTSA ($n = 122$), HHA ($n = 75$), and rTSA ($n = 65$). There were no cases of humeral

Table I Study characteristics

Study	Year	Design	No. of groups	Level of evidence	Mean follow-up (range), yr	MINORS score
Bülhoff et al ³	2015	Retrospective	1	IV	6.2 (2.6-12.6)	7/16
Jawa et al ²¹	2015	Retrospective	2	III	3.9 (2.0-5.6)	17/24
Morris et al ²⁸	2015	Retrospective	2	III	3.5 (2-8)	20/24
Garcia et al ¹⁶ (rTSA)	2016	Retrospective	1	IV	2.6 (1-4.7)	10/16
Garcia et al ¹⁵ (HHA)	2016	Retrospective	1	IV	5.1 (1-7.5)	10/16
Hurwit et al ¹⁹	2017	Retrospective	2	III	HHA: 5.3 (1.1-7.5) rTSA*: 2.7 (1.0-4.9)	16/24
Liu et al ²⁴	2018	Retrospective	1	IV	5.4 (2.5-8.6)	10/16

MINORS, Methodological Index for Non-Randomized Studies; rTSA, reverse total shoulder arthroplasty; HHA, humeral hemiarthroplasty.

* Represents duplicate data from Garcia et al; not included in the meta-analysis.

resurfacing or glenoid resurfacing/corrective reaming in the included studies.

RTW

The overall rate of RTW among the 7 studies, excluding those patients who had retired preoperatively, was 63.6% (95% confidence interval, 58.8%-68.2%; Fig. 2). Mean time out of work was 2.3 months (range, 0.3-24.0

months) as reported by 5 studies. Studies exhibited high heterogeneity ($I^2 = 93.5\%$). By arthroplasty type, there was no significant difference in RTW for patients undergoing HHA (66.1%), aTSA (65.3%), or rTSA (61.5%; $P = .53$). On analysis by WC status, a significant difference was not found in RTW for patients receiving WC (61.2%) compared with those who were not (65.3%; $P = .41$; Fig. 3). RTW was also evaluated by underlying diagnosis and work intensity. No significant difference was found for RTW by underlying diagnosis, with rates of return of

Table II Characteristics of the patients

Study	No. of patients	Mean age (range), yr	Gender (M/F), n	Dominant/nondominant, n	BMI, kg/m ² (range)	WC/NWC	RTW	Work intensity
Bülhoff et al, ³ 2015	154	72 (33-88)	35/119	103/51	NR	NR	22/57 (38.6%)*	NR
Jawa et al, ²¹ 2015	13	55.9 (39-74)	13/0	NR	NR	13/0	4/13 (30.8%)	1 light, 12 heavy
Morris et al, ²⁸ 2015	28	WC: 58.8 (49-69) NWC: 63.4 (50-72)	20/8	19/9	WC: 32.0 (SD, ±8.4) NWC: 27.1 (SD, ±5.3)	14/14	WC: 2/14 (14.3%) NWC: 5/11 (45.5%)*	WC: 8 sedentary/light, 6 heavy/strenuous NWC: 3 retired, 7 sedentary/light, 4 heavy/strenuous
Garcia et al, ¹⁶ 2016 (rTSA)	40	74.7 (56-82)	16/24	26/14	28.8 (14.8-46.2)	0/40	26/40 (65%)	25 sedentary, 15 light
Garcia et al, ¹⁵ 2016 (HHA)	79	69 (27.6-97.1)	24/55	62/17	28.3 (19.8-49.3)	0/79	34/49 (69.4%)*	20 sedentary, 25 light, 4 moderate
Hurwit et al, ¹⁹ 2017	81	HHA: 60.8 (40-88) rTSA: 68.6 (41-88)	33/48	52/29	HHA: 28.9 rTSA: 29.5	NR	55/81 (84.6%)	44 sedentary, 33 light, 4 heavy
Liu et al, ²⁴ 2018	52	67.2 (56-96)	38/14	24/28	28.0 (18.1-52.9)	5/47	48/52 (92%)	10 sedentary, 14 light, 17 moderate, 11 heavy

BMI, body mass index; WC, workers' compensation; NWC, non-workers' compensation; RTW, return to work; NR, not reported; SD, standard deviation; rTSA, reverse total shoulder arthroplasty; HHA, humeral hemiarthroplasty.

* Excluding those who were retired preoperatively.

Table III Diagnosis and surgical characteristics

Study	Diagnosis	Surgery	Mean time out of work (range), mo	Complications
Bülhoff et al, ³ 2015	Primary OA, 154 (100%)	aTSA	NR	NR
Jawa et al, ²¹ 2015	OA, 11 (84.6%); capsulorrhaphy arthropathy, 2 (15.4%)	aTSA	4.2 (2.9-6.0)	NR
Morris et al, ²⁸ 2015	CTA, 14; massive RCT, 8; post-traumatic malunion, 4; failed prior arthroplasty, 2	rTSA	NR	WC (4): postoperative anterior dislocation (2), intraoperative humeral shaft fracture, postoperative periprosthetic infection NWC (2): postoperative anterior dislocation
Garcia et al, ¹⁶ 2016 (RTSA)	CTA, 21 (52.5%); OA, 10 (25%); PHFx, 7 (17.5%); RA, 2 (5%)	rTSA	2.3 (0.5-11)	NR
Garcia et al, ¹⁵ 2016 (HHA)	OA, 40 (50.6%); PHFx, 17 (21.5%); AVN, 11 (13.9%); CTA, 8 (10.1%); RA, 3 (3.8%)	HHA	1.4 (0.25-24)	8 complications: 4 revision HHA (2 for dislocation, 2 for periprosthetic fracture after fall); 3 HHA revised to TSA; 1 HHA revised to rTSA for continued pain/glenoid wear; no infections
Hurwit et al, ¹⁹ 2017	CTA, 63 (77.8%); RA, 14 (17.2%); PHFx, 2 (2.5%)	rTSA HHA	rTSA: 3.1 HHA: 2.3	rTSA: 20 chronic pain and stiffness/limited mobility; 1 returned to OR HHA: 4 chronic pain and stiffness/limited mobility; 5 returned to OR
Liu et al, ²⁴ 2018	OA, 42 (81%); failed prior arthroplasty, 7 (13%); AVN, 2 (4%); RA, 1 (2%)	aTSA	2.1 (SD: 1.7)	22 complications: 17 postoperative stiffness, 6 chronic pain, 3 instability, 4 returned to the OR

OA, osteoarthritis; CTA, cuff tear arthropathy; RCT, rotator cuff tear; PHFx, proximal humerus fracture; RA, rheumatoid arthritis; AVN, avascular necrosis; aTSA, anatomic total shoulder arthroplasty; rTSA, reverse total shoulder arthroplasty; HHA, humeral hemiarthroplasty; TSA, total shoulder arthroplasty; NR, not reported; WC, workers' compensation; NWC, non-workers' compensation; OR, operating room.

64.4%, 65.6%, and 69.1% for osteoarthritis, cuff tear arthropathy, and proximal humerus fracture ($P = .41$), respectively, and high heterogeneity ($I^2 = 88.0\%$; Fig. 4). RTW by work intensity was reported, with return to sedentary, light, moderate, and heavy work of 69.1%, 66.9%, 69.0%, and 61.7% ($P = .16$), respectively, with I^2 of 80.7% (Fig. 5). There was a statistically lower RTW reported in those with heavy-intensity jobs in comparison to the overall group ($P = .04$).

Postoperative complications

Sixty-six complications were reported by a total of 4 studies (Table III). The most common postoperative complications were postoperative stiffness/pain ($n = 47$), anterior dislocation or shoulder instability ($n = 16$) and progressive arthritis requiring revision ($n = 7$), periprosthetic fracture ($n = 3$), and infection ($n = 1$). In total, 14 patients were reported to have returned to the operating room for revision.

Functional outcome and patient satisfaction

Functional outcomes are reported in Table IV. The rate of patient satisfaction with surgery was reported in 4 studies and ranged from 57% to 100%. Pain scores were reported in 5 studies, showing statistically significant improvements in the 4 studies in which both preoperative and postoperative values were reported. In 2 studies,^{21,28} significant differences in postoperative pain scores were noted between WC and non-WC groups, with those studies claiming that WC patients experienced greater pain. Functional outcomes were reported by 5 studies, with significant improvements noted in the 4 studies in which both preoperative and postoperative functional outcomes were noted. Again, in 2 studies, significant differences were reported between postoperative WC and non-WC groups. Jawa et al²¹ noted significantly greater American Shoulder and Elbow Surgeons (ASES) scores in the non-WC group ($P = .01$), although 12-Item Short Form Health Survey physical and mental components showed no significant differences between these

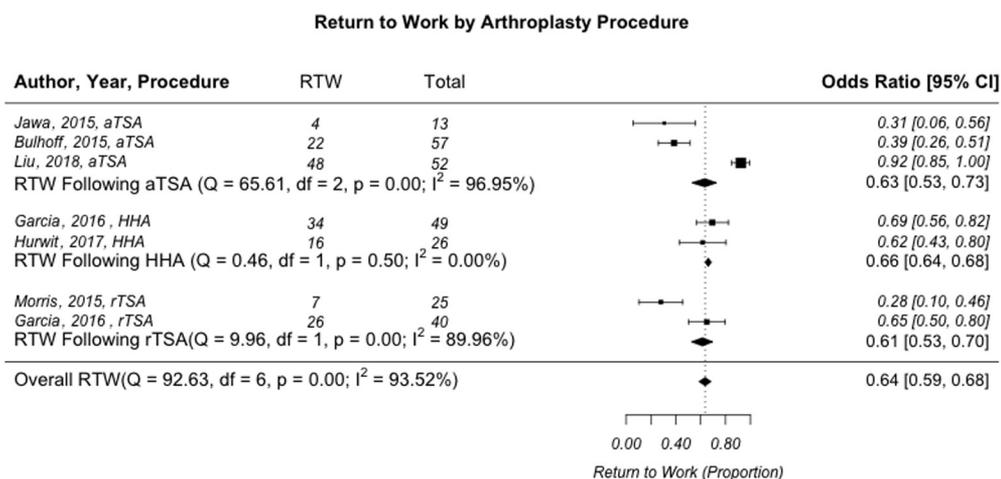


Figure 2 Return to work (RTW) by type of arthroplasty procedure. *CI*, confidence interval; *aTSA*, anatomic total shoulder arthroplasty; *HHA*, humeral hemiarthroplasty; *rTSA*, reverse total shoulder arthroplasty.

groups ($P = .09$ and $P = .6$, respectively). Morris et al²⁸ reported significant differences in modified Constant ($P = .001$), ASES ($P = .002$), Western Ontario Osteoarthritis of the Shoulder index ($P = .001$), and satisfaction ($P = .029$) scores between these 2 groups, although there was no significant difference in Single Assessment Numeric Evaluation scores.

Discussion

The results of our study demonstrate that about two-thirds of patients undergoing shoulder arthroplasty are able to return to work postoperatively. Patients return at an average of 2.3 months postoperatively, with a wide range of 0.3 to 24 months. Stratified by type of arthroplasty, no differences in the rate of RTW were found, ranging from 63.3% for rTSA to 66.1% for HHA. Similarly, there were no

significant differences in RTW among different underlying diagnoses or WC status. Compared with the overall group, patients with heavy-intensity work returned at a lower rate.

One of the surprising findings of our study was the lack of difference in RTW for patients with and without WC claims. Others have studied the differences between patients with WC claims and those without and reported differences. Morris et al,²⁸ one of the studies included in our analysis, evaluated outcomes for WC patients and a control group undergoing rTSA. Whereas they noted significant improvements in all shoulder functional scores for both the WC and non-WC groups, they found that the WC group had significantly worse Constant, ASES, and Western Ontario Osteoarthritis of the Shoulder index scores. Although not significant, rates of RTW were different, with only 14.2% of WC patients returning to work compared with 45.5% of non-WC patients. Patient satisfaction differed between the groups, with 57% and 93% of WC and

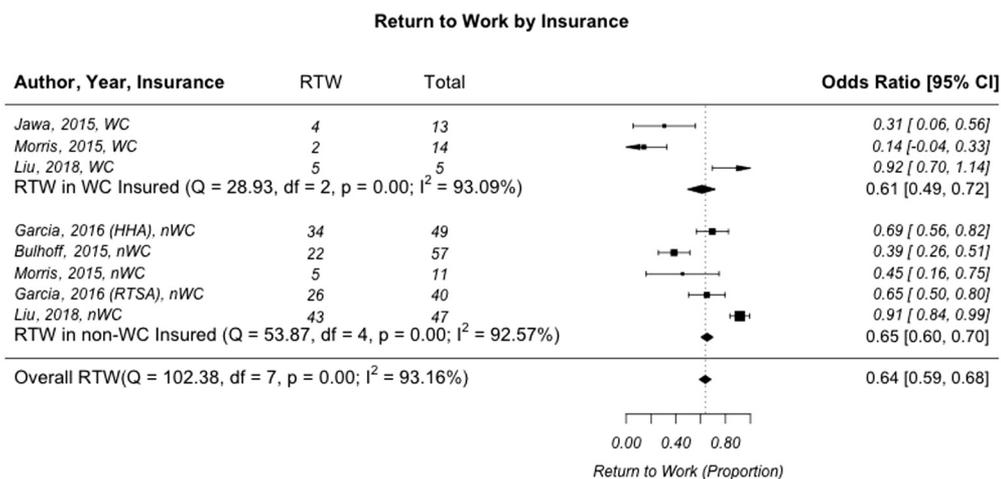


Figure 3 Return to work (RTW) in workers' compensation (WC) vs non-workers' compensation (nWC) patients. *CI*, confidence interval; *HHA*, humeral hemiarthroplasty; *rTSA*, reverse total shoulder arthroplasty.

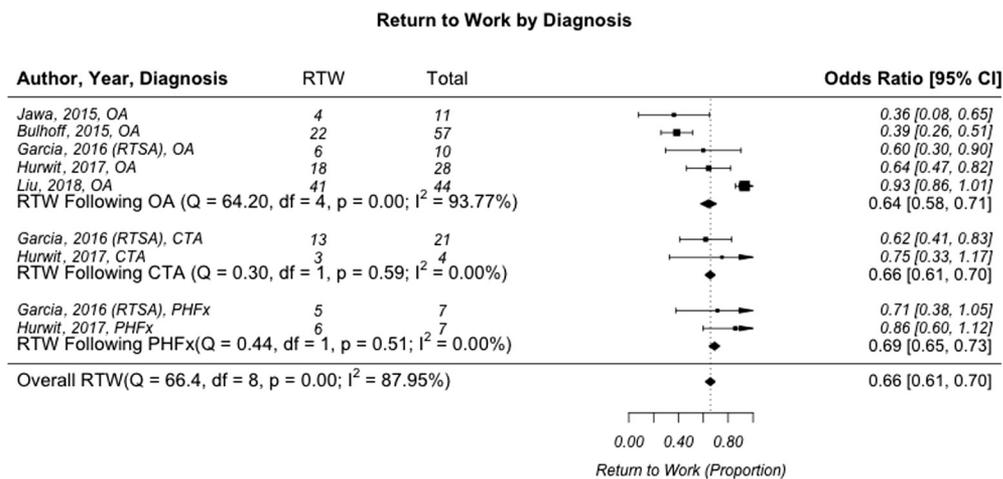


Figure 4 Return to work by (RTW) diagnoses. *CI*, confidence interval; *OA*, osteoarthritis; *CTA*, cuff tear arthropathy; *PHFx*, proximal humerus fracture; *RTSA*, reverse total shoulder arthroplasty.

non-WC patients satisfied or very satisfied, respectively.²⁸ Similarly, Chen et al⁵ studied 70 total patients undergoing TSA or HHA and noted a significant association between satisfaction and WC status ($P = .018$), although only 5 of 70 patients had WC.

Similar findings exist throughout the shoulder literature. Cameron et al⁴ studied grade IV osteochondral lesions managed with débridement and capsular release and found that WC patients had significantly higher postoperative pain, lower functional scores, and lower satisfaction. In the rotator cuff literature, patients with WC claims have been found to be significantly less compliant with postoperative protocols and have less improvement in functional outcomes and pain from preoperatively to postoperatively.⁶ In

a case-control study of rotator cuff-related injury, Holtby and Razmjou¹⁸ demonstrated significantly lower functional outcomes for WC patients. More recently, Razmjou et al³² reported that WC was significantly associated with worse flexion recovery in patients with preoperative restricted range of motion undergoing arthroscopic rotator cuff surgery. Finally, Henn et al¹⁷ performed a prospective study of 125 patients undergoing primary rotator cuff repair and found that WC patients had worse performance on the Simple Shoulder Test, Disabilities of the Arm, Shoulder and Hand index, and 36-Item Short Form Health Survey as well as worse visual analog scale pain and function outcomes after controlling for confounding factors, including age, marital status, education level, preoperative

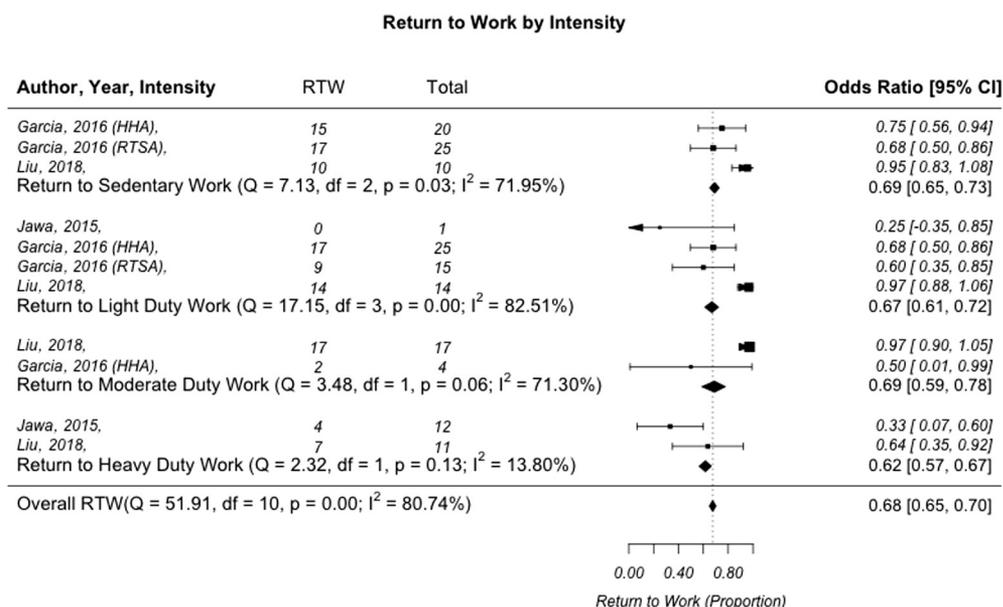


Figure 5 Return to work (RTW) by level of work intensity. *CI*, confidence interval; *HHA*, humeral hemiarthroplasty; *RTSA*, reverse total shoulder arthroplasty.

Table IV Pain and functional outcome scores

Study	Preoperative pain	Final pain	<i>P</i> value	Preoperative functional	Final functional	<i>P</i> value
Bülhoff et al, ³ 2015	NR	NR	NR	NR	NR	NR
Jawa et al, ²¹ 2015	NR	VAS: WC, 2.5; NWC, 1.0 (<i>P</i> = .01)*	NR	NR	ASES: WC, 73.6; NWC, 86.6 (<i>P</i> = .01)* SF-12: WC, P 41.8, M 53.1; NWC, P 47.3, M 52.9 (<i>P</i> = .09 and <i>P</i> = .6 for P and M components)	NR
Morris et al, ²⁸ 2015	Constant: WC, 2.4; NWC, 3.9 ASES: WC, 6.9; NWC, 5.9	Constant: WC, 6.6; NWC, 11.6 (<i>P</i> = .002)* ASES: WC, 3.7; NWC, 1.7 (<i>P</i> = .035)*	<.001	Adjusted Constant: WC, 15.7; NWC, 25.7 ASES: WC, 24.6; NWC, 33.4 WOOS: WC, 80.6; NWC, 71.4 SANE: WC, 20.9; NWC, 19.2	Adjusted Constant: WC, 53.8; NWC, 85.0 (<i>P</i> = .001)* ASES: WC, 48.0; NWC, 70.7 (<i>P</i> = .002)* WOOS: WC, 56.4; NWC, 28.4 (<i>P</i> = .001)* SANE: WC, 51.0; NWC, 56.9 (<i>P</i> = .768) Satisfaction: WC, 57%; NWC, 93% (<i>P</i> = .029)*	<.001
Garcia et al, ¹⁶ 2016 (rTSA)	VAS, 6.57	VAS, 0.63	<.001	ASES, 34.0	ASES, 81.7 96.2% satisfied of returning to work	<.001 (ASES)
Garcia et al, ¹⁵ 2016 (HHA)	VAS, 6.2	VAS, 2.1	<.001	ASES, 34.6	ASES, 71.3 79.7% fairly satisfied or satisfied with procedure	<.001 (ASES)
Liu et al, ²⁴ 2018	VAS, 5.5	VAS, 0.9	<.0001	ASES, 39.9	ASES, 88.3	<.0001

rTSA, reverse total shoulder arthroplasty; HHA, humeral hemiarthroplasty; NR, not reported; WC, workers' compensation; NWC, non-workers' compensation; VAS, visual analog scale; SF-12, 12-Item Short Form Health Survey; P, physical component; M, mental component; ASES, American Shoulder and Elbow Surgeons score; WOOS, Western Ontario Osteoarthritis of the Shoulder index; SANE, Single Assessment Numeric Evaluation.

* Significant differences between WC and NWC groups.

expectations, work demands, smoking, comorbidities, duration of symptoms, size of tear, and repair technique. Other similar results have been found for acromioplasty,²⁹ superior labral anterior-posterior tear,^{7,31,41} and biceps tenodesis for failed superior labral anterior-posterior repair.⁴³

The underlying reasons to explain these robust differences remain unknown. A study by Balyk et al¹ assessed patients undergoing rotator cuff repair and found that WC patients were younger and more likely to smoke, to have traumatic injury, and to undergo surgery within 6 months of injury. They found worse outcomes in terms of range of motion, ASES score, and Western Ontario Rotator Cuff index score; however, once these preoperative variables were controlled for, only 6-month Western Ontario Rotator Cuff index scores were lower in WC patients. The authors suggested that consideration of preoperative differences between these populations of patients is vital as they explain a considerable portion of the divergence in

outcomes.¹ In their study of rotator cuff tear, Henn et al¹⁷ found that WC patients had lower preoperative expectations and suggested that these lower expectations might be due to education, previous medical experiences, and potential secondary gain. Nevertheless, after controlling for many of these potential confounding factors, the differences in pain and outcomes persisted, suggesting that the WC claim itself may play a pivotal role. The authors suggested that either the process of making a claim may be leading to worse outcomes or these claims are also associated with another unidentified factor causing worse outcomes. Secondary gain, for example, may be such a variable that has an important impact but is difficult to isolate. Given these commonly reported findings, it is curious that our study did not identify such differences. The lack of significance found in our analysis could be due to many factors, including insufficient sample size or differences in the underlying population of patients. When patients from the study of Liu et al are excluded from the

analysis, the difference between WC and non-WC patients becomes significant, with WC patients returning at a lower rate. The population in their study was young and mostly white and included only 5 WC patients, so this may not be reflective of the general population.

Considering type of arthroplasty, it is further surprising that no differences were found between HHA, aTSA, and rTSA as aTSA has shown improvements in clinical and functional outcomes as well as in patient satisfaction in several studies.^{11,13,24} A Cochrane review³⁸ studied TSA and HHA and found that those undergoing HHA had statistically significant worse functional scores but no differences in pain, quality of life, and adverse events. In the studies included in our review, we found no differences between these groups, with patients undergoing HHA returning to work at a rate of 66.1%, whereas those with aTSA and rTSA returned at rates of 63.4% and 61.5%, respectively. The lack of differences between these groups—and the higher relative return in the HHA group—is likely due to small sample size. Another possible explanation is that patients receiving HHA tend to be younger, as in the study by Hurwit et al,¹⁹ and more likely to return to work than an older cohort.

Regarding work intensity, we found a significantly lower rate of RTW for patients performing heavy-intensity labor (61.7%) compared with the overall population reporting on intensity (67.6%). This finding was unsurprising and intuitive and reflects prior literature. In their study of HHA, Garcia et al¹⁵ found that rate and time of RTW were correlated with intensity, with 75%, 68%, and 50% of patients returning to sedentary, light, and moderate work, respectively, at an average of 1.9, 2.6, and 13.1 months, respectively. In a study of rTSA, Garcia et al¹⁶ noted similar findings, with those returning to sedentary and light work returning at a mean of 1.4 and 4.0 months, respectively. Studies by Jawa et al²¹ and Liu et al²⁴ reported similar findings, with those performing heavy-intensity work returning at a lower rate. These findings are important, particularly considering arthroplasty in younger patients who may be performing heavier work. Whereas Liu et al studied RTW in younger patients at 5 years postoperatively, relatively little is published on longer term outcomes of shoulder arthroplasty in a population of younger patients returning to heavy work. A meta-analysis of patients younger than 65 years who underwent TSA demonstrated a weighted revision rate of 17.4% at an average of 9.4 years postoperatively, although their level of work was not explicitly examined.³⁴ Thus, it may be reasonable for young patients to return to their previous level of work, with the caveat that they may eventually require either revision surgery or a decrease in their work intensity should they become symptomatic.

In addition to longer term data on work intensity in this younger cohort, another important consideration is whether implant survival rates differ by anatomic or reverse TSA.

Whereas some have found that rTSA is associated with higher complication rates,³⁵ others have found similar outcomes between the implant types. A 2015 study of a Norwegian arthroplasty registry demonstrated similar survival rates for rTSA and aTSA, with rTSA 5- and 10-year survival rates of 92% and 85%, respectively; the survival for aTSA at the same time points was 92% and 87%, respectively.¹² Comparative studies have demonstrated similar results as well, with rTSA and aTSA both requiring revision in 5%-11% of cases at 2 years of follow-up.^{22,42}

Our study has several limitations. First, identification of studies for this review relied on the search strategy described previously and inclusion of works in the searched databases. To limit the possibility of overlooking relevant studies, we searched 4 databases as well as clinical trials registries in addition to performing a reference review of all studies included in the full-text review stage. Our data rely on those reported in the included studies, and we are therefore limited by the clarity with which those results are reported as well as by the study design and level of evidence of the included works. For this reason, we employed the MINORS score to evaluate the quality of the included studies, which overall were found to be of acceptable quality, and analyzed for publication bias, finding no suggestion of a publication bias. Furthermore, our data showed a high level of heterogeneity and may be subject to treatment bias effect, which may have an impact on our findings. Specifically, surgeon-specific postoperative rehabilitation protocols were detailed in only 3 of the studies,^{3,19,21} which were conflicting in their recommendations. Similarly, with regard to work intensity, the study is limited by what was reported and may exclude important nuances that have functional consequences (eg, specific type of work and whether work involves overhead activities). To limit any bias introduced by heterogeneity, a random-effects model was used to perform the meta-analyses. In addition, although a potential drawback, the heterogeneous data are reflective of the reality of clinical practice and may therefore most accurately represent what surgeons actually encounter in the clinical setting.^{2,37}

Conclusions

We report the rate of RTW after shoulder arthroplasty with a systematic review and meta-analysis combining the results of 317 patients. A majority (63.6%) of patients are able to return to work after shoulder arthroplasty at an average of 2.3 months postoperatively. Those with heavy-intensity occupations return at a significantly lower rate, although we found no differences in RTW by underlying diagnosis, including osteoarthritis and cuff tear arthropathy. Similarly, no

differences in RTW were found by arthroplasty type or WC status.

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