Comparison of outpatient versus inpatient total hip and knee arthroplasty: A systematic review and meta-analysis of complications

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ABSTRACT

Introduction: Patients undergoing TKA or THA have traditionally been managed post-operatively as inpatients. However, with current surgical techniques and pain management, there is evidence that outpatient joint arthroplasty can be safely performed in selected patient. This systematic review and meta-analysis aimed to compare the post-operative complication rates of outpatient and inpatient TJA with subgroup analysis of TKA and THA.

Methods: Electronic searches were performed using five databases from their date of inception to October 2018. Relevant studies were identified, with data extracted and meta-analyzed from the studies.

Results: From seven included studies, 176,179 patients were inpatient TJA and 1613 were outpatient TJA. The outpatient and inpatient TJA cohorts had similar mean age and BMI, with a greater proportion of females in the inpatient group. For TJA we found no significant difference in total complications ($P = 0.06$), major complications ($P = 0.59$), readmissions ($P = 0.60$), DVT ($P = 0.94$), UTI ($P = 0.50$), pneumonia ($P = 0.42$) and wound complications ($P = 0.50$) between the outpatient and inpatient groups. However, there were fewer transfusions ($P = 0.05$) but increased reoperations ($P = 0.02$) in the outpatient TJA group. Subgroup analysis of TKA ($P = 0.25$) and THA ($P = 0.39$) also found no significant differences in total complications between the outpatient and inpatient groups.

Conclusion: Outpatient TJA had comparable total complication rates to inpatient TJA. Along with that outpatient TJA can significantly reduce costs to healthcare systems but careful pre-operative patient selection is required to optimize outcomes. More quality randomized controlled trials with longer follow-up periods are needed to add to this body of evidence.

1. Introduction

Patients undergoing total knee arthroplasty (TKA) or total hip arthroplasty (THA) have traditionally been managed postoperatively as inpatients. However, there is increasing pressure to reduce hospital length of stay in order to reduce the costs associated with total joint arthroplasty (TJA).^{1–3} The length of stay following TJA has significantly reduced in the past few decades with many centers now offering fast-track or even outpatient total joint arthroplasties. This is made possible by better patient selection, improved surgical techniques, pain management and rehabilitation programs.⁴

Although outpatient TJA has been increasing in popularity, there is no current consensus on whether outpatient TJA is safe or associated with worse outcomes. Some studies have shown that outpatient TJA can

have increased complication and readmission rates requiring further costs.^{3,5} However, there is also evidence that with adequate pre-operative patient selection, outpatient TJA has comparable outcomes to conventional inpatient TJA.^{1,2,6–8} If outpatient TJA can provide similar if not better safety than inpatient TJA, it would benefit the patient and reduce costs on the healthcare systems.

It is important to determine if an outpatient TJA protocol can be performed safely before more widespread use. Many studies have been published that compare the outcomes of outpatient and inpatient TKA and THA, however there is no systematic review and meta-analysis on the topic. This study aimed to compare the post-operative complication rates of outpatient and inpatient TJA with subgroup analysis of TKA and THA.

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Fig. 1. PRISMA flow chart of systematic review and meta-analysis of outpatient vs inpatient TJR.

2. Methods

2.1. Literature search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed for this study. Electronic database searches were performed using PubMed, Ovid Medline, Cochrane Database of Systematic Reviews (CDSR), Database of Abstracts of Review of Effectiveness (DARE) and Cochrane Central Register of Controlled Trials (CCTR), from their dates of inception to October 2018. The sensitivity of the search strategy was maximized by combining the terms “outpatient OR day-case” AND “arthroplasty OR joint replacement OR hip arthroplasty OR knee arthroplasty OR hip replacement OR knee replacement” as the keywords when searching in the title, abstract, keywords and MeSH fields. The reference list of all retrieved articles was manually reviewed to further identify potentially relevant studies.

2.2. Selection criteria

Eligible studies for this systematic review and meta-analysis compared inpatient and outpatient cohorts receiving TKA and/or THA. The TJA cohort in this study consisted of only TKA and THA patients. If a study also reported unicompartmental knee replacement or hip resurfacing outcomes, these patients were excluded. Included studies were required to report post-operative complications at any follow-up length. If multiple studies reported outcomes from the same cohort, data from the longest follow-up period was included for quantitative analysis. All publications included were limited to those in the English language and involving human subjects. Conference presentations, case reports, reviews, editorials, and expert opinions were excluded.

2.3. Data extraction and critical appraisal

All the relevant data was extracted from the article text, figures and tables. Two investigators (J.X and G.C) independently reviewed and

extracted data from the retrieved articles. Discrepancies between the two reviewers were resolved by discussion with senior authors to reach a consensus. The study characteristics extracted include study year, country, number of patients undergoing TKR and/or THR, and number of inpatients or outpatients. The primary outcomes reported were total complications, major complications, readmissions, reoperations, deep vein thrombosis (DVT), urinary tract infection (UTI), pneumonia, wound complication and transfusions. Major complications included thromboembolic events, renal failure, myocardial infarction, cardiac arrest, cerebrovascular event, sepsis, return to operating room and death.

2.4. Statistical analysis

Outcomes with data extracted from more than one study were analyzed, with the relative risk (RR) or weighted mean difference (WMD) used as the summary statistic. Random effects model was used in all cases due to its more conservative estimates and inherent differences in patient and surgical characteristics between studies. Sensitivity analysis was performed by leave-one-out analysis. Publication bias was assessed by funnel plots. All statistical analysis was performed using Review Manager 5.3 software (Cochrane Collaboration, Software Update, Oxford, United Kingdom).

3. Results

3.1. Quality of studies

A total of 1127 studies were identified by searching five electronic databases using our search strategy (Fig. 1). By examining the study abstracts and removing duplicates, 1090 studies were excluded leaving 37 potentially relevant articles. Following the application of the inclusion criteria, a total of 7 studies^{1,2,7–11} were selected for quantitative analysis. These studies included a total of 177,792 patients, with 176,179 in the inpatient group and 1613 in the outpatient group. From these patients, 64,484 were THA and 113,308 were TKA. The

Table 1
Characteristics and demographics of studies included in the systematic review and meta-analysis.

First author	Year	Study period	Country	Study Type	Total Patients	No. patients		Type of Surgery	TKA and/or THA (No.)		Follow up time (days)	Outpatient definition
						Outpatient	Inpatient		Outpatient	Inpatient		
Darrith	2018	2013–2016	USA	R, OS	486	243	243	TKA, THA	73 THA & 46 TKA	73 THA & 46 TKA	90 days	Same day discharge
Springer	2017	2010–2011	USA	R, OS	243	137	106	TKA, THA	45 THA & 92 TKA	32 THA & 74 TKA	30 days	Same day discharge
Goyal	2017	2014–2015	USA	RCT	220	112	108	THA	112	108	4 weeks	Same day discharge
Nelson	2017	2005–2014	USA	R, OS	63,844	420	63,424	THA	420	63,424	30 days	Same day discharge
Bovonratwet	2017	2005–2014	USA	R, OS	112,922	642	112,280	TKA	642	112,280	30 days	Same day discharge
Aynardi	2014	2008–2011	USA	R, OS	197	119	78	THA	119 THA	78 THA	90 days	Discharge within 23 h
Kolisek	2009	2004–2006	USA	R, OS	128	64	64	TKA	64 TKA	64 TKA	90 days	Discharge within 23 h

(R, retrospective; OS, observational study; RCT, randomized controlled trial; TKA, total knee arthroplasty; THA, total hip arthroplasty).

characteristics and demographics of the included studies are summarized in Table 1.

Of all the included studies, one study was a randomized controlled trial and 6 studies were retrospective observational studies. The outcomes of the risk of bias assessment for these studies are summarized in Table 2. All studies had a clear definition of study population, outcomes and outcome assessment along with sufficient duration of follow-up. Two studies had unclear independent assessment of outcome parameters, four studies had unclear selective loss during follow-up and two studies have unclear identification of confounders and prognostic factors. There was no publication bias in the total complication rates for TJA as visually assessed by funnel plot. Leave-one-out analysis did not reveal significant impact from any single study on the overall direction and size of effect.

3.2. Baseline characteristics

The mean patient age in the outpatient TJA group ranged from 54 to 59.8 years, compared to the inpatient group which ranged from 53.75 to 64 years. The difference in mean age was not significant in the outpatient group when compared to the inpatient group ($P = 0.10$). For the outpatient TJA group, 48.9% of the cohort were female which was significantly lower than the 59.9% of female in the inpatient group ($P = 0.007$). The mean BMI of the outpatient TJA group ranged from 27.6 to 33.8 kg/m², compared to the inpatient TJA group which ranged from 25.8 to 33.2 kg/m². There was no significant difference between the outpatient and inpatient groups with regards to BMI ($P = 0.77$).

The definition of outpatient was same day discharge in five studies and within 23 h of the procedure in two studies. The follow-up period for the included studies ranged from 28 to 90 days.

3.3. Total joint arthroplasty outcomes

There was no significant difference in total complications between outpatient and inpatient TJA (RR: 0.82, 95% CI: 0.67 to 1.01, $I^2 = 57\%$, $P = 0.06$) (Fig. 2A). There were also no differences between the outpatient and inpatient TJA groups with regards to major complications (RR: 1.08, 95% CI: 0.82 to 1.41, $I^2 = 0\%$, $P = 0.59$), readmissions (RR: 0.87, 95% CI: 0.53 to 1.45, $I^2 = 28\%$, $P = 0.60$), DVT (RR: 1.07, 95% CI: 0.20 to 5.70, $I^2 = 0\%$, $P = 0.94$), UTI (RR: 0.79, 95% CI: 0.41 to 1.55, $I^2 = 0\%$, $P = 0.50$), pneumonia (RR: 0.51, 95% CI: 0.10 to 2.55, $I^2 = 0\%$, $P = 0.42$) and wound complications (RR: 0.81, 95% CI: 0.45 to 1.48, $I^2 = 0\%$, $P = 0.50$) (Fig. 3). There was an increase in reoperation rate for outpatients compared to inpatients (RR: 1.60, 95% CI: 1.08 to 2.36, $I^2 = 0\%$, $P = 0.02$). However, there was a significant reduction in transfusion rate for outpatients compared to inpatients (RR: 0.61, 95% CI: 0.37 to 1.00, $I^2 = 85\%$, $P = 0.05$).

3.4. Total knee arthroplasty outcomes

There was no significant difference in total complications between outpatient and inpatient TKA (RR: 0.86, 95% CI: 0.68 to 1.11, $I^2 = 10\%$, $P = 0.25$) (Fig. 2B). There were also no difference between the outpatient and inpatient TKA groups with regards to major complications (RR: 1.11, 95% CI: 0.81 to 1.54, $I^2 = 0\%$, $P = 0.51$), readmissions (RR: 1.03, 95% CI: 0.61 to 1.75, $I^2 = 23\%$, $P = 0.90$), UTI (RR: 0.85, 95% CI: 0.36 to 1.97, $I^2 = 0\%$, $P = 0.70$) and wound complications (RR: 0.85, 95% CI: 0.39 to 1.86, $I^2 = 0\%$, $P = 0.68$) (Fig. 3). There was an increase in reoperation rate for outpatients compared to inpatients (RR: 1.76, 95% CI: 1.07 to 2.92, $I^2 = 0\%$, $P = 0.03$). However, there was a significant reduction in transfusion rate for outpatients compared to inpatients (RR: 0.62, 95% CI: 0.46 to 0.84, $I^2 = 0\%$, $P = 0.002$).

Table 2
Assessment of the quality of included studies by MOOSE criteria.

	Clear definition of study population	Clear definition of outcomes and outcome assessment	Independent assessment of outcome parameters	Sufficient duration of follow-up	No selective loss during follow-up	Important confounders and prognostic factors identified
Darrith	Yes	Yes	Yes	Yes	Yes	Yes
Springer	Yes	Yes	Yes	Yes	Unclear	Unclear
Goyal	Yes	Yes	Yes	Yes	Yes	Yes
Nelson	Yes	Yes	Unclear	Yes	Unclear	Yes
Bovonratwet	Yes	Yes	Unclear	Yes	Unclear	Yes
Aynardi	Yes	Yes	Yes	Yes	Unclear	Yes
Kolisek	Yes	Yes	Yes	Yes	Yes	Unclear

Fig. 2. Forest plot for total complications with (A) TJA (B) TKA (C) THA.

3.5. Total hip arthroplasty outcomes

There was no significant differences between the outpatient and inpatient THA groups with regards to total complications (RR: 0.82, 95% CI: 0.53 to 1.28, $I^2 = 81\%$, $P = 0.39$) (Fig. 2C).

There were also no difference between the outpatient and inpatient TKA groups with regards to major complications (RR: 0.99, 95% CI: 0.60 to 1.63, $I^2 = 0\%$, $P = 0.96$), readmissions (RR: 0.72, 95% CI: 0.26 to 1.95, $I^2 = 32\%$, $P = 0.51$), reoperations (RR: 1.38, 95% CI: 0.74 to 2.56, $I^2 = 0\%$, $P = 0.31$), transfusions (RR: 0.59, 95% CI: 0.19 to 1.80, $I^2 = 95\%$, $P = 0.35$), UTI (RR: 0.73, 95% CI: 0.25 to 2.12, $I^2 = 0\%$, $P = 0.56$) and wound complications (RR: 0.64, 95% CI: 0.22 to 1.84, $I^2 = 0\%$, $P = 0.41$) (Fig. 3).

4. Discussion

While patients undergoing TKA or THA typically stay for between 2 and 5 nights as an inpatient, outpatient joint arthroplasty is becoming more common. Outpatient TJA is associated with reduced costs, however there is limited quality evidence regarding the safety of this protocol.¹² This meta-analysis aimed to determine whether or not complication rates associated with outpatient TJA were comparable to inpatient TJA.

For TJA there were no differences in total or major complications, readmissions, DVT, pneumonia, UTI and wound complications between the outpatient and inpatient groups. However, there were fewer transfusions but increased reoperations in the outpatient TJA group compared to inpatient group. This result was also seen in the subgroup

Fig. 3. Combined forest plot for outcomes analyzed for TJA, TKA and THA.

analysis of TKA. For THA, there were no differences in any of the reported complications. These results indicate that outpatient TKA and THA can both be performed safely with effective patient selection.

The similar complication rates between outpatient and inpatient TJA are consistent with the results of retrospective studies using data from large registries.^{3,5,6,12} However, Lovecchio et al. found that outpatient TJA led to increased complications and reoperations in the first 30 days.⁵ This may be due to their comparison of the outpatient group with a “fast-track” inpatient TJA group, where all patients with an admission over 2 days were excluded.⁵ In our meta-analysis, although the reoperation rate for both groups was low, there were increased reoperations for outpatients. Darrith et al. reports that nearly half of the reoperations could have been treated non-surgically if the patients were in a hospital and not an ambulatory surgery center.⁷ Other included studies also did not include the cause of the reoperation and whether it was related to the original procedure.^{1,8} Transfusions were the most common post-operative complication in many studies and tended to be more common for inpatients.^{1,3,6,8} Thus, pre-operative correction of anaemia and intra-operative tranexamic acid should be used to manage blood loss and minimise post-operative transfusions.^{13,14} With comparable complication rates, outpatient TJA has the additional benefit of lower financial costs. Outpatient TKA and THA has been shown to save up to \$8000 when compared to inpatient TJA or \$6000 when compared to “fast-track” TKA.^{10,12,15}

For satisfactory TJA outcomes, it is essential that effective pre-

operative patient selection is completed to determine if an outpatient protocol is suitable. In our study the outpatient group tended to be younger than the inpatient group and thus likely to be healthier pre-operatively. From our included studies some common inclusion criteria included living within 1 h from the hospital and BMI less than 40 kg/m².^{9,11} A plethora of co-morbidities such as diabetes, cardiovascular disease, smoking and corticosteroid use may make patients ineligible for TJA as there is an increased risk of post-operative complications.^{16,17} Despite this Otero et al. showed that patients with significant medical comorbidities can still be safely discharged as outpatients, but consideration must be made for other factors such as support at home after surgery.³ Delayed discharge is most commonly due to anaesthetic-related side effects such as nausea and hypotension and thus aggressive management of these symptoms or use of shorter acting agents may help reduce length of stay.¹¹ Early mobilization with adequate pain control is also important in facilitating same day discharge.¹³

It is important to recognize the limitations to this systematic review and meta-analysis. The studies included had significant heterogeneity with a variety of surgical techniques, implants and patient selection criteria. Furthermore, the definition of an outpatient varied between studies from same day to within 23 h. Thus, patients staying overnight but discharged within 23 h were able to be defined as outpatient in some studies. Additionally, the majority of studies included were retrospective observational studies. The follow-up period of most studies was relatively short with no studies having a follow-up period of greater

than 90 days. More studies are required to elucidate the complication rates of less common events such as DVT.

5. Conclusion

This meta-analysis found that outpatient TJA had comparable complication rates to inpatient TJA. Using current surgical techniques and pain control modalities, outpatient TKA and THA can be performed safely in select patients while significantly reducing costs to the healthcare systems. Quality randomized controlled trials with longer follow-up periods are needed to add to this body of evidence.

Conflicts of interest

None of the authors have any conflicts of interest to declare.

CRediT authorship contribution statement

Joshua Xu: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **Jacob Y. Cao:** Data curation, Formal analysis, Methodology, Resources, Software, Writing - original draft, Writing - review & editing. **Gurpreet S. Chaggar:** Writing - original draft, Writing - review & editing. **Jonathan J. Negus:** Conceptualization, Methodology, Supervision, Validation, Writing - original draft, Writing - review & editing.

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