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Review

Effect of Parkinson's disease on primary total joint arthroplasty outcomes: A meta-analysis of matched control studies

Huan Min[a], Hui Lin[b], Gang Chen[a,*]

[a] Department of Orthopedics, Jiangxi Provincial People's Hospital Affiliated to Nanchang University, 92 Aiguo Road, Nanchang, 330006, Jiangxi, China
[b] Department of Orthopedics, The First Affiliated Hospital of Nanchang University, 17 Yongwaizheng Street, Nanchang, 330006, Jiangxi, China

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ABSTRACT

Background: Currently, no meta-analysis exists elucidate the outcomes of total joint arthroplasty (TJA) in patients with Parkinson's disease (PD). The aim of this study was to investigate the outcomes of TJA in patients with PD with respect to complication and revision in comparison to a TJA cohort without PD.

Methods: MEDLINE, Scopus, EMBASE, and Cochrane Library databases were searched **with English** language restrictions. The primary outcome measures were complications and revision, whereas the secondary outcomes included length of stay (LOS) and total charge.

Results: Seven studies with a total of 124163 patients were included. The most important finding from our study was that PD patients had a 42% higher risk for any medical complication ($P = 0.004$) and a 65% higher risk for any surgical complication ($P = 0.01$) compared to the matched cohort. Specifically, PD was associated with increased superficial wound infection ($P = 0.006$), dislocation ($P = 0.01$), deep vein thrombosis (DVT) ($P = 0.02$), LOS ($P = 0.0005$), and total hospital charges ($P < 0.00001$). However, PD did not increase the risks for periprosthetic infection ($P = 0.32$) and revision ($P = 0.17$).

Conclusions: Patients with PD are at increased risk for medical complication and surgery complications, particularly superficial wound infection, dislocation, and DVT as compared to patients without PD. PD patients also exhibit increased LOS and total hospital charges. However, PD did not increase the risks for periprosthetic infection and revision.

1. Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disease where the loss of dopaminergic neurons in the substantia nigra leads to the typical clinical phenotype characterized by worsening motor symptoms, including a resting tremor, bradykinesia, rigidity, shuffling gait, and poor overall coordination [1,2]. In the United States, the prevalence of PD in the elderly population has been reported to be 1%–2% in persons aged ≥65 years [3] and 4%–5% in persons aged > 85 years, which is noticeably larger than the overall 0.3% prevalence found in the general population [4]. There are approximately 1 million people living with PD in the United States alone, with an estimated 60,000 new cases diagnosed annually [5].

Many patients with PD have severe osteoarthritis that warrants total joint arthroplasty (TJA). However, PD is associated with a variety of orthopedic conditions, including osteopenia and increased risk of fall and fracture [6]. The muscular rigidity and diminished bone quality encountered in PD patients presents important challenges to the orthopedic surgeon [5,7]. In addition, some of the disease symptoms, such as tremor, shuffling gait, and instability, can potentially make performing TJA riskier. The instability in PD patients can potentially make them more likely to fall, resulting in postoperative prosthesis dislocation, periprosthetic fracture, and infection [7]. Because of these concerns, PD has historically been considered a relative contraindication to TJA. Recently, some studies have suggested that both hip and knee arthroplasty in PD patients provide excellent long-term pain relief, with complication and revision rates likely comparable to that of the general population. However, these studies are few and have small cohort sizes [8–10]. Despite the increase in interest in the application of arthroplasty procedures in patients with PD, data on outcomes of these procedures are still relatively scarce.

Currently, no meta-analysis exists elucidate the outcomes of TJA in patients with PD. Therefore, the purpose of this study is to systematically review the current evidence in the literature to ascertain the outcomes of TJA in patients with PD with respect to complication and revision in comparison to a TJA cohort without PD. Our hypothesis was

* Corresponding author.
E-mail address: srmdoctormh@163.com (G. Chen).

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that patients with PD were associated with high complication and revision rates after TJA.

2. Materials and methods

2.1. Search strategy

The systematic literature review was structured to adhere to AMSTAR (Assessing the methodological quality of systematic reviews) and PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-analyses), which include requirements deemed essential for the transparent reporting of results [11]. The following search terms were used in MEDLINE, Scopus, EMBASE, and Cochrane Library databases on April 1, 2019, as the search algorithm: (total hip arthroplasty (THA) OR total hip replacement OR total knee arthroplasty (TKA) OR total knee replacement) AND (Parkinson's disease). No time limit was given to publication date. References within included articles were reviewed to include articles that were not included within our literature search.

2.2. Eligibility criteria and study selection

Study included in our meta-analysis had to meet all of the following inclusion criteria in the PICOS order: (1) population: patients undergoing primary TKA or THA; (2) intervention: PD group; (3) comparison intervention: no-PD group; (4) outcome measures: at least one of the following outcome measures was reported: complications, revision, length of stay (LOS), and charge; (5) study design: prospective study, retrospective study, or registry study. Articles with no assessment of outcomes mentioned above or no comparison of PD and no-PD were not included into meta-analysis. Duplicate reports and conference abstracts were excluded. Case reports, biochemical trials, letters, and reviews were also eliminated. Articles were exported to EndNote, and duplicates removed. Two independent authors screened the titles and abstracts of potentially relevant studies to determine their eligibility based on the criteria. Disagreements were resolved through a discussion with a third review author.

2.3. Data extraction

The method of data extraction followed the approach outlined by the *Cochrane Handbook for Systematic Reviews of Interventions* [12]. Two independent authors extracted the following descriptive raw information from the selected studies: study characteristics such as author, publication year, study design, follow-up period; patient demographic details such as patients' number, average age, and gender ratio. The primary outcome was the incidence of complications at a minimum of 12 months postoperatively, including medical complication, infection, dislocation, deep vein thrombosis (DVT), and revision. Secondary outcomes included LOS and total charges. Where disagreement in the collection of data occurred, this was resolved through discussion. If the data were missing or could not be extracted directly, we contacted the corresponding authors to ensure that the information integrated. Otherwise, we calculated them with the guideline of *Cochrane Handbook for Systematic Reviews of Interventions* [12]. If necessary, we would abandon the extraction of incomplete data.

2.4. Statistical analysis

Review Manager software (v 5.3; Cochrane Collaboration) was used for the meta-analysis. Extracted data were entered into Review Manager by the first independent author and checked by the second independent author. We used the Mantel-Haenzel method to calculate the pooled odds ratio (OR). OR with a 95% confidence interval (CI) or mean difference (MD) with 95% CI were assessed for dichotomous outcomes or continuous outcomes, respectively. The heterogeneity was assessed by using the Q test and I^2 statistic. An I^2 value of $< 25\%$ was chosen to represent low heterogeneity and an I^2 value of $> 75\%$ to indicate high heterogeneity. All outcomes were pooled on random-effect model. A P value of < 0.05 was considered to be statistically significant.

2.5. Quality evaluation

The literature search did not yield any randomized trials. The Downs and Black tool was adopted to evaluate the quality of non-randomized surgical studies [13]. Each paper was reviewed by one reviewer and verified by a second and disagreements were resolved by discussion with a third reviewer. Subgroup analyses were planned by type of arthroplasty (THA or TKA) and infection (superficial wound infection or periprosthetic infection). We also conducted the sensitivity analysis to evaluate whether any single study had the weight to skew on the overall estimate and data. Furthermore, we did not conduct publication bias because of the limited number of included studies.

3. Results

3.1. Database search and study characteristics

The initial literature search resulted in 167 total studies. After removal of duplicates, 41 irrelevant articles were excluded based on title and abstract screening. Among the remaining 23 studies, 15 articles were then further excluded for reasons such as conference abstract, reviews, and no comparison of PD and no-PD. Additionally, one cohort study which evaluated the outcomes following hemiarthroplasty for femoral neck fractures in patients with PD compared with patients without PD was also deleted [14]. Ultimately, 7 studies from 2013 to 2019 were available for meta-analysis (Fig. 1) [8,9,15–19].

The study baseline characteristics and patient demographic details can be seen in Table 1. All 7 studies were matched control studies. A total of 124163 patients were included for analysis, with 15810 patients had Parkinson's disease prior to TJA and 108353 no-PD patients. The mean age between groups was similar. Overall, the female percentage ranged from 36.6% to 59.3%. Mean follow-up period ranged from 1 to 6 years.

3.2. Assessments of study quality

The quality of the research was moderate to good (Table 2). Recurrent strengths in the 7 studies included clearly stating the aims and objectives, the characteristics of the patients, the surgical procedures and the potential confounders to influence the outcome. All 7 studies clearly presented the results with both point and variance data for clinical scores and adverse events. The evidence-base, however, had limitations. Only 1 study undertook a subgroup analysis based on type of arthroplasty [16]. Due to their retrospective nature, it was not possible to blind or randomly assign patients. Finally, no authors performed a power calculation to determine whether they analysed enough patients to detect a statistically significant difference.

3.3. Meta-analyses of TJA outcomes

A summary of the results of the meta-analyses is presented in Table 3.

3.3.1. Any medical complication

Any medical complication was reported in 4 studies [8,9,15,17]. It was present in 492 of 10829 patients (4.5%) in the PD group and 900 of 31997 patients (2.8%) in the no-PD group, with statistically significant differences in favor of the no-PD group (OR 1.42, 95% CI 1.12–1.79, $I^2 = 20\%$, $P = 0.004$) (Fig. 2A).

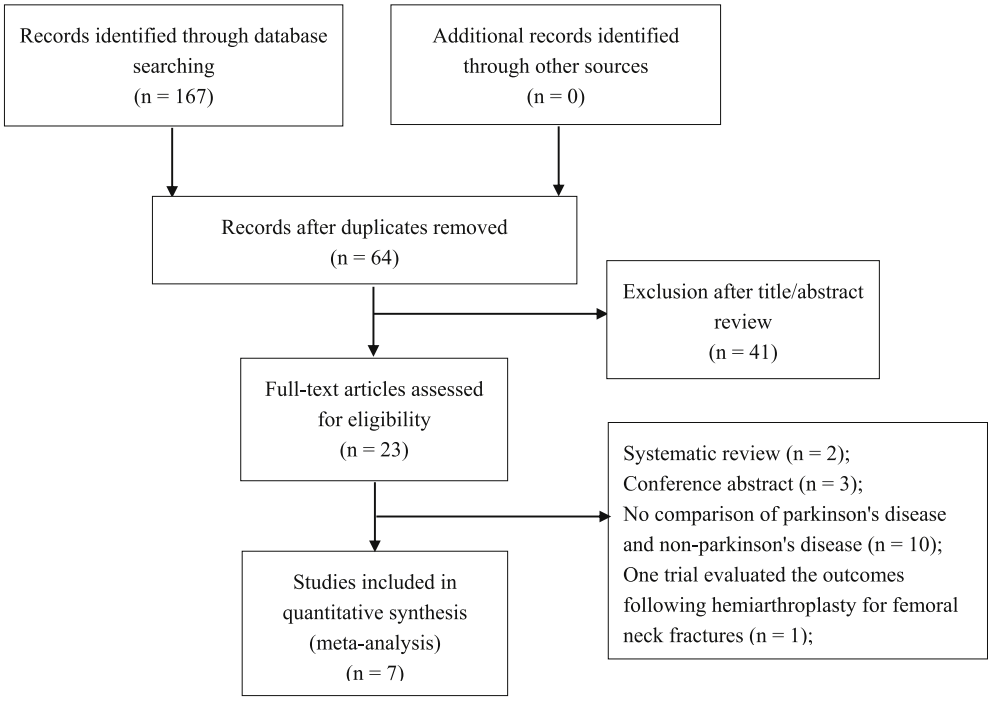


Fig. 1. PRISMA Flow diagram describing the selection process for relevant clinical trials used in this meta-analysis.

3.3.2. Any surgical complication

Any surgical complication was reported in 6 studies [8,9,15–17,19]. It was present in 300 of 11809 patients (2.5%) in the PD group and 631 of 34793 patients (1.8%) in the no-PD group, with statistically significant differences in favor of the no-PD group (OR 1.65, 95% CI 1.11–2.45, $I^2 = 69\%$, $P = 0.01$) (Fig. 2B).

3.3.3. Infection

Infection was reported in 5 studies [8,9,16,17,19]. It was present in 75 of 1290 patients (5.8%) in the PD group and 90 of 3114 patients (2.9%) in the no-PD group, with statistically significant differences in favor of the no-PD group (OR 2.49, 95% CI 1.05–5.89, $I^2 = 55\%$, $P = 0.04$) (Fig. 3A).

3.3.4. Dislocation

Dislocation was reported in 4 studies [8,16,17,19]. It was present in 30 of 616 patients (4.9%) in the PD group and 30 of 1252 patients (2.4%) in the no-PD group, with statistically significant differences in favor of the no-PD group (OR 2.14, 95% CI 1.17–3.90, $I^2 = 8\%$, $P = 0.01$) (Fig. 3B).

3.3.5. DVT

DVT was reported in 4 studies [8,9,15,17]. It was present in 66 of 10829 patients (0.6%) in the PD group and 132 of 31997 patients (0.4%) in the no-PD group, with statistically significant differences in favor of the no-PD group (OR 1.43, 95% CI 1.06–1.93, $I^2 = 0\%$, $P = 0.02$) (Fig. 3C).

3.3.6. Revision

Five trials [8,9,16,17,19] reported the revision between the groups, with 73 of 1290 patients (5.7%) in the PD group and 95 of 3114 patients (3.1%) in the no-PD group. The difference was not significant (OR 2.05, 95% CI 0.74–5.69, $I^2 = 82\%$, $P = 0.17$) (Fig. 4).

3.3.7. LOS

Five trials including 123722 patients showed the LOS [8,15,17–19]. According to the analysis, there were statistically significant differences in favor of the no-PD group in the LOS (MD = 0.59, 95% CI 0.26 to 0.92, $I^2 = 75\%$, $P = 0.0005$) (Fig. 5).

3.3.8. Total charges

Only 3 studies including 120229 patients showed the total charges [15,17,18]. According to the analysis, there were statistically

Table 1
Characteristics of the included studies.

Study	Study Design	Surgery Types	No. of Patients	PD	no-PD	Mean Age (y)		Female gender (%)	Follow-Up	Outcome Measures
						PD	no-PD			
Kleiner 2019	MR	THA	77561	4001	73560	74.5	74.5	51.5	NC	LOS, total charges;
Shah 2019	MR	THA	470	235	235	74.3	74.3	49.0	2 y	Complications, revision, LOS, total charges;
Newman 2018	MR	THA	42198	10519	31679	73.0	73.0	49.0	NC	Complications, LOS, total charges;
Rondon 2018	MR	THA/TKA	348	123	225	68.6	69.7	44.5	5.3 y	Complications, revision, SF-12 score;
Wong 2018	MR	TKA	93	43	50	72.6	71.8	36.6	1.6 y	Complications, revision, OKS, ROM;
Jämsen 2014	MR	THA/TKA	3428	857	2571	72.0	73.0	59.3	6 y	Complications, revision, LOS;
Tinning 2013	MR	TKA	65	32	33	73.0	73.0	50.9	1 y	Complications, revision, LOS, KSS, ROM;

MR, matched retrospective; THA, total hip arthroplasty; TKA, total knee arthroplasty; PD, Parkinson's disease; NC, not clear; LOS, length of stay; SF-12, Short-Form 12; OKS, Oxford Knee Score; KSS, Knee Society Score; ROM, range of motion.

Table 2
Summary of the critical appraisal results using the Downs and Black checklist for non-randomised studies.

	Kleiner 2019	Shah 2019	Newman 2018	Rondon 2018	Wong 2018	Jämsen 2014	Tinning 2013
Hypothesis/aims/objectives clearly stated	Y	Y	Y	Y	Y	Y	Y
Main outcome measures clearly described	Y	Y	Y	Y	Y	Y	Y
Characteristics of patients/subjects clearly described	Y	Y	Y	Y	Y	Y	Y
Interventions of interest clearly described	Y	Y	Y	Y	Y	Y	Y
Distribution of principal confounders in each group clearly described	Y	Y	Y	Y	Y	Y	Y
Main findings clearly described	Y	Y	Y	Y	Y	Y	Y
Estimates of random variability in the data provided	Y	Y	Y	Y	Y	Y	Y
Important adverse events reported	Y	Y	Y	Y	Y	Y	Y
Characteristics of patients lost to follow-up described	UTD	N	UTD	N	N	UTD	Y
Actual probability values reported	Y	Y	Y	Y	N	N	N
Participants approached representative of entire population	Y	Y	Y	Y	Y	Y	Y
Participants recruited representative of entire population	Y	Y	Y	Y	Y	Y	Y
Staff, places and facilities representative of majority of population	Y	Y	Y	Y	Y	Y	Y
Blinding of study subjects	N	N	N	N	N	N	N
Blinding of assessors	N	N	N	N	N	N	N
Data based on data-dredging clearly stated	UTD	UTD	UTD	UTD	UTD	UTD	UTD
Adjustment of different length of follow-up or duration between case and control	Y	Y	Y	Y	Y	Y	Y
Appropriate statistical tests used.	Y	Y	Y	Y	Y	Y	Y
Compliance to intervention reliable.	Y	Y	Y	Y	Y	Y	Y
Main outcome measure reliable and valid	Y	Y	Y	Y	Y	Y	Y
Intervention groups or case-controls recruited from same population	Y	Y	Y	Y	Y	Y	Y
Intervention groups or case-controls recruited at the same time	Y	Y	Y	Y	Y	Y	Y
Study subjects randomized to the interventions	N	N	N	N	N	N	N
Was concealed randomization to allocation undertaken	N	N	N	N	N	N	N
Adequate adjustment made in the analysis of confounders	Y	Y	Y	Y	N	N	N
Patient losses accounted for	UTD	Y	UTD	Y	Y	UTD	Y
Sufficiently powered cohort size	N	N	N	N	N	N	N

Y, yes; N, no; UTD, unable to determine.

significant differences in favor of the no-PD group in the total charges (MD = 0.10, 95% CI 0.09 to 0.12, I^2 = 0%, $P < 0.00001$) (Fig. 6).

3.4. Subgroup analysis

There was insufficient data to perform subgroup analyses by type of arthroplasty. However, there was sufficient data to perform further subgroup analyses by type of infection. Three studies reported superficial wound infection [8,9,17]. The no-PD group tended to have a lower rate of superficial wound infection, with 21 of 310 patients (6.8%) in the PD group and 6 of 318 patients (1.9%) in the no-PD group. The difference was significant (OR 3.36, 95% CI 1.41–7.99, I^2 = 0%, P = 0.006) (Fig. 3A). Three studies reported periprosthetic infection [8,16,17]. The no-PD group tended to have a lower rate of periprosthetic infection, with 17 of 390 patients (4.4%) in the PD group and 4 of 493 patients (0.8%) in the no-PD group. However, the difference was not significant (OR 3.31, 95% CI 0.31–34.92, I^2 = 65%, P = 0.32) (Fig. 3A).

3.5. Sensitivity analysis

Among the outcomes with high heterogeneity, the sensitivity analysis showed that excluding any one single study did not change the statistical results. Therefore, we believe that our findings in this review are reliable.

4. Discussion

To date, no meta-analysis has been conducted to assess the outcomes of TJA in patients with PD. The purpose of this study was to systematically review the current evidence in the literature to ascertain if PD increases the risks of complication and revision rate after TJA. The most important finding from our study was that PD patients had a 42% higher risk for any medical complication and a 65% higher risk for any surgical complication compared to the matched cohort. Specifically, PD was associated with increased superficial wound infection (P = 0.006), dislocation (P = 0.01), DVT (P = 0.02), LOS (P = 0.0005), and total hospital charges ($P < 0.00001$). However, PD did not increase the risks for periprosthetic infection (P = 0.32) and revision (P = 0.17). Sensitivity analysis showed that our findings in this review are reliable.

Increased risk of dislocation has been theorized following THA in PD patients because of the presence of muscular rigidity and flexion deformity seen in some PD patients [5]. Our study showed that PD patients who underwent THA had an approximately two-fold increased

Table 3
Results of the meta-analyses.

Outcomes	OR or MD (95% CI)	*P*-Value	Number	Statistical heterogeneity (I^2; chi^2 p-value)
Any medical complication	1.42 (1.12–1.79)	**0.004**	42826	20%; 0.29
Any surgical complication	1.65 (1.11–2.45)	**0.01**	46602	69%; 0.006
Infection	2.49 (1.05–5.89)	**0.04**	4404	55%; 0.06
Dislocation	2.14 (1.17–3.90)	**0.01**	1868	8%; 0.35
DVT	1.43 (1.06–1.93)	**0.02**	42826	0%; 0.60
Revision	2.05 (0.74–5.69)	0.17	4404	82%; 0.0007
LOS	0.59 (0.26–0.92)	**0.0005**	123722	75%; 0.003
Total charges	0.10 (0.09–0.12)	< **0.00001**	120229	0%; 0.83

DVT, deep vein thrombosis; LOS, length of stay; MD, mean differences; OR, odds ratio; CI, confidence intervals; I^2, inconsistency value.
Bold indicates a statistically significant *P*-value.

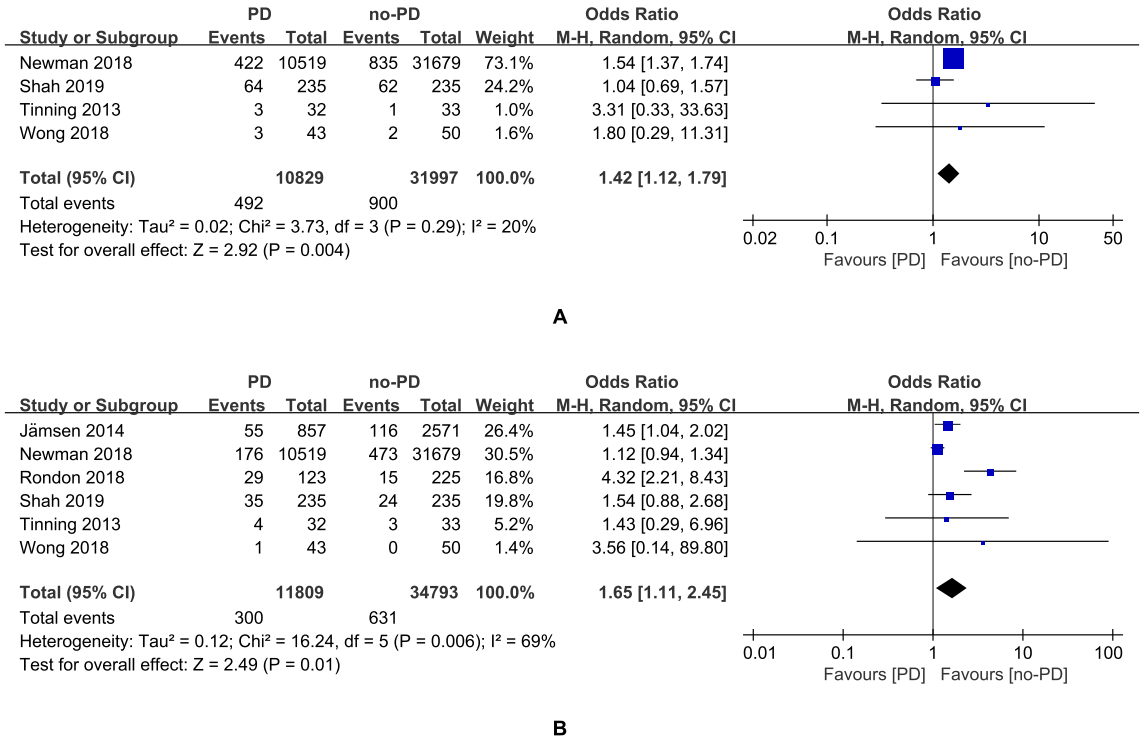


Fig. 2. A. Forest plots of the any medical complication between PD group and no-PD group after TJA; B. Forest plots of the any surgical complication between PD group and no-PD group after TJA.

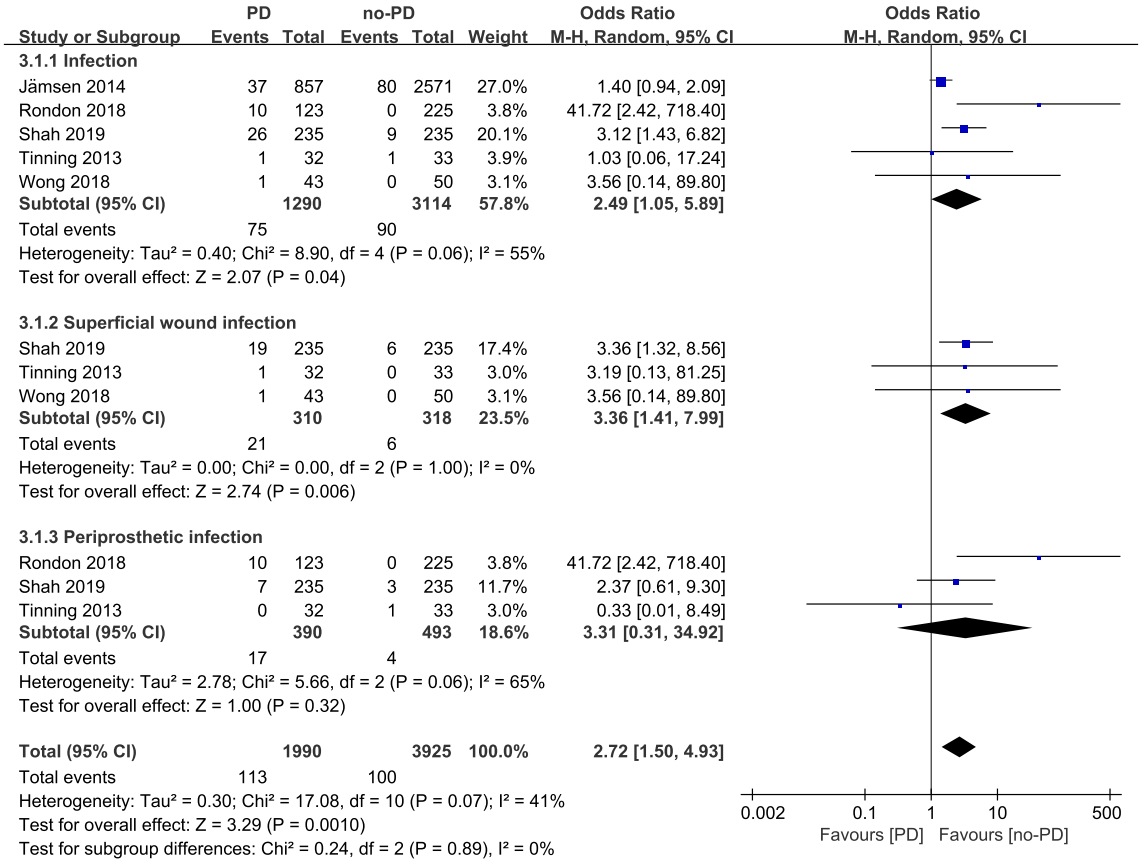
risk of dislocation than no-PD patients at least 1 year postoperatively. However, the current body of literature offers conflicting evidence on the dislocation risk following THA in PD patients. In a review of a Scottish National Registry, Meek et al. reported that PD patients were not at increased risk of dislocation [20]. More recently in 2018, Elizabeth et al. used the Nationwide Readmissions Database data between 2012 and 2014 and demonstrated PD was significantly associated with hip dislocation [21]. Lazennec et al. performed a retrospective analysis of 59 PD patients to investigate the long-term outcomes of primary and revision THAs with cementless dual mobility implants. Only 1 patient sustained an intraprosthetic hip dislocation 9 years after surgery, which required revision [10]. These findings suggest that neuromuscular weakness may impact implant choice, and the use of cementless dual mobility implant may be considered in this population.

In our subgroup analysis, we revealed that PD patients may have a higher risk of superficial wound infection at least 1 year postoperatively, but do not increase the risk of deep infection. PD is known to predispose to both pneumonia and urinary tract infections after surgery, likely via poor respiratory effort and clearance of secretions and urinary retention, respectively [7,22]. Impaired wound healing has been previously suggested to be a theoretical consequence of PD due to immobility, risk of incontinence-associated dermatitis, and altered sudomotor innervation [23]. Our study also revealed a higher risk of DVT in PD patients. Long-term immobility and longer hospital stay may be the main factors leading to this result.

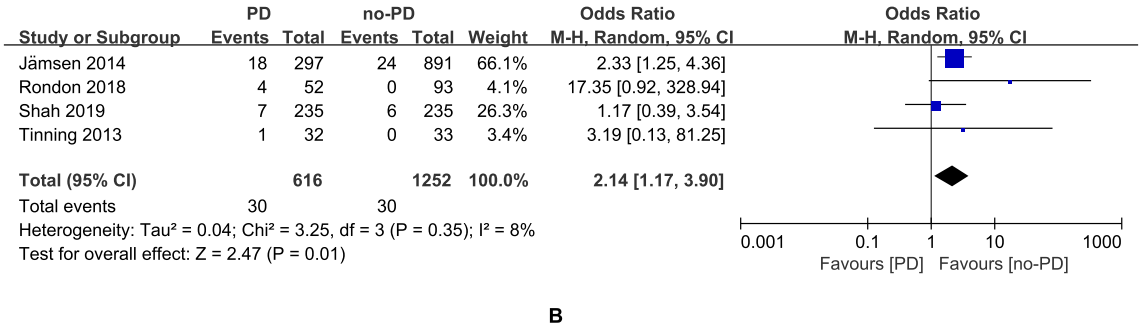
The 3 most common reasons for revision in our study were periprosthetic infection, dislocation, and aseptic loosening. Although there was an increased rate of dislocation in the PD cohort compared to matched controls, the risk of periprosthetic infection was similar in PD cases and controls. However, there was insufficient data to perform a meta-analysis in risk of aseptic loosening. Prior studies have suggested contrasting results with regard to revision rates in PD patients. A retrospective study by Lazennec et al. examined 59 PD patients who underwent primary THAs with cementless dual mobility implants, demonstrating an 8.5% rate of revision [10]. Jämsen et al. used the nationwide PERFECT database data from 1998 to 2009 to evaluate the impact of PD on survivorship, outcome, and complications following primary TJA. There was no difference in revision rate in the first year in 857 patients with Parkinson's disease and 2571 matched control patients, which is similar to our results [19]. A matched retrospective study by Rondon et al. suggested that patients with PD before TJA presented higher revision rate compared with control patients, which was conflicting with our results. However, there may be a selection bias in their study [16].

As previously stated, PD patients tended to have longer LOS, a risk in itself for acquisition of hospital-associated infections. These findings, combined with the increased risk of postoperative complications, indicate that PD patients treated with TJA place an increased burden on our healthcare system. Early post-operative involvement of Neurology has been found to decrease length of stay in PD patients and may be an effective tool for combatting this discrepancy while also helping to decrease infection risk [24]. It has been recommended that such interdisciplinary collaboration involve early and aggressive rehabilitation with rapid return to full weight-bearing in order to maximize long-term functional gains and decrease dislocation risk [25,26].

Functional outcomes following TJA in PD patients have been studied in the literature with contrasting results. An examination of the functional outcomes of the included studies have a weak but similar trend in favor of no-PD. A meta-analysis could not be performed on these outcomes due to insufficient and heterogenous data; however, the functional outcomes of the included studies will be noted here. Tinning et al. showed that PD group displayed similar functional results than no-PD group with respect to knee scores, pain scores, and knee range of motion [8]. Wong et al. only examined Oxford Knee Score and range of motion at 1 year postoperatively, with no statistically significant differences between groups [9]. Rondon et al. found that Short-Form 12 scores was significantly better in PD group compared to no-PD group [16]. Two case series found in the literature have previously examined functional outcomes following TKA in Parkinson's disease, each with contradicting results. Vince's retrospective case series [27] found



A



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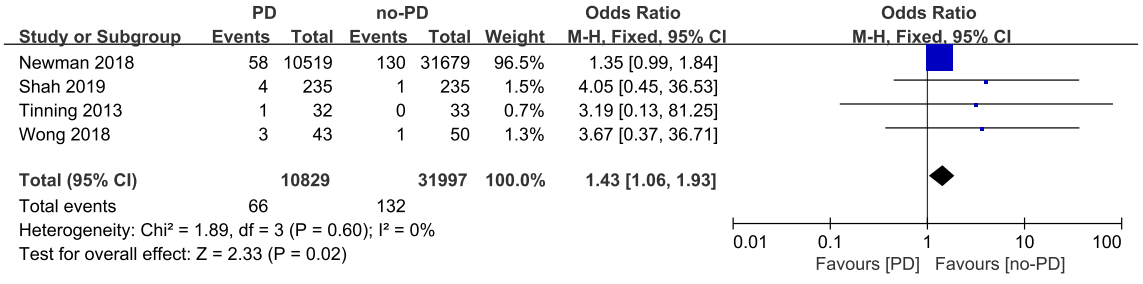

C

Fig. 3. A. Forest plots of the infection between PD group and no-PD group after TJA; B. Forest plots of the dislocation between PD group and no-PD group after TJA; C. Forest plots of the DVT between PD group and no-PD group after TJA.

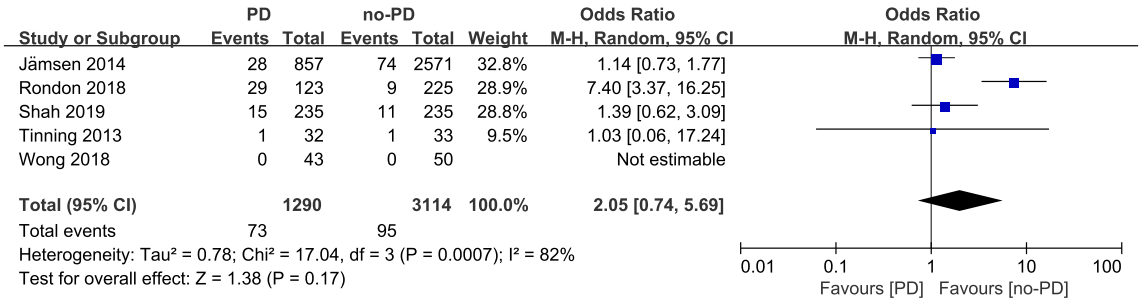

Fig. 4. Forest plots of the revision between PD group and no-PD group after TJA.

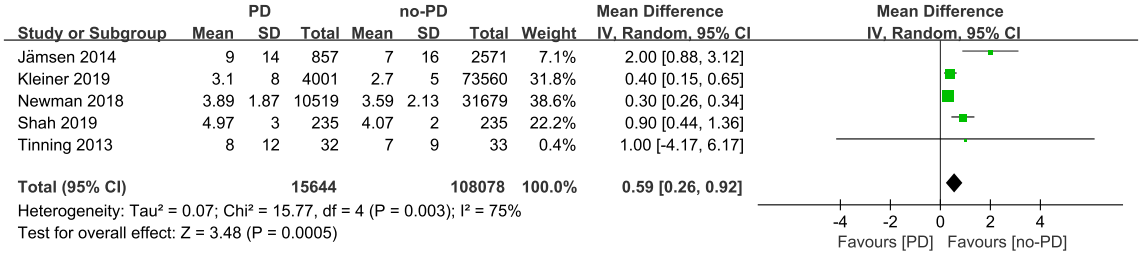

Fig. 5. Forest plots of the LOS between PD group and no-PD group after TJA.

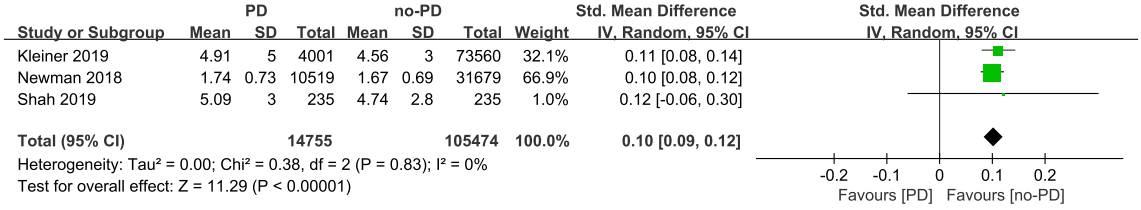

Fig. 6. Forest plots of the total charges between PD group and no-PD group after TJA.

improvement in flexion deformity and range of motion following TKA, while Duffy's case series [28] found improvement in postoperative pain but not in function.

Many weaknesses were also included in the present meta-analysis. First, All of the included studies were retrospective in nature, which can introduce potential biases with meta-analysis. Second, data from 4 papers were based on hospital and healthcare datasets and registries, which were gathered through hospital coding systems [15,17–19]. Therefore, errors in the cataloguing and coding of procedures may have caused errors in the subsequent analyses. Third, the fixations and designs of the components in the 2 groups were inconsistent across studies. However, modern cementless components have already achieved comparable results to cemented ones. Fourth, the average follow-up length was short and different in 7 studies, trials with longer and similar follow-up are still needed. Fifth, there was insufficient data to perform meta-analyses of functional outcomes or subgroup analyses by type of arthroplasty. Sixth, some outcome measures such as superficial wound infection and periprosthetic infection were based on limited sample size, so the authenticity and reliability of these results should be treated with caution. Finally, although our meta-analysis is of relatively large sample size (124163 patients), it might still lead to overestimating and could not explain all outcomes.

5. Conclusion

Patients with PD are at increased risk for medical complication and surgery complications, particularly superficial wound infection, dislocation, and DVT as compared to patients without PD. PD patients also exhibit increased length of stay and total hospital charges. However, PD did not increase the risks for periprosthetic infection and revision.

Data statement

All data in this study were derived from the original literature.

Provenance and peer review

Not commissioned, externally peer-reviewed.

Ethical approval

Ethical approval was not necessary because the present meta-analysis was performed on the basis of previous published studies.

Sources of funding

None.

Author contribution

Huan Min: first author, whole study: collection, data analysis writing. First reviewer of the included studies.

Hui Lin: collection. Did a pre-review of the full body of text. Rewrote a significant and important part of the study.

Gang Chen: (corresponding author): supervised the whole study.

Research registration number

Research Registry.
Reviewregistry723.
https://www.researchregistry.com/browse-the-registry#registryofsystematicreviewsmeta-analyses/registryofsystematicreviewsmeta-analysesdetails/5d3471b7c602c900108cc2b8/

Guarantor

Gang Chen.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijsu.2019.09.013.

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