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Review

Impact of obesity on lumbar spinal surgery outcomes

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ABSTRACT

Controversy exists regarding the effect of obesity on surgical outcomes and complications following lumbar spinal surgery. A systematic electronic literature review of all relevant studies through to June 2015 was performed using the PubMed, Embase, and Cochrane library databases. Pooled risk ratios (RR) or standardised mean differences (SMD) with 95% confidence intervals (CI) were calculated using random or fixed effects models. The Newcastle-Ottawa Scale was used to evaluate the methodological quality, and Stata 11.0 was used to analyse data (StataCorp, College Station, TX, USA). Significant differences between obese and non-obese patients were found for operation time (SMD, −0.273; 95% CI, −0.424 to −0.121), blood loss (SMD, −0.265; 95%CI, −0.424 to −0.107), surgical site infections (RR, 0.610; 95%CI, 0.446 to 0.834), and nerve injury (RR, 0.188; 95%CI, 0.042 to 0.841). Deep vein thrombosis, dural tear, revision surgery, and mortality were not significantly differences between the two groups ($P < 0.05$). Obesity appears to be associated with longer operative times, greater blood loss, and higher risk of surgical site infections and nerve injuries. However, the results of this meta-analysis should be interpreted with caution due to heterogeneity amongst the included studies.

1. Introduction

Obesity, commonly defined as a body mass index (BMI) of more than 30 kg/m^2, has become a global epidemic that is increasingly prevalent in adults [1]. Obesity is considered to be an important public health issue due to the numerous adverse effects on quality of life and overall increased morbidity and mortality [2,3].

In previous studies, being overweight or obese has been associated with a higher prevalence of musculoskeletal disorders, including osteoarthritis [4], chronic low back pain [5] and intervertebral disc degeneration [6]. As obesity becomes more common in the general population, a portion of obese patients will inevitably undergo spinal surgery. However, available data from researchers on the association between obesity and spinal surgery outcomes remains controversial. Several studies have reported a higher rate of perioperative complications and unfavourable outcomes among obese patients [7–9]. However, other studies have not demonstrated a significantly increased risk of postoperative complications or worsened outcomes [10–12] among obese patients after spinal surgery. Although many studies have investigated the association between obesity and outcomes of spinal surgery, the number of studies focusing exclusively on lumbar surgery is limited.

In this meta-analysis, we evaluated the differences between obese and non-obese patients who underwent lumbar surgery with regards to operative time, blood loss, surgical site infections, deep vein thrombosis, dural tears, nerve injuries, revisions, and mortality in an attempt to determine whether obesity is associated with worse surgical outcomes after lumbar surgery.

2. Materials and methods

2.1. Literature search

We searched the Pubmed, Embase, and Cochrane central databases for all relevant literature through to June 2015 that were controlled or comparative studies exploring the influence of obesity on outcomes and complications after lumbar surgery. The following search terms and Boolean operators were used: ("lumbar" or "spine" or "spinal") and ("obesity" or "adiposity" or "body mass index" or "BMI"). This search was limited to human subjects. Only full-text articles published in English were included in this study. We also performed a manual search of references from relevant articles to identify additional potentially eligible studies, and this process was repeated until no further studies could be identified.

2.2. Inclusion criteria

Two independent reviewers screened study titles and abstracts to determine relevance for this analysis. A published article was

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included if it (1) had a case-control or comparative design; (2) explored the influence of obesity on outcomes or complications after lumbar surgery; and (3) published sufficient data for estimating risk ratio (RR) or standardised mean difference (SMD) with 95% confidence intervals (CI). When several publications were duplicated or drew from the same study population, we retained only the most informative one. Articles investigating cervical or thoracic spine surgery or those that did not report on outcomes of interest were excluded.

2.3. Data extraction and outcome measures

Two authors independently extracted relevant data from each included study into a data form. Items included on the data form were first author, publication year, country, sample sizes of non-obese and obese groups, total number of participants in the study, type of disease and surgery, main outcomes and complications. The data forms from each of the two authors were compared, and disagreements were resolved by discussion until a consensus was reached.

The following outcomes and complications were investigated in this meta-analysis: operative times, blood loss, surgical site infections, deep vein thrombosis, dural tears, nerve injuries, revisions, and mortality.

We used classifications recommended by the World Health Organization for BMI and defined obesity as a BMI of $\geqslant 30\ \mathrm{kg/m^2}$. For continuous outcomes, if a group was divided into several subgroups, all members were combined into a single sample size, and means and standard deviations were calculated using the Cochrane Handbook methodology [13].

2.4. Assessment of methodological quality

To assess study quality, a nine point system based on the Newcastle-Ottawa Scale [14] was used. Each study was scored based on the following three broad perspectives: the selection of the study groups (0–4 points), the comparability of study groups (0–2 points) and the determination of either the exposure or the outcome of interest (0–3 points). A high quality study was defined as a study with $\geqslant 7$ points.

2.5. Statistical analysis

Differences were expressed as RR with 95%CI for dichotomous outcomes and SMD with 95%CI for continuous outcomes. Heterogeneity among the studies was quantitatively tested by Q-test statistics, with the significance being set at $P < 0.10$. I^2 statistics were used as a second measure of heterogeneity, with $I^2 > 50\%$ showing significant inconsistency. A random effects model was used to calculate pooled RR or SMD in the case of significant heterogeneity ($P < 0.10$ or $I^2 > 50\%$); otherwise, a fixed-effects model was used. The meta-analysis results of relevant variables were summarised, and $P < 0.05$ indicates a significant difference between the two groups.

To explore the reliability of the results, we also performed a sensitivity analysis by excluding low-quality studies and re-analysed the results. Publication bias was assessed using the Begg test and graphed on a funnel plot. $P < 0.10$ was considered to be a significant difference. All analyses were carried out using the Stata 11.0 software (StataCorp, College Station, TX, USA).

3. Results

3.1. Literature search results

One hundred and sixty-three articles without duplications were identified from a total of 269 records, and 106 articles were excluded after reviewing titles and abstracts. After evaluating the full text of the remaining 15 studies, a further three full-text articles were excluded. As a result, 12 unique studies were included in this meta-analysis [15–26]. A flow diagram demonstrating the search process for locating relevant studies is presented in Figure 1.

3.2. Characteristics of included studies

Descriptive data for the studies included in our meta-analysis are summarised in Table 1. Eight studies were carried out in the USA [16,19,20,22–26], one in Israel [17], one in Austria [21], one in Brazil [18], and one in Norway [15]. When assessing the study quality two studies received a score of 9 [16,25], four studies received a score of 8 [15,22,23,26], five studies received a score of 7 [17,18,20,21,24], and one study received a score of 6 [19].

3.3. Main results of this analysis

The 12 studies included 5654 non-obese and 2412 obese patients for a total sample size of 8066. A meta-analysis of combinable data was conducted to compare outcomes between obese and non-obese patients undergoing lumbar spinal surgery. Significant heterogeneity was observed among studies when comparing operative time and blood loss.

On the basis of the combined RR or SMD, significant differences were observed for operative time (SMD, −0.273; 95%CI, −0.424 to −0.121), blood loss (SMD, −0.265; 95%CI, −0.424 to −0.107), surgical site infections (RR, 0.610; 95%CI, 0.446 to 0.834), and nerve injuries (RR, 0.188; 95%CI, 0.042 to 0.841). The analyses for the outcomes are presented in Table 2. Deep vein thrombosis, dural tears, revisions, or mortality did not demonstrate significant differences between non-obese and obese groups ($P < 0.05$).

3.4. Subgroup analysis and sensitivity analysis

In the analysis of blood loss resulting from lumbar surgery, significant heterogeneity ($I^2 \geqslant 50\%$; $P < 0.10$) was observed. Because both minimally invasive surgery and open surgery were performed in the included studies, we further divided patients into two subgroups based on the type of surgery. The analysis for this outcome is presented using forest plots in Figure 2. Other outcomes did not show significantly different results between minimally invasive surgery and open surgery.

The exclusion of one study [19] with low quality did not affect the statistical significance of the four meta-analysis outcomes, revealing that the results of this review were robust.

3.5. Publication bias

Funnel plot and Begg tests showed no significant publication bias among included studies with regards to the rate of surgical site infections (Fig. 3).

4. Discussion

With an ageing population, the incidence of lumbar spinal disease, such as lumbar spinal stenosis, lumbar disc herniation, and degenerative spondylolisthesis, has been rising rapidly. As a result, an increasing number of lumbar spinal surgeries are being performed. Meta-analysis is commonly used as an efficient method for integrating valid study results and providing a basis for rational decision making [27]. This meta-analysis pooled 12 studies; the results indicated that obesity was associated with longer operative times, greater postoperative blood loss, and a higher risk of surgical site infections and nerve injuries after lumbar surgery. No