Orthopaedics & Traumatology: Surgery & Research 101 (2015) 289–296

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Original article

The influence of obesity on primary total hip arthroplasty outcomes: A meta-analysis of prospective cohort studies

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Clinical Case

ARTICLE INFO

Article history:
Received 13 October 2014
Accepted 27 January 2015

Keywords:
Obesity
Hip arthroplasty
Outcome
Meta-analysis
Prospective studies

ABSTRACT

Background: Whether or not, obesity negatively influencing the outcomes of primary total hip arthroplasty (THA) remains a controversial issue. Though observational studies focused on this topic, the reported conclusions remain inconsistent. Therefore, we performed a meta-analysis of prospective cohort studies to evaluate if obesity negatively affects: (1) the overall complication rate (incidence of dislocation, deep infection and osteolysis); (2) functional outcome; (3) operative time and stay duration in hospital for the primary THA.

Methods: We searched the PubMed, Embase, Web of Science, and the Cochrane Library until July 2014 to identify the eligible prospective studies. The Newcastle Ottawa Scale (NOS) was used for quality assessment of the included studies. We extracted and pooled the data. As for continuous data, mean difference (MD) was calculated; for dichotomous variables, we calculated a weighted relative risk (RR) with its 95% confidence interval. Heterogeneity was evaluated using I^2 statistics. $P \leq 0.05$ was thought to be significant.

Results: Fifteen studies were eligible for data extraction, which involved 11,271 total hip arthroplasties. The pooled data of complication rate demonstrated that obese patients suffered higher rates of complication (RR: 1.68, 95% CI 1.23 to 2.30, $P = 0.0004$), dislocation (RR: 2.08, 95% CI 1.54 to 2.81, $P < 0.0001$) and deep infection (RR: 2.92, 95% CI 0.74 to 11.49, $P = 0.13$). For the functional result, obese patients acquired relatively lower Harris Hip Score than non-obese patients (MD: −2.75, 95% CI −4.77 to −0.6), no difference was found regarding Oxford Hip Score (MD: −0.46, 95% CI −2.18 to 1.26, $P = 0.60$). Obese patients compared to non-obese patients showed an increase duration of operation (MD: 10.67, 95% CI 3.00 to 18.35, $P = 0.006$). However, no significant difference was found in the length of stay in hospital between obese and non-obese patients (MD: −0.16, 95% CI −0.34 to 0.02, $P = 0.08$).

Conclusions: This meta-analysis of prospective cohort studies demonstrates that obesity negatively influences the overall complication rate, dislocation rate, functional outcome and operative time of primary total hip arthroplasty.

Level of evidence: Level II. Low-powered prospective randomized trial.

1. Introduction

More than one million patients undergo total hip arthroplasty (THA) every year, and this number is estimated to double within the next two decades [1,2]. It is clear that obesity is a risk for arthritis, increasing need for arthroplasties can be predicted [3]. With the obesity epidemic, the proportion of obese patients needing THA is on ascension. Studies focusing on the influence of obesity in THA also gain its popularity. However, different conclusions were reported regarding whether obesity has a negative influence on primary THA [4,5]. Some centers have already refused to perform THA for obese patients considering the high forces acting on the prosthesis and polyethylene wear unless an acceptable body mass index (BMI) is obtained [6,7]. Thus, an improved understanding of the influence of obesity on THA seems to be necessary. According to the World Health Organization guideline, BMI > 30 kg/m^2 is considered obese [8]. We performed this meta-analysis to compare outcomes in different groups (BMI < 30, 30–40, > 40 kg/m^2) using the PRISMA protocol. This meta-analysis of 15 prospective studies was designed to evaluate if obesity negatively affects:

- the overall complication rate (incidence of dislocation, deep infection and osteolysis);
- functional outcome;
- operative time and length of stay in hospital of the primary THA?

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http://dx.doi.org/10.1016/j.otsr.2015.01.011
1877-0568/

2. Methods

2.1. Search strategy

Our search strategy was performed in the databases of PubMed/Medline, Embase, Web of Science, and the Cochrane Library until July 2014 to identify the eligible prospective cohort studies. The search strategy combined free keywords with Mesh Terms as following words:

- obesity, obese, body mass index, BMI, overweight, overweighed;
- hip arthroplasty, hip replacement, THA;
- prospective study(ies), cohort study(ies), longitudinal study(ies).

Only English articles were included. Furthermore, the references lists of retrieved studies were also checked for additional studies that met the criteria but not found by the electronic search.

2.2. Study inclusion and exclusion criteria

Studies that were included in this meta-analysis should meet the following criteria:

- include patients undergoing a primary THA;
- include an obese group (BMI > 30 kg/m^2) and a non-obese (BMI < 30 kg/m^2) group, the cutoff point of obesity should be BMI > 30 kg/m^2;
- the study design must be a prospective cohort study;
- useful outcomes should be reported such as complication rate, operative time and function score.

Studies were excluded if:

- the definition of obese group was not BMI > 30 kg/m^2;
- it was impossible to extract or pool the necessary data from the published results (not absolutely data but column chart, for example);
- no interested outcome was reported and non-prospective study design.

Review articles, expert opinions, surgical techniques, and abstracts from meetings were excluded.

2.3. Data Extraction and Quality Assessment

The studies selection and data extraction were independently assessed by two reviewers (WL and TW). Studies were not blinded regarding author, affiliation, or source [9]. Disagreement was resolved by discussion and eventually determined by a senior author (TC). Outcomes of interest in this study were overall complication rate, incidence of dislocation, deep infection, and osteolysis, blood loss, functional score (Harris Hip Score and Oxford Hip Score), operative time and length of stay in hospital. The data in different groups were finally pooled into three groups (BMI < 30, 30–40, > 40 kg/m^2). Besides, the characteristics of each study were also recorded as follows: first author's last name, year of publication, study population, country of origin, study period and duration of follow-up.

Quality assessment of the prospective cohort studies included in this meta-analysis was assessed by the Newcastle Ottawa Scale (NOS) as recommended by the Cochrane non-randomized studies methods working group, which was composed of three sections (selection, comparability and assessment of outcome) [10]. Consensus was reached on study quality assessment through reviewing the study and discussing the discrepancy. Studies were considered of high quality if at least 5 of 9 criteria were met.

2.4. Subgroup analysis

It was reported by some studies that patients with BMI > 40 kg/m^2 suffered a worse outcome of the primary THA [5,11–13]. We performed a subgroup analysis for the outcomes (overall complication rate, incidence of dislocation, deep infection, Harris Hip Score, operative time, length of stay in hospital) that contained enough data to be divided into two subgroups (obesity BMI 30–40 kg/m^2 and super-obesity BMI > 40 kg/m^2).

2.5. Statistical analysis

We used Revman 5.3 software (The Nordic Cochrane Centre, Copenhagen, Denmark) to pool data, $P \leq 0.05$ was thought to be significant. Relative risk (RR) and its 95%CI were used to assess the association between obesity and its influence on THA complication rate, incidence of dislocation, deep infection and osteolysis across studies. For continuous data, which was reported with a range, the SD was calculated using the method described by Walter and Yao [14]. Finally, the data was pooled as mean difference (MD) and its 95%CI. The I^2 statistic was used to measure inconsistency across studies [15]. The data was pooled using fixed-effect (Mantel-Haenszel test) when no statistical heterogeneity was detected between studies ($P > 0.10$; $I^2 < 50\%$). Otherwise, the random-effect (DerSimonian-Laird method) model was used. We also performed a sensitivity analysis to explore possible explanations for heterogeneity.

3. Results

3.1. Study collection

One thousand and seventeen articles were identified through databases search, 654 records were left after the removal of duplicates, and finally, 625 were excluded after the screening of title and abstract. The remaining 29 articles were carefully viewed full-text, subsequently, 14 were excluded because of inconsistent with the inclusion or exclusion criteria. Finally, 15 studies were eligible for this meta-analysis including 11,271 THA [4,9,11–13,16–25]. Among the whole included studies, only four studies had a cut-off point of BMI > 40 kg/m^2 [5,11–13]. More details were shown in Fig. 1.

3.2. Study characteristics

Fifteen prospective studies were included in this meta-analysis, which were published ranging from 1999 to 2013. Among the included studies, 5 were performed in UK [5,13,17,20,24], 2 in Germany [16,22], 2 in USA [11,23], 2 in Switzerland [18,21], 3 in Australia [4,12], 1 in Swedish [19]. As for the follow-up time, it ranged from 3 months to 18 years. More detailed information about the study characteristics was presented in Table 1.

Not all of the studies contain the defined interest of outcomes: 10 studies for complication rate (2 for super-obese group), 6 studies for dislocation (2 for super-obese group), 3 for deep infection, 3 for osteolysis, 4 for blood loss, 2 for Oxford Hip Score, 6 for Harris Hip Score (2 for super-obese group). Regarding operative time, 7 studies were pooled (2 for super-obese group), 6 studies for length of stay in hospital (2 for super-obese group). Because the number of included studies about the complication rate reached 10, we performed a funnel plot to assess the publication bias.