JSES International 5 (2021) 413–423

Contents lists available at ScienceDirect

JSES International

journal homepage: www.jsesinternational.org

Complication rates and outcomes after outpatient shoulder arthroplasty: a systematic review

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ARTICLE INFO

Keywords:
Total shoulder arthroplasty (TSA)
Reverse total shoulder arthroplasty (rTSA)
Outpatient
Ambulatory

Level of evidence: Level IV; Systematic Review

Background: As the number of total shoulder arthroplasties (TSAs) performed annually increases, some surgeons have begun to shift toward performing TSAs in the outpatient setting. However, it is imperative to establish the safety of outpatient TSA. The purpose of this systematic review was to define complication, readmission, and reoperation rates and patient-reported outcomes after outpatient TSA.

Methods: A systematic review of the literature was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines using three databases (PubMed, Ovid, and Embase). English-language publications describing results on complication rates in patients who underwent TSA in an outpatient or ambulatory setting were included. All nonclinical and deidentified database studies were excluded. Bias assessment was conducted with the methodologic index for nonrandomized studies criteria.

Results: Seven studies describing outcomes in outpatient TSA were identified for inclusion. The included studies used varying criteria for selecting patients for an outpatient procedure. The total outpatient 90-day complication rate (commonly including hematomas, wound issues, and nerve palsies) ranged from 7.1%-11.5%. Readmission rates ranged from 0%-3.7%, and emergency and urgent care visits ranged from 2.4%-16.1%. Patient-reported outcomes improved significantly after outpatient TSA in all studies. Two studies found a higher complication rate in the comparative inpatient cohort (P = .023-.027). Methodologic index for nonrandomized studies scores ranged from 9 to 11 (of 16) for noncomparative studies (n = 3), while all comparative studies received a score of a 16 (of 24).

Conclusion: Outpatient TSA in properly selected patients results in a similar complication rate to inpatient TSA. Further studies are needed to aid in determining proper risk stratification to direct patients to inpatient or outpatient shoulder arthroplasty.

With an ever-increasing emphasis on cost-effective delivery of health care, total joint arthroplasty (TJA) has received continued attention as a target for improved efficiency and cost reduction.[35] These efforts have resulted in decreased lengths of stay and gradual transition to outpatient and same-day discharges for various TJA procedures. This transition has initially been observed in total knee (TKA) and total hip (THA) arthroplasty.[18,29] However, this move has recently received more attention in the total shoulder arthroplasty (TSA) literature, given the continued increase in the number of TSA procedures and concurrent decrease in both lengths of stay and complication rates.[1,11,14,19–21,27,31,33,34] However, the push for improved efficiency and cost reduction must be continually balanced with concerns for patient safety, perioperative complications, and patient outcomes.

Retrospective investigations have demonstrated no significant differences between same-day discharge and inpatient TSA for several measures of perioperative complications including readmission rates, emergency department visits, and 1-year mortality.[6,8,22,26] Given that candidates for outpatient arthroplasty are generally healthier with fewer comorbidities, they may even have significantly lower complication rates postoperatively.[26,30] Additional studies have attempted to identify patient populations and characteristics that make them suitable candidates for outpatient arthroplasty procedure. This has included patient selection algorithms that are subsequently tested based on observed complications rates, including cardiopulmonary, thromboembolic events, wound complications, pain management issues, and readmission rates.[5,16]

This study was performed at Rush University Medical Center.
Institutional review board approval was not required for this systematic review.

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https://doi.org/10.1016/j.jseint.2020.11.005
2666-6383/

As the economic and healthcare system pressures continue to push TSA procedures into the outpatient and ambulatory setting, it is imperative to have a comprehensive understanding of the current literature including perioperative complications, readmission rates, and ultimately patient-reported outcomes (PROs). Therefore, the purpose of this investigation was to perform a systematic review and summary of the available literature regarding outpatient TSA, including complications, and PROs.

Methods

Search strategy

Systematic review registration was performed in March 2020 using the International Prospective Register of Systematic Reviews (currently under editorial assessment). This investigation was completed in accordance with the 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. A search of the literature was performed to identify articles investigating complication rates after outpatient TSA or reverse TSA (rTSA). PubMed, Ovid, and Embase databases were searched for relevant studies from the inception of the databases to February 25, 2020. Search terms included a combination of the following: (1) “outpatient,” “ambulatory,” “same day,” “24-hour,” OR “23-hour,” AND (2) “shoulder,” AND (3) “arthroplasty” OR “replacement.”

Study selection and data extraction

A search of the databases resulted in 789 total studies. Studies were uploaded to and reviewed in Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia; available at www.covidence.org). Two independent reviewers (E.P. and H.H.) screened title and abstracts for relevance under the guidance of the senior author (N.V.), followed by full-text review. If the two reviewers did not reach a consensus, inclusion was ultimately decided by the senior author (N.V.). To have qualified for inclusions, studies must have (1) reported on TSA or rTSA, (2) described a procedure performed in an outpatient or ambulatory setting, and (3) included information on postoperative complication rate. Exclusion criteria were applied to (1) articles not in the English language, (2) nonhuman studies, (3) basic science studies, (4) systematic review articles, meta-analysis, and expert opinions, and (5) deidentified database studies. Based on these criteria, 9 articles were included in the final cohort. However, three of these studies had overlapping patient data sets, and thus the study with the largest patient cohort was included and the two others by the same senior author were removed.[6,16,25] Owing to the absence of randomized controlled trials, pooled statistics and formal meta-analysis was not performed to avoid potentially inaccurate conclusions.

All articles then underwent data extraction by a single reviewer (H.H.). Extraction included information on demographics, comorbidities, outcomes (complication number and type, PROs), and the demographics and outcomes of the comparative inpatient cohort, if applicable.

Bias assessment

The quality and bias of the studies was assessed using the methodologic index for nonrandomized studies (MINORS) score.[32] The MINORS score is an 8- (for noncomparative studies) or 12-question (for comparative studies) assessment that was developed to describe the quality of observational or nonrandomized trials. Questions range from clearly stating an aim to stating the percentage of patients lost to follow-up and to whether a power analysis was performed. Each question is scored with a “0” if it is not addressed, “1” if it addressed but inadequately, or “2” if it is addressed and adequate. Thus, each article could attain a maximum of 16 (noncomparative) or 24 (comparative study) points. Two authors (E.P. and H.H.) independently performed the MINORS assessment for each included study. Any disagreements were resolved by consensus.

Results

A search of the databases resulted in 789 studies (Figure 1). After duplicates were removed, 293 studies underwent title and abstract review. Sixteen of these studies underwent full-text review, and 9 studies were included. Of these studies, 2 were removed owing to overlapping patients.[6,25] Thus, 7 studies accounting for 937 patients were ultimately included in the final qualitative assessment.[4,8,12,16,22,23,26]

Demographics

Article details and patient demographics for each study are included in Table I. All studies included both TSA and rTSA procedures except that of Erickson et al, which only included rTSA.[12] Each study described unique criteria for selecting patients for outpatient TSA or rTSA. All articles except that by Kramer et al[22] stated that patient comorbidities or current health status was accounted for in the decision-making process. Instead, Kramer et al[22] used anesthesiologist and surgeon preference to make this decision. Four studies (Charles et al,[8] Nwankwo et al,[26] Erickson et al,[12] and Leroux et al[23]) also took into account the patient's current social and/or living situation. The mean American Society of Anesthesiologists (ASA) score was a mean of 2.3 for the 4 studies in which it was reported. In addition, Kramer et al[22] reported that 36.3% of their cohort had an ASA score $\geq$ 3.

Complications

Complication, reoperation, readmission rates, and emergency department (ED) or urgent care visits are reported in Table II (Figures 2-5). All but 1 study reported on 90-day complication rates.[12] Total 90-day complication rates ranged from 7.1%-11.5%. Commonly reported 90-day complications included wound issues, infections, and nerve palsies. Ninety-day reoperation rates were reported by 5 studies. Nwankwo et al,[26] Bean et al,[4] and Leroux et al[23] reported 0 reoperations. Charles et al[8] reported 1 incision and drainage procedure, while Fournier et al[16] reported 1 hematoma evacuation. Three studies reported no readmissions (Fournier et al,[16] Bean et al,[4] Leroux et al[23]). Charles et al[8] reported 1 readmission who was the same patient who underwent the incision and drainage procedure. Nwankwo et al[26] and Kramer et al[22] reported a readmission rate of 2.5% (3 patients: acute kidney injury, aortic dissection, and abdominal pain) and 3.7% (readmission reason not specified), respectively. However, these studies did not report how long after surgery these readmissions occurred. In addition, three studies reported on 90-day ED and/or urgent care visits. Nwankwo et al[26] reported a 16% ED visit rate, while Leroux et al[23] and Bean et al[4] reported a rate of 2.4% and 4.8%, respectively. However, Nwankwo et al[26] reported that many of these ED visits were related to exacerbations of preexisting chronic medical conditions.[25]

Two studies reported on longer term complications. Charles et al[8] reported at 9.3 $\pm$ 6 months that 1 additional patient underwent reoperation and 2 additional patients had complications (subscapularis failures). Erickson et al[12] reported a 4.1% reoperation rate within the first 2 years postoperatively and a total complication rate of 7%.

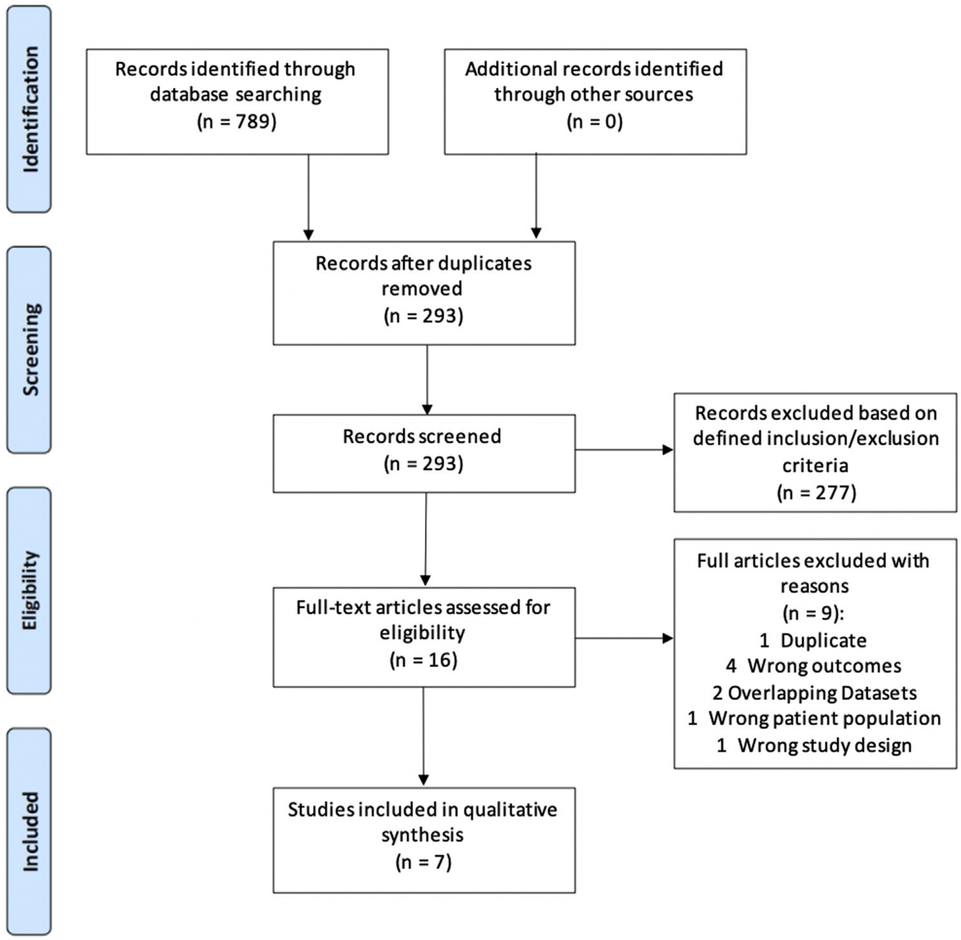

Figure 1 PRISMA flowchart of study selection. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Patient-reported outcomes

Three studies included PROs. Of the three, 1 study only reported preoperative PROs and 1 study only reported postoperative satisfaction (Table III). Bean et al[4] did not compare preoperative with postoperative visual analog scale (VAS) pain scores, instead only compared them with the inpatient cohort. Charles et al[8] reported significant improvements compared with baseline for Single Assessment Numeric Evaluation, American Shoulder and Elbow Surgeons (ASES) score, and VAS (all $P < .001$) and in forward elevation and external rotation (both $P < .001$). Similarly, Erickson et al[12] reported improvements from preoperative to each of their two tested postoperative time points: 1 and 2 years ($P < .0001$ for all). Finally, Leroux et al[23] reported that 84.9% of patients were very satisfied, 12.1% were satisfied, and 3% were adequately satisfied at a mean of 60 weeks postoperatively (range 16.4 to 156 weeks).

Comparison with an inpatient cohort

Four of the included studies compared outpatient complication rates with an inpatient cohort (Table IV, Figure 6). Three studies compared the preoperative demographics of the cohorts. Bean et al[4] only reported differences in the number of patients receiving an interscalene block (2 in outpatient vs. 18 in inpatient, $P = .005$). In contrast, the inpatient cohort described by Nwankwo et al[26] was significantly older ($P = .01$) and had a significantly higher ASA score ($P < .01$) than the outpatient cohort. Erickson et al[12] also had an inpatient cohort that was older ($P < .0001$), had a greater proportion of female patients ($P < .001$), had a higher average body mass index ($P = .022$), and had a higher rate of diabetes ($P = .007$).

Bean et al[4] and Nwankwo et al[26] reported an inpatient 90-day complication rate of 17.5% and 17.1%, respectively. Similar to the outpatient cohort, the high complication rate reported by Nwankwo et al[26] was likely owing to the high rate of ED visits, most of which, the authors stated, were likely not surgery related but because of exacerbations of preexisting chronic medical conditions.[25] One reoperation (implant revision) was reported by Nwankwo et al[26] during this period. The inpatient 90-day readmission rate was 2% to 5% to 9.4%. Kramer et al[22] and Bean et al[4] reported no significant differences between outpatient and inpatient readmissions, ED/urgent care visits, or complication rate. In contrast, Nwankwo et al[26] observed a higher inpatient readmission rate ($P = .027$). Erickson et al[12] compared complications at 2 years and found the inpatient group to have a significantly higher rate of complications ($P = .023$).

Erickson et al[12] and Bean et al[4] compared preoperative and postoperative PROs between the inpatient and outpatient TSA/rTSA cohorts (Table V). Erickson et al[12] reported a significantly lower preoperative ASES score in the inpatient cohort (36.3 ± 17.6 vs. 40.5 ± 17.6, $P = .0046$). Otherwise, no differences were observed between cohorts for the ASES, VAS, or Single Assessment Numeric Evaluation score preoperatively or at the 1- or 2-year follow-up. In addition, Erickson et al[12] reported no significant differences between the change in ASES, VAS, and Single Assessment Numeric Evaluation scores from baseline to 1 or 2 years postoperatively

Table I
Demographic information of the included studies.

Author	Study type	Factors considered in for outpatient surgery selection	N (TSA/rTSA/Hemi)	Age	Male/Female	BMI	Charlson comorbidity index	ASA score	History of smoking	Comorbidities	Length of stay, hr
Fournier et al., 2019[16]	LOE IV: Case series	Age Preoperative anemia Pulmonary disease CAD HTN CHF	61 (49/12/0)	58 (range: 37 to 69)	39/22	31 (range: 21 to 49)	Not Reported	2.3 ± 0.5	Not reported	Not reported	Not reported
Charles et al., 2019[8]	LOE IV: Case series	Medical comorbidities Prior narcotic use Social support at home	50 (44/4/2)	56.9 ± 6.9	40/10	29.8 ± 5.9	1.6 ± 1.2	Not reported	1 (2%)	Not reported	9.6
Nwankwo et al., 2018[26]	LOE III: Cohort Comparison	Social support Health status Patient preference	118 (96/20/2)	68.1 (range: 31 to 90)	63/55	Not reported	Not reported	2.3	Not reported	Not reported	NA not reported
Erickson et al., 2019[12]	LOE III: Cohort Comparison	Medical comorbidities Living status Patient preference	241 (0/241/0)	68.93	115/126	29.72	Not Reported	NA not reported	28 (11.6%)	Diabetes: 17 (7.1%)	Not reported
Leroux et al., 2018[23]	LOE IV: Case series	Exclusion criteria: COPD, renal disease, DVT, sleep apnea, active or untreated CAD or CVD	41 (32/9/0)	60.6 ± 4.8	19/22	31.8 ± 6.6	2.9 ± 1.9	2.3 ± 0.6	12 (29.3%)	Diabetes: 4 (10%) HTN: 25 (60%) Depression: 12 (28.6%)	3.54
Bean et al., 2018[4]	LOE III: Cohort Comparison	Inclusion Criteria: No history of significant cardiopulmonary disease, DVT, PE, or severe obstructive sleep apnea, ASA score of <3, age < 65 y, no preoperative opioid dependence, no walker or wheelchair dependence, social support at home, living within 1 h from the surgery center, motivated for the outpatient process Relative exclusion criteria: BMI > 30	21 (12/9/0)	59.8 (IQR: 57.0 to 61.8)	10/10	29.0 ± 7.2	1.76 ± 0.77	2.3 ± 0.5	9 (43%)	Diabetes: 3 (15%) Cardiopulmonary: 4 (19.1%)	5.35
Kramer et al., 2018[22]	LOE III: Cohort Comparison	Based on surgeon and anesthesiologist rather than specific preexisting condition, no exclusions were made based on comorbidities	405 (294/111/0)	69.4 ± 8.2	224/181	< 30: 234 (57.8%) 30 to 34.9: 104 (25.7%) ≥ 35: 67 (16.5%)	Not reported	ASA ≥ 3: 144 (36.3%)	237 (58.5%)	Diabetes: 81 (20%) Chronic pulmonary disease: 90 (22.3%) Congestive heart failure: 13 (3.2%) Cognitive: 36 (8.9%) Drug abuse: 5 (1.2%) Pulmonary circulation disorders: 4 (1%)	Not reported

ASA, American Society of Anesthesiologists; *BMI*, body mass index; *CAD*, coronary artery disease; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CVD*, cerebrovascular disease; *DVT*, deep vein thrombosis; *HTN*, hypertension; *IQR*, interquartile range; *LOE*, level of evidence; *PE*, pulmonary embolism; *rTSA*, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty.

between the cohorts. Bean et al[4] only noted significant differences between cohorts for VAS scores at 2 weeks postoperatively ($P = .0441$).

Bias assessment

Results of the MINORS criteria for each study are illustrated in Table VI. The three case series had a total score of 11 of 16 (Fournier et al[16]), 9 of 16 (Charles et al[8]) and 10 of 16 (Leroux et al[23]). In contrast, the cohort studies all had a total score of 16 of 24 (Nwankwo et al,[12] Erickson et al,[12] Bean et al,[4] and Kramer et al[22]).

Discussion

The most important finding of this investigation was that outpatient TSA and rTSA had a relatively low 90-day complication rate, comparable with inpatient complication rates. This review complied data from TSA and rTSA procedures in more than 900 patients performed by multiple surgeons across a variety of clinical settings including institution-owned hospitals and ambulatory surgery centers. Our findings support the idea that TSA is successful in the outpatient setting without compromising outcomes when compared with inpatient counterparts.

A 90-day complication rate was reported by 6 of 7 studies and ranged from 7.1%-11.5%.[4,8,16,22,23,26] In the literature, short-term complication rates after inpatient TSA vary from 2.8%-9.4% depending on complication definition and follow-up time period.[2,7,13,36] Of the studies included in this review, many of the most common complications, including hematoma, nerve palsy, and wound issues, are likely independent of discharge timing and more consequence of the procedure, regardless of the surgery setting. Further study is necessary to fully understand this relationship. Kramer et al[22] only tracked venous thromboembolism and deep infection; however, because of the rarity of these events,

Table II
Complication rates and types of complication for each included study.

Author	Postoperative F/U	Reoperation	Reoperation type	Readmission	Readmission reason	ED/UC visits	Total complications	Complications
Fournier et al., 2019[16]	90 days	1 (1.6%)	Hematoma evacuation (1)	0	NA	Not reported	7 (11.5%)	Hematoma: 1 (1.6%) Perioperative anesthesia issue: 2 (3.3%) Arthrofibrosis: 2 (3.3%) Anterior subluxation: 1 (1.6%) Subscapularis rupture: 1 (1.6%)
Charles et al., 2019[8]	90 days Final f/u: 9.3 ± 6 months	90 days: 1 (2%) Total at final f/u: 2 (4%)	90 days: I&D (1)	90 days: 1 (2%)	I&D (1)	Not reported	90 days: 4 (8%) Total at final f/u: 6 (12%)	*90 days:* Hematoma: 1 (2.0%) Infection: 1 (2.0%) Nerve palsy: 1 (2.0%) DVT: 1 (2.0%) *Final f/u:* Subscapularis rupture: 2 (4%)
Nwankwo et al., 2018[26]	90 days	0	NA	3 (2.5%)	Abdominal pain (1) Aortic dissection (1) AKI (1)	ED: 19 (16.1%)	9 (7.6%)	Death: 1 (0.8%) Undefined wound issue: 4 (3.4%) Nerve palsy: 1 (0.8%) Abdominal pain with identified liver lesions: 1 (0.8%) Ascending aortic dissection: 1 (0.8%) Acute kidney injury: 1 (0.8%)
Erickson et al., 2019[12]	2 years	10 (4.1%)	I&D (3) Baseplate revision for loosening (2) Revision for instability (2) ORIF (2)	Not reported	NA	Not reported	17 (7.1%)	MI/death: 1 (0.4%) Pneumonia: 1 (0.4%) Systemic Infection: 2 (0.8%) Localized Infection: 2 (0.8%) Implant Instability: 1 (0.4%) Shoulder dislocation: 4 (1.7%) Humeral fracture: 1 (0.4%) Acromial stress fracture: 3 (1.2%) Excessive pain: 2 (0.8%)
Leroux et al., 2018[23]	90 days	0	NA	0	NA	UC: 1 (2.4%)	3 (7.3%)	Hematoma: 1 (2.4%) Rash: 1 (2.4%) Superficial phlebitis: 1 (2.4%)
Bean et al., 2018[4]	90 days	0	NA	0	NA	UC: 1 (4.8%)	2 (9.5%)	Brachioplexopathy: 1 (4.8%) Fall: 1 (4.8%)
Kramer et al., 2018[22]	90 days	Not reported	NA	15 (3.7%)	Not reported	ED: 50 (12.3%)	Not reported	VTE: 1 (.2%) 1-year mortality: 5 (1.2%)

AKI, acute kidney injury; *DVT*, deep vein thrombosis; *ED*, emergency department; *F/U*, follow-up; *I&D*, incision and drainage; *MI*, myocardial infarction; *NA*, not applicable; *ORIF*, open reduction internal fixation; *UC*, urgent care; *VTE*, venous thromboembolism.

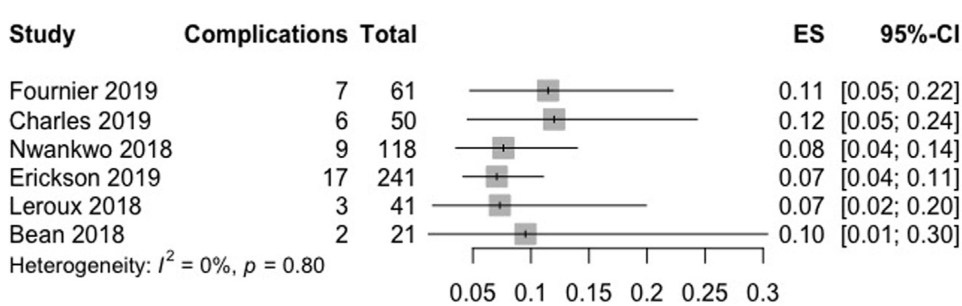

Figure 2 Pooled results for outpatient complication rates.

the authors were not able to perform an adjusted analysis between inpatient and outpatient procedures.[3] Erickson et al[12] found that complications were significantly more frequent in patients undergoing rTSA as inpatients vs. as outpatients. Expectedly, death was a rare complication of outpatient TSA, with Nwankwo et al[26] reporting 1 death at the 90-day follow-up from aortic dissection, which was deemed unrelated to the index TSA. Erickson et al[12] reported 1 death from myocardial infarction at the 2-year follow-up and Kramer et al[22] found 1.2% 1-year mortality after outpatient TSA, comparable with the inpatient TSA cohort (1.1%) and likely related to underlying comorbidities.

Reoperation rate was low or 0 in all studies that measured this outcome. Erickson et al[12] was the only study that reported reoperation for mechanical issues such as instability and loosening but measured this outcome at 2 years postoperatively rather than 90 days as in the other studies. Ninety-day readmission rates were also low, ranging from 0 to 3.7%. Three of the 4 recorded readmissions were for medical issues, whereas most readmissions came from the cohort reported by Erickson et al,[12] where the reason for readmission was not available. Furthermore, readmission and reoperation after outpatient TSA were equivalent to or lower than inpatient procedures. In addition, it is unclear how far these

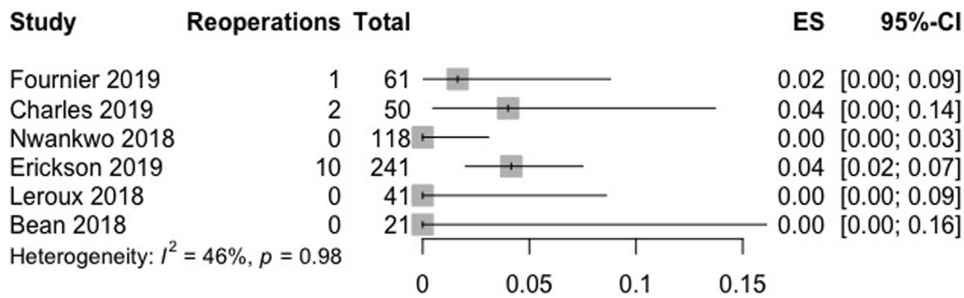

Figure 3 Pooled results for outpatient reoperation rates.

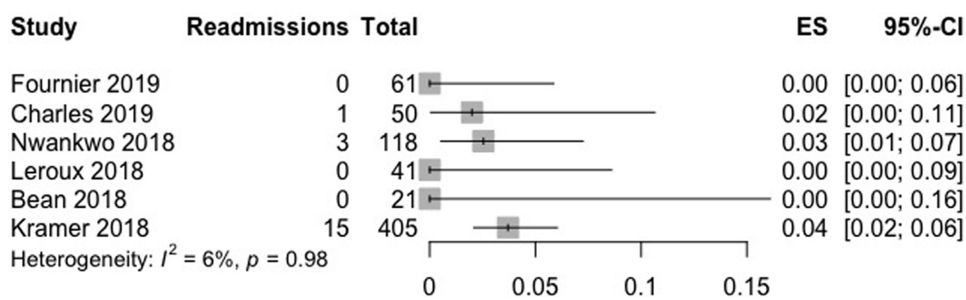

Figure 4 Pooled results for outpatient readmission rates.

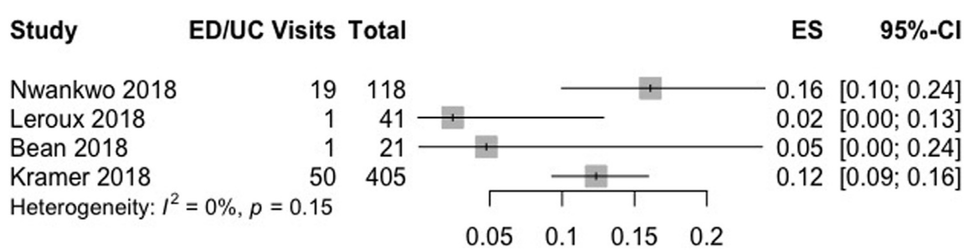

Figure 5 Pooled results for outpatient emergency department or urgent care rates. ED, emergency department; UC, urgent care.

readmissions occurred and would likely have been no different in the inpatient setting as many patients are discharged by postoperative day 1 or 2.

All studies included in this review cited proper patient screening as an important factor in selecting patients suitable for outpatient TSA. Patient selection was noted as a significant influencer of low complication, readmission, and reoperation rate after these procedures. Patient selection is often more stringent for outpatient cohorts than inpatient, which can account for lower rates of readmission, reoperation, and complications. In the hip and knee arthroplasty literature, careful patient selection, multidisciplinary care coordination, multimodal pain control strategies, and patient education have been consistently noted to be essential for optimizing outcomes and avoiding complications after outpatient procedures.[3,17,28] Inpatient cohorts undergoing TKA/THA have been shown to have higher rates of medical comorbidities such as diabetes, obesity, and congestive heart failure. Older patients and those with greater comorbidities were shown to have a higher chance of being readmitted after primary TKA.[9,10] Historically, TSA has been shown to have shorter hospital stays, fewer readmissions, and lower rates of complications such as pulmonary embolism and mortality than TKA and THA.[13,15] Following the model of successful transition to outpatient TKA and THA, it is reasonable to expect similar or better success in TSA.

The ideal risk assessment tool for patient selection for outpatient TSA has yet to be identified. The ASA and Charlson comorbidity index have been used previously to identify patients at risk for complications. Age, ASA score, and comorbidity have been shown to be risk factors for complications after shoulder arthroplasty.[36] However, the ASA score has not demonstrated validity in selecting appropriate patients for same-day joint arthroplasty.[24] While only Bean et al[4] explicitly used ASA score < 3 as a criteria in selecting patients, all 4 studies that reported an ASA score had mean of 2.3, with Kramer et al[22] reporting only 36.3% of their cohort having ASA score > 3. Five studies used medical comorbidities as selection criteria, and 4 studies incorporated living status and social support as factors in selecting patients. In the largest cohort included in this review by Kramer et al,[22] the decision to discharge patients the same day was made by the surgeon and anesthesiologist, and no patients were excluded based on comorbidities alone.

The results from our cohort demonstrate that screening may be effective: patients who underwent outpatient TSA are generally younger and healthier than inpatient cohorts translating into equivalent or improved postoperative outcomes and equivalent or decreased rates of complications, readmissions, and reoperations. However, future study is necessary to develop a formal risk stratification tool to stratify patients most suitable for same-day discharge and those at risk for higher complications who would benefit from an inpatient stay. Fournier et al[16] developed a patient selection algorithm for outpatient TSA that stratifies patients

Table III
Patient-reported outcomes for outpatient TSA/rTSA patient.

SANE						
	F/U		Preoperative SANE	Postoperative SANE	Postoperative SANE	
Charles et al., 2019[8,*]	9.3 ± 6.0 mo ($P < .001$)		39.6 ± 23.4	77.6 ± 19.0	-	
Erickson et al., 2019[12,*]	1 y ($P < .0001$) 2 y ($P < .0001$)		30.7 ± 19.4	74.3 ± 23.0	75.9 ± 21.4	
ASES						
	F/U		Preoperative ASES	Postoperative ASES	Postoperative ASES	
Charles et al., 2019[8,*]	9.3 ± 6.0 mo ($P < .001$)		44.4 ± 17.1	80.2 ± 22.4	-	
Erickson et al., 2019[12,*]	1 y ($P < .0001$) 2 y ($P < .0001$)		40.5 ± 17.6	79.7 ± 17.3	82.6 ± 14.3	
Bean et al., 2018[4]	NA		37.7 ± 14.5	-	-	
VAS						
	F/U		Preoperative VAS	Postoperative VAS	Postoperative VAS	Postoperative VAS
Charles et al., 2019[8,*]	9.3 ± 6.0 mo ($P < .001$)		5.2 ± 2.0	1.5 ± 2.3	-	-
Erickson et al., 2019[12,*]	1 y ($P < .0001$) 2 y ($P < .0001$)		5.5 ± 2.6	1.5 ± 2.0	1.33 ± 1.7	-
Bean et al., 2018[4]	2 weeks (NA) 6 weeks (NA)) 3 mo (NA)		8.0 (range: 0 to 10)	2 (range: 0 to 8)	2 (range: 0 to 8)	1 (range: 0 to 8)
VR-12						
	F/U		Preoperative VR-12			
Bean et al., 2018[4]	NA					
		VR-12 M	36.3 ± 11.4			
		VR-12 P	0.6 ± 0.1			
ROM						
	F/U		Preoperative ROM	Postoperative ROM		
Charles et al., 2019[8,*]	9.3 ± 6.0 mo ($P < .001$)					
		FE	124.6 ± 35.3 degrees	150.2 ± 29.7 degrees		
		ER	31.3 ± 17.9 degrees	49.5 ± 15.8 degrees		
Satisfaction						
	F/U		Postoperative Satisfaction			
Leroux et al., 2018[23]	60 weeks (range: 16.4 -156 weeks)					
		Satisfaction	Very 28 (84.9%) Satisfied 5 (15.2%) Adequate 1 (3%)			
		Would not do outpatient again?	2 (5.7%)			
		Did Not Feel Ready for Discharge?	2 (5.7%)			

ASES, American Shoulder and Elbow Surgeons assessment; *ER*, external rotation; *FE*, forward elevation; *F/U*, follow-up; *NA*, not applicable; *ROM*, range of motion; *SANE*, single assessment numeric evaluation; *VAS*, visual analog scale; *VR-12*, Veteran RAND 12 item health survey.
* Statistically significant.

based on age and cardiopulmonary comorbidities. Although they found that patients undergoing outpatient TSA as selected by their algorithm have a low rate of complication and no readmissions, there was no comparison with an inpatient cohort. Further investigation is necessary to offer a comparison between these two settings.

Limitations

This study is not without limitations. First, only 7 of 293 unique studies met inclusion criteria, highlighting the general paucity of study on outpatient TSA in the literature. Although the combined sample size was large at 937 patients, 646 of them came from just two cohorts. Furthermore, all studies included were level of evidence III or IV, and accordingly, owing to the limitations of available literature, a meta-analysis was unable to be performed. This made it difficult to facilitate direct comparisons between study cohorts. Furthermore, not all studies reported on comparative outcomes between outpatient and inpatient cohorts, so the sample sizes of these comparisons are considerably smaller than the total pooled cohort. Finally, there was a large variation in the collection and reporting PROs between studies. This lack of standardization yielded general trends but made comparisons difficult.

Conclusion

Outpatient TSA in properly selected patients results in a similar complication rate to inpatient TSA. Further studies are needed to

Table IV
Complication rates and types of complication for each included study.

	F/U	N (TSA/rTSA/hemi)	Age	Male/Female	BMI	Comorbidities	Reoperation	Reoperation type	Readmission	Readmission reason	ED/UC	Total complications	Complications
Nwankwo et al., 2018[26]	90 d	64 (45/25/4)	68.1 (range: 31 to 90) ($P = .01$)	55/63 ($P = .15$)	NA	NA	1 (1.6%)	Implant revision (1)	6 (9.4%) ($P = .27$)	CHF exacerbation (1) AMS/TIA (1) Decompensated cirrhosis (1) Atrial fibrillation (1) Fall (1) Pneumonia (1)	ED: 18 (28.1%) ($P = .150$ - $.774$)	11 (17.1%)	CVA: 2 Wound issue: 2 Nerve issue: 1 CHF exacerbation: 1 AMS/TIA: 1 Decompensated cirrhosis: 1 Atrial fibrillation: 1 Fall: 1 Pneumonia: 1
Erickson et al., 2019[12]	2 y	373 (0/373/0)	72.43 ($P < .001$)	128/245 ($P < .001$)	29.72 ± 11.5 ($P = .022$)	Diabetes: 58 (15.5%) ($P = .007$)	17 (4.6%)	Humeral fracture ORIF (4) I&D (4) Revision for instability (3) Distal clavicle excision (3) Conversion to hemiarthroplasty (1) Revision for stiffness (1) Revision biceps tenodesis (1)	Not Reported	NA	Not Reported	48 (12.9%) ($P = .023$)	Acromion stress fracture: 8 Subscapularis tear: 2 Localized infection: 2 Biceps injection: 8 PE: 2 Dislocation: 4 Wound dehiscence: 2 MI or death: 1 Hematoma evacuation: 1 Acromioclavicular joint injection: 2 Instability of implant: 2 Swelling and/or urinary retention: 1 Excessive pain: 1 Subluxation: 1 Hypoxia: 3 Deep venous thrombosis: 1 Humeral fracture: 1 Numbness and/or nerve injury: 6
Bean et al., 2018[4]	90 d	40 (22/17/0)	59.9 (IQR: 55.9 to 62.8) ($P = .5116$)	18/19	30.6 ± 7.3 ($P = .3958$)	Cardiac/pulmonary disease/CVA: 14 (35%), ($P = 0.1943$) Diabetes: 9 (24.3%) ($P = .5124$)	0	NA	1 (2.5%) ($P = 0.9999$)	NA	ED: 2 (5%) ($P = .54$) UC: 0 (0%)	7 (17.5%) ($P = .9999$)	MI: 1 Transient axillary neurapraxia: 1 Fall: 1 Transient brachial plexopathy: 1

													Postoperative bigeminy and hypoxia: 1 Constipation: 1 Superior mesenteric vein thrombosis: 1
Kramer et al., 2018[22]	90 d	6098 (1894/4204/0)	70.1 ± 8.9	2810/3288	< 30: 3376 30-34.9: 1540 ≥ 35: 4954	Alcohol abuse: 236 (4%) Chronic pulmonary disease: 1337 (22.5%) Cognitive disorders: 749 (12.6%) CHF: 281 (4.7%) Diabetes: 1674 (27.5%) Drug abuse: 152 (2.6%) Pulmonary circulation disorders: 90 (1.5%)	Not Reported	NA	342 (5.6%) ($P = .198$)	NA	ED: 760 (12.5%) ($P = .609$)	Not reported	VTE: 66 (1.1%) Deep Infection: 16 (0.3%) 1 y: 66 (1.1%) ($P = .320$)

AMS, altered mental status; *BMI*, body mass index; *CHF*, congestive heart failure; *CVA*, cerebrovascular accident; *ED*, emergency department; *F/U*, follow-up; *IQR*, interquartile range; *MI*, myocardial infarction; *ORIF*, open reduction internal fixation; *PE*, pulmonary embolism; *rTSA*, reverse total shoulder arthroplasty; *TIA*, transient ischemic attack; *TSA*, total shoulder arthroplasty; *UC*, urgent care; *VTE*, venous thromboembolism.
Included *P* values refer to comparisons between inpatient and outpatient cohorts.

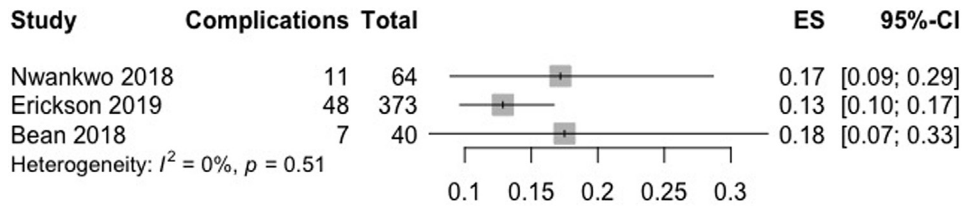

Figure 6 Pooled results for inpatient complication rates.

Table V
Patient-reported outcomes for outpatient TSA/rTSA patient.

SANE						
	F/U		Preoperative SANE	Postoperative SANE	Postoperative SANE	
Erickson et al., 2019[12]	1 y 2 y		30.0 ± 19.4 (*P* = .668)	74.2 ± 22.3 (*P* = .954)	75.8 ± 23.9 (*P*=.961)	
ASES						
	F/U		Preoperative ASES	Postoperative ASES	Postoperative ASES	
Erickson et al., 2019[12]	1 y 2 y		36.3 ± 17.6 (*P* =.046)	77.6 ± 18.3 (*P* = .158)	78.9 ± 19.6 (*P* = .0392)	
Bean et al., 2018[4]	NA		33.6 ± 13.3 (*P* = .4401)	-	-	
VAS						
	F/U		Preoperative VAS	Postoperative VAS	Postoperative VAS	Postoperative VAS
Erickson et al., 2019[12]	1 y 2 y		5.8 ± 2.6 (*P* = .135)	1.7 ± 2.2 (*P* = .154)	1.68 ± 2.3 (*P* = .108)	-
Bean et al., 2018[4]	2 weeks 6 weeks 3 mo		6.0 (range: 2.0 to 10.0) (*P* = .2517)	3.0 (range: 0.0 to 9.0) (*P* = .0441)	2.0 (range: 0.0 to 9.0) (*P* = .5153)	2.0 (range: 0.0 to 6.0) (*P* = .1999)
VR-12						
	F/U		Preoperative VR-12			
Bean et al., 2018[4]	NA					
		VR-12 M	54.0 ± 11.9 (*P* = .9130)			
		VR-12 P	34.3 ± 10.7 (*P* = .6245)			

ASES, American Shoulder and Elbow Surgeons assessment; *F/U*, follow-up; *SANE*, single assessment numeric evaluation; *VAS*, visual analog scale; *VR-12*, Veteran RAND 12 item health survey.
All *P* values refer to comparisons between inpatient and outpatient scores.

Table VI
MINORS assessment for each included study. Assessment was performed independently by two authors. Any disagreements were resolved by consensus.

	Clearly states aim	Consecutive patients	Prospective collection	Relevant end points	Unbiased assessment	Appropriate follow-up period	Loss to follow-up < 5%	Power analysis	Comparative studies				Total
									Adequate control group	Contemporary groups	Baseline equivalence	Adequate statistical analysis	
Fournier et al., 2019[16]	2	2	2	2	0	2	0	1	NA	NA	NA	NA	11
Charles et al., 2019[8]	2	2	1	2	0	2	0	0	NA	NA	NA	NA	9
Nwankwo et al., 2018[26]	2	2	1	2	0	2	0	0	2	2	1	2	16
Erickson et al., 2019[12]	2	2	1	2	0	2	0	0	2	2	1	2	16
Leroux et al., 2018[23]	2	2	1	2	0	2	1	0	NA	NA	NA	NA	10
Bean et al., 2018[4]	2	2	1	2	0	2	0	0	2	2	1	2	16
Kramer et al., 2018[22]	2	0	1	2	0	2	2	0	2	2	1	2	16

aid in determining proper risk stratification to direct patients to inpatient or outpatient shoulder arthroplasty.

Disclaimers:

Funding: No funding was disclosed by the authors.

Conflicts of interest: Michael Fu reports other from Arthroscopy, other from DJ Orthopaedics, other from HSS Journal, outside the submitted work. Nikhil Verma reports other from AOSSM, other from ASES, nonfinancial support from Arthrex, Inc, personal fees and nonfinancial support from Arthroscopy, other from AANA, nonfinancial support from Breg, personal fees from Cymedica, other from Knee, personal fees from Minivasive, personal fees from Omeros, personal fees from Orthospace, nonfinancial support from Ossur, other from SLACK Inc, personal fees and nonfinancial support from Smith & Nephew, personal fees and nonfinancial support from Vindico Medical-Orthopedics Hyperguide, nonfinancial support from Wright Medical Technology, Inc, other from Stryker, other from Relievant MedSystems, personal fees from Medacta USA, Inc, other from Medwest Associates, outside the submitted work. Adam Yanke reports personal fees from CONMED Linvatec, personal fees from JRF Ortho, personal fees from Olympus, grants from Organogenesis, nonfinancial support and other from Patient IQ, nonfinancial support from Smith & Nephew, nonfinancial support from Sparta Biomedical, grants from Vericel, grants from Arthrex, Inc., outside the submitted work.

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