Original Article

A systematic review and meta-analysis of the correlation between operation time and postoperative delirium in total hip arthroplasty

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Background: Delirium is a common postoperative complication of total hip arthroplasty (THA), excessively long time surgery may be one of the factors associated with it. This article aimed to employ literature retrieval and meta-analysis to investigate the correlation between operation time and postoperative delirium in THA.

Methods: The databases of PubMed and Springerlink libraries were searched for retrospective case-control studies on delirium-related factors after THA. The retrieved studies were screened according to the inclusion criteria. Newcastle-Ottawa scale (NOS) was used to assess the quality of literatures. After extracting the data of included literatures, RevMan 5.3.5 software was used to analyze the data and obtain a forest plot and funnel plot.

Results: A total of 137 literatures were initially screened in this study. According to the inclusion and exclusion criteria and literature quality evaluation, 6 studies were finally included, involving a total of 3,494 patients. The NOS scores were above 6 points in all 6 literatures. Meta-analysis revealed statistical heterogeneity among the 6 studies (I^2=80%, P=0.0002). The random effects model was used, revealing that the operation time of patients with postoperative delirium was longer, and the difference was statistically significant [standardized mean difference (SMD) =0.43, 95% confidence interval (CI): 0.20 to 0.66, P=0.0003]. The 6 studies were divided into unilateral or bilateral THA subgroups according to the type of surgery. Homogeneity was detected between the internal literatures: bilateral subgroup (I^2=5%, P=0.37), unilateral subgroup (I^2=0%, P=0.78). Postoperative delirium was associated with longer operation time in both subgroups, which was consistent with the combined analysis: bilateral subgroup (SMD =0.25, 95% CI: 0.12 to 0.37, P=0.0001), unilateral subgroup (SMD =0.70, 95% CI: 0.55 to 0.84, P=0.0001).

Discussion: Operation time is one of the related factors of delirium after THA. The longer the operation time, the greater the possibility of delirium.

Keywords: Total hip arthroplasty (THA); operation time; delirium; meta-analysis

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Introduction

With the growth of the elderly population worldwide, age-related diseases have also shown an increasing trend. Hip fracture and osteonecrosis of the femoral head are common diseases in the elderly, which seriously affect mobility and reduce their quality of life (1). Total hip arthroplasty (THA) is an effective treatment for advanced hip joint disease, which can replace the necrotic hip joint, reduce joint pain, and reinstate the patient's mobility (2). However, due to the insufficient physical tolerance of the elderly to surgery and anesthesia, post-operative cognitive and psychology-related complications are likely to occur (3). Delirium is a common postoperative complication of THA, which can suddenly develop in a short period of time, and patients experience complex and diverse mental symptoms such as disordered perception, emotion, consciousness, and orientation, which prolong the length of hospital stay and increase patient mortality (4). The occurrence of postoperative delirium may be associated with various factors such as age, gender, surgical approach, anesthesia, pain, history of stroke, and hypertension, some scholars consider patients with ASA grades ≥3 before operation will increase the risk of post delirium tremendously (5). The elderly body has a weakened ability to cope with stressors, and therefore excessively long surgery may diminish compensation due to increased body stimulation (6). At present, there is no systematic review about the correlation between operation time and the occurrence of delirium after THA surgery. In this study, the correlation between the two was systematically evaluated under the guidance of evidence-based medicine. We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-2190).

Methods

Search strategy

The PubMed and SpringerLink databases were searched for studies published since 2010 using the keywords: "postoperative delirium" AND "total hip arthroplasty" AND "risk factors", or "factors" AND "THA" AND "postoperative delirium", or "factors" AND "delirium" AND "arthroplasty", or "surgery duration" AND "postoperative delirium" AND "THA", or "predictors" AND "delirium" AND "arthroplasty".

Inclusion criteria

Literature type

Case-control studies published in English on factors related to delirium after THA, and all were retrospective analyses.

Participants

(I) Elderly patients aged >60 years who were diagnosed with femoral neck fracture or avascular necrosis of the femoral head, without fractures at other sites; (II) all patients needed the replacement surgery and underwent elective unilateral (or bilateral) THA; (III) all patients had no preoperative cognitive impairment, mental disorders, and normal language and hearing function; (IV) postoperative delirium symptoms: patients with confusion, disordered speech, and agitation 1–3 d after operation, delirium assessment tools were Confusion Assessment Method (CAM) or Delirium Rating Scale (DRS) or Nursing Delirium Screening Scale (NU-DESC) or Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV); (V) the study allocated participants to a delirium group and non-delirium group for comparative study, and the evaluation indicators included the comparison of operation time of different groups, which were expressed as mean ± standard deviation (SD).

Exclusion criteria

Studies were excluded if they met any of the following criteria: (I) analysis combined with other cases (such as total knee or joint arthroplasty, etc.); (II) interventional studies, without review of grouping method and index statistics, case, investigation, systematic review, experience summary, or report literatures; (III) series report, cohort report, discontinuous sequence report, or cross-sectional report of a non-case-control study.

Literature screening and data extraction

Literature retrieval, screening, quality evaluation, and data screening were conducted by two researchers at the same time. The quantity of studies retrieved from different databases was statistically analyzed. All literatures were de-duplicated. After reading the abstract for primary screening, the full text was read and continued to be screened. The quality of the remaining studies, including participant selection, comparability and outcome indicators, was assessed using the Newcastle-Ottawa scale (NOS) (7).

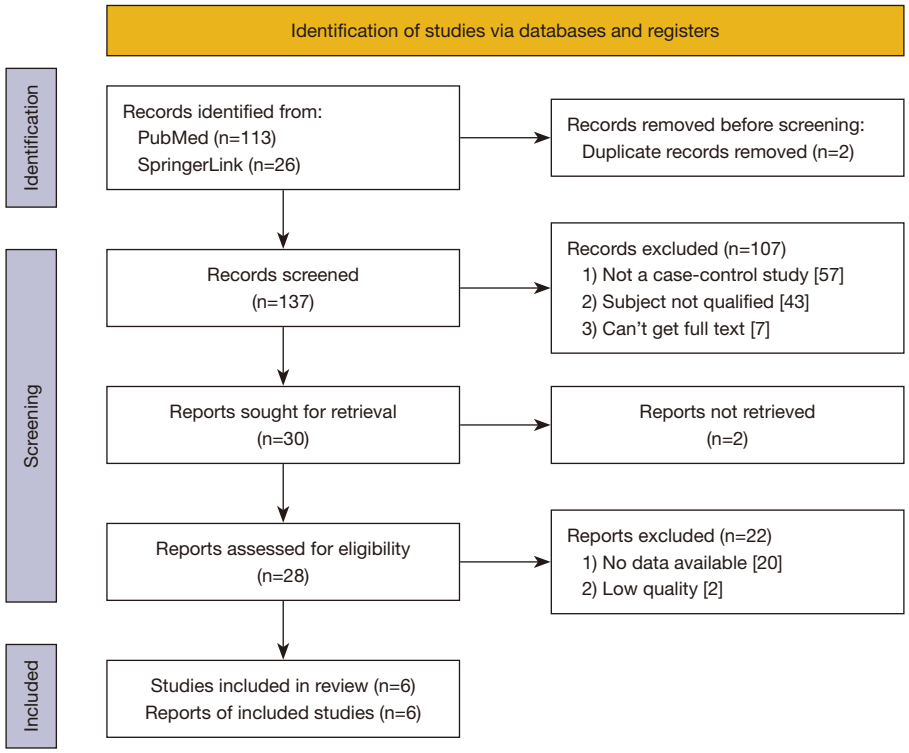

Figure 1 Screening flow chart.

The maximum score was 10 stars: studies with more than 5 stars were deemed high-quality, and those with low scores were excluded. Relevant data were extracted and tabulated (*Figure 1*).

Data items

The number of delirium patients and their operation time, and the number of patients without delirium and their operation time were obtained from each study. General characteristics including year of publication, research area, sample size, gender ratio, average age of participants, delirium evaluation tool, and so on were obtained.

Statistical methods

The software RevMan 5.3.5 (Review Manager, Copenhagen: The Nordic Cochrane Center, The Cochrane Collaboration, 2014) was used for statistical analysis. All the studies with complete data were included in the meta-analysis. The incidence of delirium was expressed as the number of cases, and the operation time was expressed as the mean and SD. Heterogeneity was assessed using I^2 analysis and Q test. Heterogeneity of results was indicated when I^2>50% or P<0.1. If heterogeneity was detected among the studies, the literatures were excluded by analysis and sensitivity analysis, and the case-by-case exclusion method was used for sensitivity analysis. Using fixed-effects model analysis, continuous variable standardized mean difference (SMD) was calculated and forest plots were made, with the confidence interval (CI) set at 95% (95% CI) and P<0.1 considered statistically significant. Funnel plots were used to represent publication bias.

Results

Literature screening results

In this study, 139 studies (113 from PubMed, 26 from SpringerLink) were initially screened. Two studies were excluded after repetitive check. After reading the whole text of the left studies, according to the inclusion and exclusion criteria and literature quality evaluation, 6 studies were finally included, involving a total of 3,494 patients (*Table 1*).

Table 1 Basic characteristics of included literature

Author	Year	Study region	Total population	Gender (M/F)	Mean age (years)	Delirium tool	Number (delirium/control)	Operation time (delirium/control) (min)
Guo *et al.* (8)	2016	China	572	206/366	76.7±5.8	CAM	120/452	72.5±15.2/62.5±13.6
de Jong *et al.* (9)	2019	The Netherlands	463	153/310	81.0±8.0	DSM-IV	121/342	73.4±14.4/63.5±12.7
Bilge *et al.* (10)	2015	Turkey	250	142/108	68.8±12.7	CAM	46/204	151.6±29.4/139.2±29.7
Lee *et al.* (11)	2011	Korea	232	173/59	78.5±7.7	CAM	70/162	95.9±35.7/95.2±35.1
Huang *et al.* (12)	2017	Singapore	954	827/127	73.9±14.3	DSM-IV	6/948	99.2±14.3/94.3±12.8
Uzoigwe *et al.* (13)	2020	UK	1,023	314/709	80.7±8.7	DSM-IV	242/781	122.2±14.6/118.8±12.4

CAM, Confusion Assessment Method; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders IV.

Table 2 Quality evaluation of included literatures

Studies	Cohort selection				Comparability		Outcome measures		Total score
	Whether the case definition is sufficient	Whether the cases are representative	Selection of controls	Control definition	Based on design and analysis	Determination of exposure	Are exposures determined in the same manner	Non-response rate	
Guo *et al.* (8)	1	1	1	1	2	1	1	–	8
de Jong *et al.* (9)	1	1	1	1	1	1	1	–	7
Bilge *et al.* (10)	1	1	1	0	2	1	1	–	7
Lee *et al.* (11)	1	1	1	1	0	1	1	–	6
Huang *et al.* (12)	1	1	1	1	1	1	1	–	7
Uzoigwe *et al.* (13)	1	1	0	1	1	1	1	–	6

Literature quality evaluation

The NOR scale scores of the 6 included literatures in this study were all above 6 points, as shown in *Table 2*.

Meta-analysis results

Statistical analysis

Meta-analysis revealed statistical heterogeneity among the 6 included studies (I^2=80%, P=0.0002), so the random effects model was used for further analysis. The operation time of patients with postoperative delirium was longer, and the difference was significant (SMD =0.43, 95% CI: 0.20 to 0.66, P=0.0003). The 6 studies were divided into unilateral or bilateral THA subgroups according to the type of surgery. There was internal homogeneity between the subgroups: bilateral subgroup (I^2=5%, P=0.37), unilateral subgroup (I^2=0%, P=0.78). Both subgroups showed that patients with postoperative delirium had longer operation time, which was consistent with the combined analysis: bilateral subgroup (SMD =0.25, 95% CI: 0.12 to 0.37, P=0.0001), unilateral subgroup (SMD =0.70, 95% CI: 0.55 to 0.84, P<0.00001), as shown in *Figure 2*.

Analysis of publication bias

The funnel plot showed that the two subgroups were evenly distributed, suggesting that there was no publication bias, as shown in *Figure 3*.

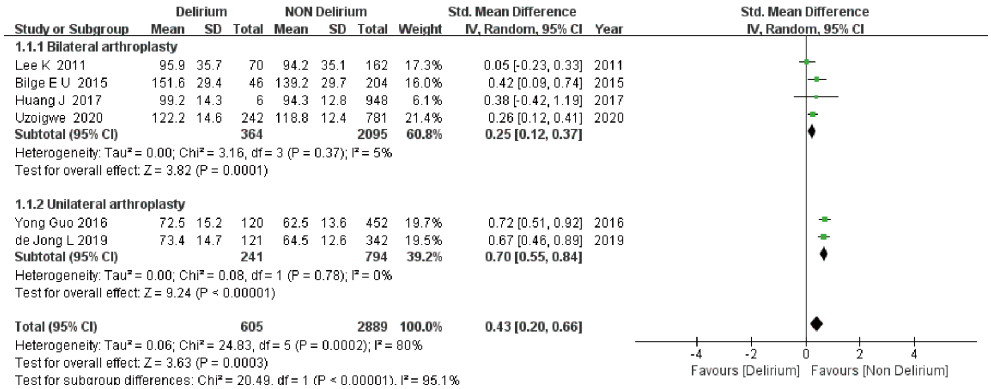

Figure 2 Statistical analysis of correlation between postoperative delirium and operation time. CI, confidence interval; SD, standard deviation.

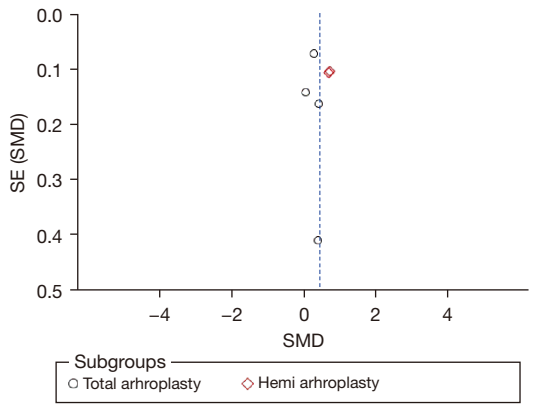

Figure 3 Funnel plot of correlation between postoperative delirium and operation time.

Sensitivity analysis

The results of the analysis were stable, and no subsequent sensitivity analysis was performed.

Discussion

Postoperative delirium is a psychotic phenomenon characterized by fluctuations in the patient's cognition and attention, which usually appears 1–3 days after surgery and can last from hours to days (14). Previous research (15) has shown that the incidence of postoperative delirium in patients after pelvic surgery is 10–60%. The correlation between operation time and the occurrence of delirium after THA surgery is still under discussion, and some researchers (8,10,11,13) believe that the correlation between the 2 is statistically significant, while others (9,12) have shown that the 2 are not significantly correlated. Therefore, in this study, we performed a systematic evaluation on the basis of evidence-based medicine to clarify the correlation between the occurrence of postoperative delirium and operation time.

The databases of PubMed and SpringerLink were used to retrieve the studies included in this analysis. Most of the non-case-control studies and those without corresponding indicators were screened out. The selected studies were evaluated according to the NOS literature quality assessment scale. A total of 6 studies were finally included. These 6 literatures had a total number of more than 5 stars after evaluation according to the 3 dimensions of cohort selection, comparability, and outcome measure, and were classified as excellent quality and suitable for subsequent meta-analysis. The RevMan software was used to establish the continuous variable of operation time. Data analysis was performed according to the grouping provided by the studies. Significant heterogeneity was detected among the 6 studies (I^2=80%, P=0.0002), thus the random-effects model was used. A forest plot was generated. The difference in operation time between the delirium and control group was deemed statistically significant (SMD =0.43, 95% CI: 0.20 to 0.66, P=0.0003), indicating that operation time was related to the occurrence of delirium. To exclude heterogeneity between studies, we divided the studies into two subgroups according to the type of surgery (unilateral surgery and bilateral surgery). The results showed that the studies within the two subgroups showed good homogeneity, suggesting that the heterogeneity among the 6 studies was probably from the types of surgeries. Meta-analysis showed that postoperative delirium was correlated with operation time, which was consistent with

the combined study results. Since the analysis results were stable, no subsequent sensitivity analysis was performed. There was a possibility of bias in all 6 literatures. For example, when NOS was used to evaluate the study by Bilge *et al.* (10), it was concluded that its control definition was unclear, therefore, the score of this item was 0. A similar situation was noted in the other studies, as shown in *Table 2*. However, the RevMan funnel plot showed that the two subgroups were evenly distributed on both sides, suggesting that there was no publication bias, and the meta-analysis results were stable and reliable. The results of this study were also consistent with those of a meta-analysis by Shi *et al.* (16). The difference was that the participants were patients undergoing spinal surgery, but the participants of this study were patients undergoing THA surgery, yet all of them showed that there was a correlation between the operation time and the occurrence of postoperative delirium.

In their study, Song *et al.* (17) analyzed the factors for the occurrence of delirium after orthopedic surgery, and it was shown that the incidence of delirium after hip surgery was higher than that of after knee surgery, while the operation time was also a risk factor for the occurrence of postoperative delirium. The reason for this may be that prolonged surgery induces a strong stress response, which can lead to disturbance of norepinephrine secretion and abnormal brain activity, and thus engender delirium (18). In addition, prolonged operation time can lead to increased blood loss and increased local seepage, which leaves patients prone to anemia, which is a factor in postoperative cognitive impairment (19). At the same time, prolonged operation time will predict an increase in the amount of anesthetic, which is also a factor associated with the development of delirium after surgery.

A study by Hommel (20) showed that implementation of the pathway for optimised treatment of people with hip fracture would result in shorter operation time, which meant that strengthening preoperative and intraoperative guarantee would avoid prolonged operation time.

Mesures should be taken to reduce postoperative delirium, a study by Siddiqi (21) concluded that the role of drugs and other anaesthetic techniques to prevent delirium remained uncertain, but by using the Bispectral Index to monitor and control depth of anaesthesia would reduce the incidence of postoperative delirium. Prevention and diagnosis involve efforts from the anesthesiologist and postoperative clinical care team, the delirium observation screening scale should be used to diagnosis the postoperative delirium as early as possible (22). Adamis *et al.* (23) conducted a study comparing delirium diagnosis with CAM, DRS, DSM-IV, DSM-5, which showed they all correlation coefficient, of which DSM-IV is the most inclusive diagnostic method while DSM-5 is the most restrictive.

In this study, sensitivity analysis was not conducted because the analysis was stable. However, a related study (24) showed that the occurrence of delirium was closely related to patient age, that is the older the patient is, the more likely they were to experience postoperative delirium. The age of patients in each study included in this analysis may be the source of literature heterogeneity, which may have affected the accuracy of the analysis results. In addition, the criteria of different delirium assessment tools vary, so there are different selection biases, which may have been the source of literature heterogeneity and may also have caused deviation of the results. This paper was limited by the finite resources available, and no detailed study was conducted to further explore this influence.

Conclusions

In this meta-analysis on the correlation between the operation time of THA and the occurrence of delirium, 6 studies were included, involving a total of 3,494 patients. The results showed that operation time was one of the related factors of delirium after THA. The longer the operation time, the greater the possibility of delirium.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://dx.doi.org/10.21037/apm-21-2190

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-2190). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved.

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