

Review

Outpatient Total Knee Arthroplasty: A Meta-Analysis

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Abstract: **Introduction:** Outpatient total knee arthroplasty (TKA) is attracting growing interest. This meta-analysis compared patient reported outcome measures (PROMs), infection, readmission, revision, deep vein thrombosis (DVT), and mortality rates of outpatient versus inpatient TKA. **Methods:** This meta-analysis was conducted according to the 2020 PRISMA statement. In August 2021, the following databases were accessed: Pubmed, Web of Science, Google Scholar, Embase. All the clinical trials comparing outpatient versus inpatient (>2 days) TKA were considered. Studies which reported data on revision settings were not considered, nor studies which included patients discharged between one and two days. **Results:** Data from 159,219 TKAs were retrieved. The mean follow-up was 5.8 ± 7.6 months. The mean age was 63.7 ± 5.0 years and the mean BMI 30.3 ± 1.8 kg/m². Comparability was found in age ($p = 0.4$), BMI ($p = 0.3$), and gender ($p = 0.4$). The outpatient group evidenced a greater Oxford knee score ($p = 0.01$). The inpatient group demonstrated a greater rate of revision ($p = 0.03$), mortality ($p = 0.003$), and DVT ($p = 0.005$). No difference was found in the rate of readmission ($p = 0.3$) and infection ($p = 0.4$). **Conclusions:** With regards to the endpoints evaluated in this meta-analysis, current evidence does not support outpatient TKA. However, given the limited data available for inclusion and the overall poor quality of the included articles, no reliable conclusion can be inferred. Further high quality clinical trials with clear eligibility criteria are required.

Keywords: total knee arthroplasty; inpatient; outpatient



Citation: Migliorini, F.; Pintore, A.; Cipollaro, L.; Oliva, F.; Maffulli, N. Outpatient Total Knee Arthroplasty: A Meta-Analysis. *Appl. Sci.* **2021**, *11*, 9376. <https://doi.org/10.3390/app11209376>

Academic Editor: Arnd Steinbrück

Received: 24 August 2021

Accepted: 4 October 2021

Published: 9 October 2021

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1. Introduction

Total knee arthroplasty (TKA) is one of the most performed surgical intervention worldwide. In the last two decades, average hospital duration after TKA has decreased from 9 days to 3–4 days [1,2]. The transition to modern anesthetic strategies, multimodal pain control modalities, rehabilitation protocols, and perioperative care have promoted a faster recovery [2]. Consequently, for selected patients, outpatient TKA is performed [3,4]. Several morbidity scoring systems are available to select appropriate patients for outpatient procedure [5]. Despite these ameliorations, outpatient TKA still remains relatively uncommon [6]. Indeed, up to 3% of all TKAs in the US are performed as outpatient procedure [4,7,8]. Patients undergoing outpatient TKA benefit of a faster discharge at homestay, reducing the health care burden [9–11]. On the other hand, especially for uncompliant patients or for those with other comorbidities, outpatient TKA may increase the rate of perioperative complications [12,13]. Given the limited and controversial evidence, previous reviews were inconclusive, concluding that current literature will benefit from additional studies [2,5,11,14–16]. In recent years, new studies have been published [17–21] and an update of current literature may expose novel understanding and insights on outpatient TKA. Therefore, a meta-analysis was conducted to compare outpatient versus inpatient

TKA. The outcomes of interests were the rate of infection, readmission, revision, deep vein thrombosis (DVT), mortality, and patient reported outcomes measures (PROMs). We hypothesized that outpatient TKA in selected patients performed similar to the inpatient procedure and can be safely performed.

2. Material and Methods

2.1. Eligibility Criteria

All the clinical trials comparing outpatient versus inpatient (>2 days) TKA were accessed. Given the authors language capabilities, articles in Italian, English, French, German, and Spanish were eligible. Level I to IV of evidence, according to the Oxford Centre of Evidence-Based Medicine [22], were considered. Reviews, opinions, letters, and editorials were not considered. Animals, in vitro, biomechanics, computational, and cadaveric studies were also not eligible. Studies which reported data on experimental physiotherapy protocols or enhanced TKA with cell therapies or innovative implants were not eligible. Studies which reported data on patients undergoing revision TKA were not included, nor were studies including patients discharged between one and two days. Only studies which reported quantitative data under the outcomes of interest were considered for inclusion.

2.2. Search Strategy

This meta-analysis was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the 2020 PRISMA statement [23]. The PICO algorithm was preliminarily pointed out:

- P (Population): end stage knee osteoarthritis;
- I (Intervention): outpatient TKA;
- C (Comparison): inpatient TKA;
- O (Outcomes): PROMs, complications.

In August 2021, the following databases were accessed: Pubmed, Web of Science, Google Scholar, Embase. No time constraint was used for the search. The following keywords were used in combination: *total knee arthroplasty, replacement, prosthesis, outpatient, inpatient, day surgery, fast track, ambulatory, admission, discharge, outcomes, readmission, revision, and complication*. The search was accomplished using the Boolean operators AND/OR, with no time constrain.

2.3. Selection and Data Collection

Two authors (F.M.; A.P.) independently performed the database search. All the resulting titles were screened and, if suitable, the abstracts were accessed. Subsequently, the full-text of the abstracts of interest were accessed. A cross reference of the bibliography of the full-text articles were also performed to identify additional studies. Any disagreements were discussed and settled by consensus.

2.4. Data Items

Two authors (F.M.; A.P.) independently performed data extraction. The following data were extracted: author, year, journal, study design, number of patients, mean age, body mass index (BMI), and women:men ratio. Data concerning the following endpoints were collected at last follow-up: Oxford knee score (OKS) [24], rates of readmission, infection, revision, DVT, and mortality

2.5. Methodology Quality Assessment

The Coleman methodology score (CMS) was performed to assess the quality of the included studies [25]. This score evaluated the studies under several criteria: study size, length of the follow-up, surgical approach, study design, description of diagnosis, surgical technique, and rehabilitation. Further, the outcome criteria, procedure of assessing outcomes, and the description of subject selection process is also evaluated. The quality of

the included studies resulted in a value between 100 (excellent) and 0 (poor). Values of 60 are considered satisfactory. To assess the overall risk of publication bias, the funnel plot of the most reported outcome was performed.

2.6. Synthesis Methods

The statistical analyses have been performed by the main author (F.M.). The meta-analyses were performed using the Review Manager Software 5.3 (The Nordic Cochrane Collaboration, Copenhagen). Binary data were evaluated through a Mantel Haenszel analysis, with odds ratio (OR) effect measure. Continuous data were evaluated using the inverse variance, with mean difference (MD) effect measure. The comparisons were performed with a fixed model effect as set up. Heterogeneity was assessed through the χ^2 and Higgins-I² test. If $\chi^2 < 0.05$ and if I² test $> 50\%$, high heterogeneity was detected. In cases of heterogeneity, a random model effect was used. The confidence intervals (CI) were set at 95% in all comparisons. The overall effect was considered statistically significant if $p < 0.05$. The funnel plot of the most reported outcome was performed to assess the risk of publication bias. Egger's linear regression was performed through the STATA MP Software version 16 (StataCorp, College Station, TX, USA) to assess funnel plot asymmetry, with values of $p < 0.05$ indicating statistically significant asymmetry.

3. Results

3.1. Study Selection

The literature search resulted in 1337 articles. Of them, 622 were duplicates. A further 696 articles were excluded as they did not match our eligibility criteria: study design ($N = 387$), not matching the topic ($N = 267$), not focusing on knee ($N = 21$), discharge within one or two postoperative days ($N = 11$), uncertain results ($N = 4$), other ($N = 4$), language limitations ($N = 2$). Another 9 articles were excluded as they did not report quantitative data under the outcomes of interest. This left 10 studies for inclusion. The literature search results are shown in Figure 1.

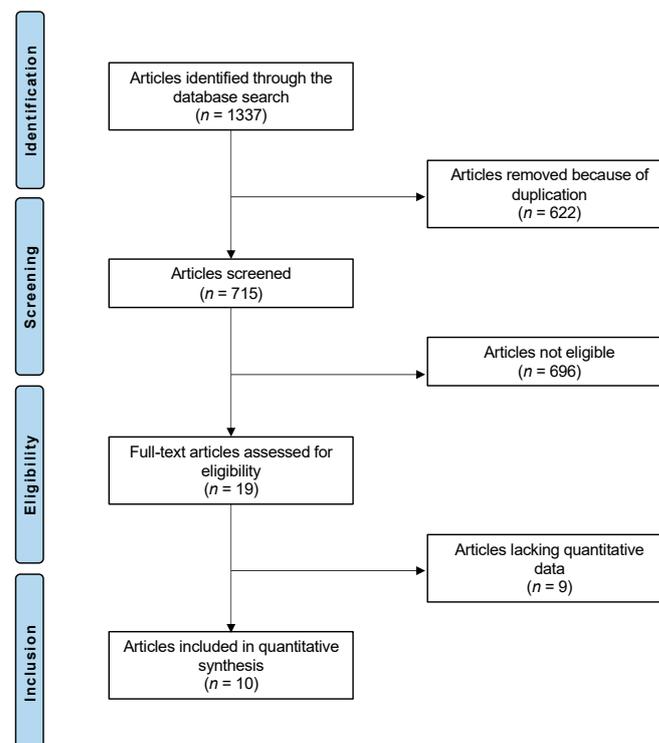


Figure 1. Flow chart of the literature search.

3.2. Risk of Publication Bias Assessment

The funnel plot of the most reported outcome (readmission) was performed to assess the risk of publication bias. The plot evidenced some variability of the effects of the studies; however, the Egger’s test detected no significant asymmetry ($p = 0.09$). Concluding, the funnel plot indicated a low to moderate risk of publication bias (Figure 2).

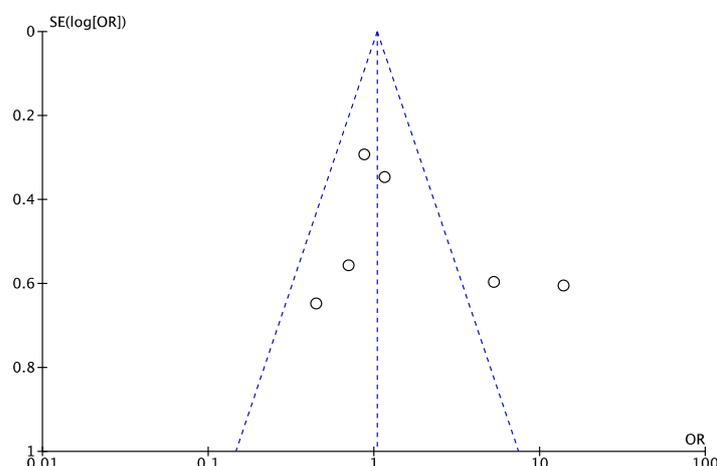


Figure 2. Funnel plot.

3.3. Methodological Quality Assessment

The study size was optimal in most of the included studies, as were the description of diagnosis, surgical technique, and postoperative rehabilitation. The retrospective design of most studies and the limited length of the follow-up represented further limitations highlighted by the CMS. Outcome measures and timing of assessment were frequently defined, providing moderate reliability. Finally, the procedures for assessing outcomes, along with subject selection were often biased and poorly described. To conclude, the CMS scored 66 points, attesting the good quality of the methodological assessment of the articles included in the present meta-analysis (Table 1).

Table 1. Coleman methodology score.

Part A: Only One Score to be Given for Each of the 7 Sections	
1. Study size: number of patients	9.1 ± 2.0 (4 to 10)
2. Mean follow-up	2.2 ± 3.0 (4 to 0)
3. Surgical approach	7.8 ± 3.1 (0 to 10)
4. Type of study	7.5 ± 5.4 (0 to 10)
5. Description of diagnosis	4.5 ± 1.6 (0 to 5)
6. Descriptions of surgical technique	6.0 ± 3.9 (0 to 10)
7. Description of postoperative rehabilitation	3.5 ± 3.4 (0 to 5)
Part B: Scores may be Given for Each Option in each of the 3 Sections if Applicable	
1. Outcome criteria	
Outcome measures clearly defined	1.4 ± 1.0 (0 to 2)
Timing of outcome assessment clearly stated	1.6 ± 0.8 (0 to 2)
Use of outcome criteria that has reported reliability	2.1 ± 1.4 (0 to 3)
General health measure included	2.4 ± 1.3 (0 to 3)
2. Procedure of assessing outcomes	
Participants recruited	3.5 ± 2.4 (0 to 5)
Investigator independent of surgeon	3.2 ± 1.7 (0 to 4)
Written assessment	2.4 ± 1.3 (0 to 3)
Completion of assessment by patients themselves with minimal investigator assistance	2.4 ± 1.3 (0 to 3)
3. Description of subject selection process	
Selection criteria reported and unbiased	3.5 ± 2.4 (0 to 5)
Recruitment rate reported > 80%	3.9 ± 2.2 (0 to 5)

3.4. Study Characteristics and Results of Individual Studies

Data from 159,219 patients were retrieved (Table 2). The mean follow-up was 5.8 ± 7.6 months. The mean age was 63.7 ± 5.0 years and the mean BMI 30.3 ± 1.8 kg/m². Comparability was found in mean age ($p = 0.4$), mean BMI ($p = 0.3$), and gender ratio ($p = 0.4$). Table 2 reported the main generalities and patient demographic of the included studies.

Table 2. Generalities and patient baseline of the included studies.

Author, Year	Journal	Design	Follow-up (Months)	Treatment	Patients (n)	Mean Age	Women (%)	Mean BMI
Carey et al., 2019 [17]	<i>J. Arthroplasty</i>	Retrospective	3	Outpatient	858	61.0		
				Inpatient	2574	61.0		
Courtney et al., 2018 [18]	<i>J. Arthroplasty</i>	Retrospective	1	Outpatient	365	72.3	62	31.8
				Inpatient	45,738	72.8	63	31.8
Gromov et al., 2019 [19]	<i>Acta Orthop.</i>	Prospective	3	Outpatient	46	61.0	41	28.0
				Inpatient	134	62.0	43	28.0
Husted et al., 2019 [20]	<i>Acta Orthop.</i>	RCT	3	Outpatient	16	58.0	8	28.0
				Inpatient	14	63.0	64	29.0
Kelly et al., 2018 [21]	<i>J. Arthroplasty</i>	Prospective		Outpatient	21	59.2	58	30.4
				Inpatient	61	64.1	28	32.7
Kolisek et al., 2009 [1]	<i>Clin. Orthop. Relat. Res.</i>	Prospective	12	Outpatient	64	55.0	38	30.8
				Inpatient	64	55.0	38	30.8
Lovald et al., 2014 [26]	<i>J. Arthroplasty</i>	Retrospective	24	Outpatient	454	68.0		
				Inpatient	71,341	71.0		
Lovecchio et al., 2016 [27]	<i>J. Arthroplasty</i>	Prospective	3	Outpatient	309	64.0	56	30.0
				Inpatient	891	64.0	55	31.0
Otero et al., 2016 [28]	<i>J. Arthroplasty</i>	Prospective	1	Outpatient	379	65.2	58	32.5
				Inpatient	35,870	67.3	66	32.9
Schotanus et al., 2016 [29]	<i>Knee Surg. Sport Traumatol. Arthrosc.</i>	Prospective	2	Outpatient	10	64.1	20	27.7
				Inpatient	10	66.9	50	29.2
Overall					159,219	63.7	46.8%	30.3

3.5. Results of Syntheses

The outpatient group evidenced a greater OKS (MD 4.77; 95%CI 1.06 to 8.49; $p = 0.01$). The inpatient group demonstrated a greater rate of revision (OR 5.06; 95%CI 1.18 to 21.75; $p = 0.03$), mortality (OR 15.07; 95%CI 2.58 to 88.07; $p = 0.003$), and DVT (OR 4.99; 95%CI 1.63 to 15.33; $p = 0.005$). No difference was found in the rate of readmission ($p = 0.3$) and infection ($p = 0.4$). The forest plot of each endpoint is shown in Figure 3.

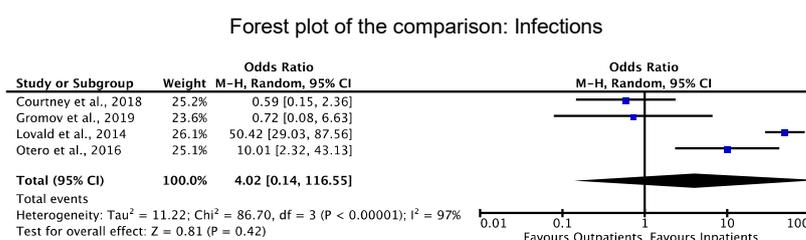
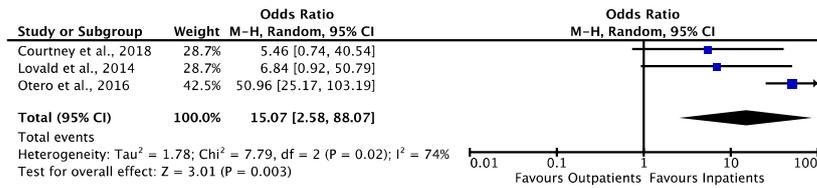
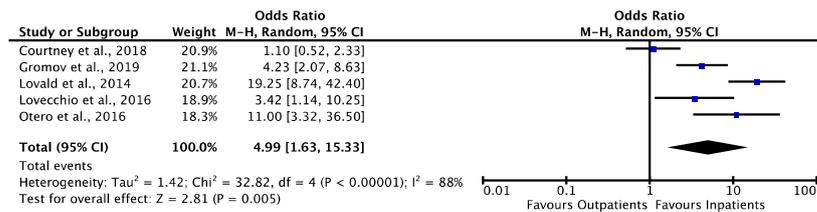


Figure 3. Cont.

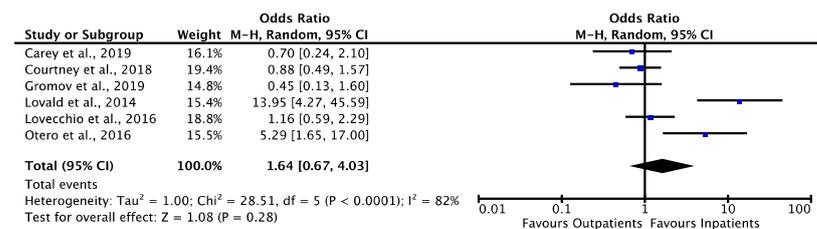
Forest plot of the comparison: Mortality



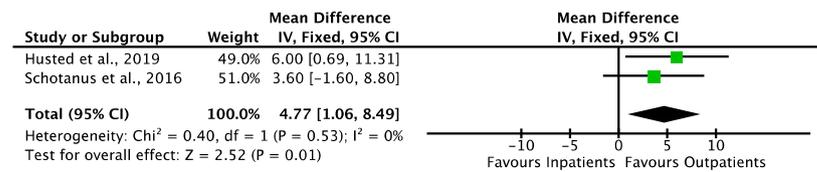
Forest plot of the comparison: DVT



Forest plot of the comparison: Readmission



Forest plot of the comparison: OKS



Forest plot of the comparison: Revision

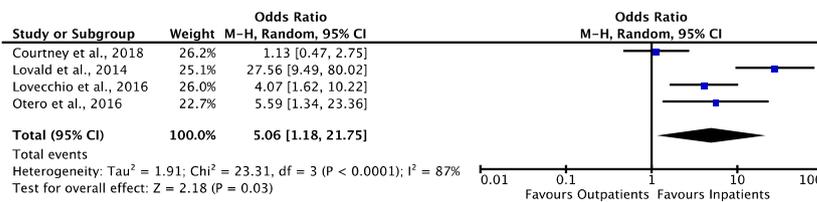


Figure 3. Forest plots of the comparisons.

4. Discussion

According to the main findings of the present study, inpatient TKA in selected patients demonstrated greater rate of revision, mortality, and DVT compared to the outpatient procedure. Similarity was found in OKS, readmission and infection rates.

Outpatient TKA has recently gained popularity and current evidence is controversial. In 2005, Berger et al. [30] firstly found a greater rate of early readmissions for pain in the

outpatient compared to inpatient TKA group on 50 procedures. The same authors in 2009 found greater rates of complication for outpatient compared to the inpatient procedure on 111 patients [31]. Arshi et al. [32] compared 4391 outpatient versus 128,951 inpatient TKAs from an insurance database. They found a greater risk of complications in the outpatient TKA: infections, DVT, component failure, and stiffness were the most common events [32]. Lovecchio et al. [27], investigating 1200 procedures, in addition to a greater complication rate, to find a greater rate of patients requiring blood transfusions. This finding could be explained by the increased activity of outpatient TKA when support at home is not adequate [33]. Outpatient TKA reported similar knee society score (KSS) and pain level to the inpatient procedure in a clinical setting involving 128 procedures (64 procedures each group) [1].

The clinical relevance of the OKS is questionable. Indeed, only two studies were included in the analyses [20,29]. Moreover, the final effect did not overcome the minimally clinically important difference (MCID) of the OKS, which is approximately 5 to 6/100 [34–37]. Moreover, with an overall number of 60 patients, they involved a small sample size [20,29]. The comparison of the OKS demonstrated narrow estimated effects, and CI overlapping the no-effect threshold. Thus, the reliability of this endpoint is limited, and no solid conclusion can be inferred. The increased incidence of complications is concerning. For a satisfactory implementation to outpatient TKA, preventing complications, such as DVT and pain management, is pivotal. The increased rate of DVT has been reported by previous investigations [27,38]. This may result from limited patient's compliance with postoperative DVT prophylaxis regimens, or perioperative use of tranexamic acid. Indeed, tranexamic acid, although it significantly reduces blood transfusion by 39%, is considered an independent risk factor for DVT [38–40]. Lovald et al. [26] analyzed 71,795 patients from the US Medicare database. At 2-year follow-up, outpatient TKA resulted in a greater rate of revision (2.1%) compared to inpatient procedure (1.9%) [26]. The most common causes for revision were infections, aseptic loosening, implant failures, dislocations, and mechanical complications [26]. Kolisek et al. [1] reported 3% (2 of 64 procedures) of revisions in outpatient TKA (one genu recurvatum deformity, one tibial plateau fracture), and 3% (2 of 64 procedures) revisions for inpatient TKA (two infections). Carney et al. [17] observed no revisions within 90 days. A statistically significant greater rate of mortality in patients undergoing outpatient TKA has been detected. This comparison included three studies, with an overall 1198 patients in the outpatient TKA and 152,589 patients in the inpatient group [18,26,28]. The most commonly causes of death were pulmonary diseases and cardiac failure [41]. Courtney et al. [18] showed no difference in within 30 day mortality between outpatient and inpatient on 46,103 patients from the US Medicare database. On the contrary, Otero et al. [28] analyzed data from the National Surgical Quality Improvement Program of the American College of Surgeons, demonstrating that outpatient had the highest rates of mortality, from infections, cardiac failure, thrombosis, and pulmonary embolism on 36,249 procedures. Lovald et al. [26] found a greater revision, readmission, and mortality risk for the outpatient and short stay TKA groups.

Fast-track regimes, multimodal pain control, and early mobilization have markedly reduced the length of hospitalization [42]. Peri-articular injections of local anesthetic and adductor canal block provide better pain control and faster functional recovery [43,44]. Several surgical approaches have been compared in terms of hospitalization; the mini-subvastus approach has demonstrated a faster recovery and better pain control when compared to the medial parapatellar approach [45,46]. Cardiovascular disorders, obesity, chronic renal or hepatic insufficiency, diabetes mellitus, physical and cognitive impairment, age greater than 75, and social support at home are considered pivotal for outpatient TKA [31,47–49]. Patients who already received a successful contralateral TKA were more likely suitable for an outpatient procedure, suggesting the importance of patient expectations [50]. However, there are no clear recommendations and eligibility criteria, and further investigations are necessary to define the best candidates.

The present study has several limitations. The inpatient group included different hospitalization protocols and timing of discharge. Moreover, the reason of the prolonged hospitalization in some studies was poorly described. Different health care systems may also influence the results. The limited number of included studies represented an important limitation of the present study. To improve data pooling, both clinical investigations and database analyses were included for analysis, improving the risk of selection bias. Interestingly, database studies have shown conflicting results with an overall greater rate of complication in the outpatient group [17,18,26,28]. On the other hand, the included clinical studies have shown similar risk of adverse events and readmissions [1,19–21,27,29]. The strength of the databases analyses is the large scale of the population investigated; however, results may be highly biased, and the quality of the recommendation is limited. Subject selection was often biased, heterogeneous, and poorly described. Some included studies did not report separately the surgical outcomes, with the diagnoses not described. Furthermore, the description of the surgical technique and postoperative rehabilitation were not adequately reported by some studies. Since outpatient TKA remains relatively uncommon with limited data available for inclusion, there is considerable discrepancy in the sample size included for analysis between the two groups; this may jeopardize the frequency of complications in the outpatient TKA group. Given these limitations, results from the present study must be interpreted with caution. Further high quality clinical trials are required to improve evidence. A widely standardized protocol for patient eligibility and education for outpatient TKA is strongly recommended.

5. Conclusions

With regards of the endpoints evaluated in this meta-analysis, current evidence does not support outpatient TKA. However, given the limited data available for inclusion and the overall poor quality of the included articles, no reliable conclusion can be inferred. Further high quality clinical trials with clear eligibility criteria are required.

Author Contributions: L.C.: writing; F.O.: supervision; A.P.: writing; N.M.: final approval; F.M.: writing, data source and extraction; selection and data collection, data items, statistical analyses; L.C.: data source and extraction; selection and data collection, data items, methodology quality assessment. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

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