

Comparing Outcomes of Minimally Invasive Transforaminal Lumbar Interbody Fusion in Obese and Nonobese Patients: A Systematic Review and Meta-Analysis

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Abstract

Background: Our study aimed to compare the outcomes of obese and nonobese patients following minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF).

Methods: Relevant studies comparing the outcome of MIS-TLIF between obese and nonobese patients were involved to make a systematic literature review and meta-analysis. All of the comparative studies published in PubMed, MEDLINE, and Web of Science databases as recently as 10 July 2020, were included. Primary outcomes (complications) and secondary outcomes (Oswestry Disability Index (ODI) score, visual analog scale (VAS) score, the length of hospital stay, the duration of surgery, and the estimated blood loss) were assessed between obese patients and nonobese patients. Statistical analysis was performed by Review Manager 5.3 and forest plots were made for each outcome.

Results: Nine studies were enrolled in this meta-analysis. BMI correlated significantly with complications, and postoperative complications occurred more frequently in obese patients. Additionally, obese patients after MIS-TLIF were associated with similar Oswestry Disability Index (ODI) score, Visual Analog Scale score for back pain (BP-VAS), and Visual Analog Scale score for leg pain (LP-VAS) scores in early (≤ 6 months after MIS-TLIF) and late period (≥ 24 months after MIS-TLIF). There was no significant difference in intraoperative complications, duration of surgery, length of hospital stay, and estimated blood loss between the two groups.

Conclusion: Obese patients should not be excluded from MIS-TLIF procedures due to worry about higher postoperative complication rates. Understanding common postoperative complications after MIS-TLIF will improve the treatment of obese patients with the degenerative lumbar disease.

Introduction

Transforaminal lumbar interbody fusion (TLIF) was first introduced in 1982, which could significantly reduce the amount of the nerve root retraction and thecal sac[1]. Then, the minimally invasive technique was first introduced by Foley et al for the TLIF surgery in 2000[2]. Nowadays, MIS-TLIF has been a well-known surgical procedure for the management of various spine diseases such as spondylolisthesis and degenerative disk disease[3]. MIS-TLIF was reported to have a similar curative effect as open-TLIF with the potential advantages of less pain and estimated blood loss and shorter length of hospital stay[4].

Obesity, one of the most serious public health issues, has an increasing prevalence in recent years, and its impact on orthopedic surgery continues to draw more attention to orthopedic surgeons[5–7]. Currently, over half of Americans are obese or overweight, and obesity is linked to a variety of diseases, including diabetes and osteoarthritis, and has thus been a focus of health care initiatives[8–10]. Consequently, spinal surgeons must consider the influence of obesity on MIS-TLIF because of the increasing number of obese patients with degenerative lumbar diseases requiring MIS-TLIF[11].

Many previous studies had proven that obese patients incline to have inferior surgical outcomes than patients of normal weight undergoing operation[12–16]. MIS-TLIF has been reported to improve the surgical treatment of obese patients by minimizing the size of surgical skin incision and cavity, and the number of surgical trauma[3]. Some cohort studies[17–20] have demonstrated that MIS-TLIF was safe for obese patients. However, no meta-analysis has been performed to investigate the influence of obesity on clinical outcomes in patients with MIS-TLIF. Besides, no randomized controlled trial (RCT) has been conducted to compare the outcomes of MIS-TLIF between obese and

nonobese patients. Consequently, we searched all relevant literatures to perform a meta-analysis in an attempt to investigate the influence of obesity on outcomes of minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) in patients with degenerative lumbar disease.

Methods

Literature Retrieval Strategy

Our research literature was obtained by searching the Web of Science, Medline, and PubMed databases. The literature search was based on the PRISMA statement and guidelines[21]. “Minimally invasive transforaminal lumbar interbody fusion”, “TLIF”, “MIS-TLIF”, “obese”, “minimally invasive” and “BMI” were used as the Medical Subject Headings (MeSH) or Emtree in the search strategy. The search terms were first based on the title and abstract, and the full text was retrieved if a decision could not be made from the summary.

Study selection criteria

There were several criteria for the study that we have included: (1) the study population was patients who underwent MIS-TLIF, (2) Essential data could be easily extracted or calculated from the original essay, (3) studies that reported more than two following variables: complication, estimated blood loss, length of hospital stay, duration of surgery and Oswestry Disability Index (ODI), visual analog score (VAS) for leg pain and back pain, (4) retrospective study listed the comparison between obese patients and nonobese patients.

Exclusion criteria were as follows: (1) studies such as review articles, book chapters, case reports, cadaver studies, and summaries of experience; (2) cell or animal studies; (3) the original data of the comparison outcomes could not be extracted.

Data extraction and quality assessment

The following data were extracted independently from the final eligible studies, the details include the first author of the article, publication date, study design, study population characteristics (age, sex, and nation), the definition (as BMI) of obesity and normally used, demographical data, the number of events for dichotomous outcomes, the mean and standard deviation (SD) for continuous outcomes. Two reviewers extracted the data independently and all disagreements between the investigators were resolved by discussion. According to the Cochrane Handbook for Systematic Reviews, the qualities of the selected studies were assessed by using the Newcastle–Ottawa Scale (NOS)[22].

Study outcomes

In our study, the primary outcome measures were the complications, and complications were further subdivided into intraoperative and postoperative complications. The secondary outcome measures included the VAS scores for back and leg pain, the ODI scores, and the duration of surgery, the length of hospital stay, and estimated blood loss. Meanwhile, ODI and VAS scores were classified into early (≤ 6 months after MIS-TLIF) and late (≥ 24 months after MIS-TLIF) period.

Dealing with Missing Data

When meeting missing or inadequate data, we considered contacting the authors of the identified literature to ensure that the data was available. When the mean and SD were necessary to combine in a separate study and the data

were given for obese and morbidly obese respectively, we used the formula of Headrick et al[23] to calculate overall mean and SD.

Statistical analysis

Review Manager (Version 5.3) was used to perform the meta-analysis. Odds ratios (ORs) and weighted mean differences (WMD) and associated confidence interval (CI) were used to analyze dichotomous and continuous variables. Studies for each outcome were combined to present an overall estimate of the effect in the form of a forest plot. $P < 0.05$ was used as the level of significance and I^2 was set as the index to evaluate heterogeneity. If the $I^2 \geq 50\%$ was shown in the meta-analysis, we chose to use the random-effects model as the heterogeneity was significant. Otherwise, the fixed-effects model was suitable^[24].

Results

Search and study selection

Initially, 262 documents were yielded in the electronic databases after screening the core terms. 129 duplicates were eliminated, then 115 of 129 records were removed based on their titles and abstracts. Subsequently, after downloading and identifying the full text, 9 articles without access to the inclusion criteria were excluded. Ultimately, this meta-analysis contained a total of 9 eligible studies[17-20, 25-29] published between 1999 and 2018. The specific process of literature identification and selection is shown in Figure 1.

Study characteristics

Nine retrospective studies with 1043 patients were enrolled in our meta-analysis and the characteristics and the general demographics of the identified studies were listed in Table 2 and Table 3. The sample size of the included studies ranged from 16 to 186, and the studies were published between 2008 and 2019. The 1043 patients all underwent MIS-TLIF, 412 obese patients, and 631 nonobese patients (Table 2). The duration of surgery was reported in 6 studies, estimated blood loss was reported for 3 studies, the length of hospital stay was reported in 5 studies, and ODI and LP-VAS scores were reported in 2 studies, BP-VAS score was shown in 2 studies. The number of complications was reported in 6 studies (Table 4). According to the data extracted, ODI, LP-VAS, and BP-VAS scores were divided into early (≤ 6 months after MIS-TLIF) and late (≥ 24 months after MIS-TLIF) period. The NOS score as the aspect of methodological quality for each selected study were all over six points, revealing the high quality (Table 1).

Results of Meta-Analysis

Primary Outcomes. Complications were the primary adverse events to evaluate the safety and efficacy of MIS-TLIF for obese patients and nonobese patients. In our study, major complications included durotomy, epidural hematoma, genitourinary, neurologic, cardiac, pulmonary, and any medical condition. The data of the complications in 6 studies[18, 19, 27, 29-31] was pooled and there was a higher risk of adverse events in obese patients (OR, 1.89; 95% CI 1.10 to 3.23; $n = 471$; $p = 0.02$; $I^2 = 38\%$; Figure 2a). Besides, 4 trials[18, 19, 25, 29] had compared the intraoperative complications between the obese group and normal group undergoing MIS-TLIF, and no difference was found between obese and nonobese groups for intraoperative complications (OR: 0.57; 95% CI 0.14 to 2.30; $n = 251$; $p = 0.43$; $I^2 = 0\%$; Figure 2b), however, based on a comprehensive analysis of data of postoperative complication from five studies[18, 19, 27, 29, 30], the fixed-effect model was used and obese patients had the increasing risk of

complication than nonobese patients and the difference was significant (OR, 2.26; 95% CI 1.26 to 4.05; $n = 455$; $p = 0.006$; $I^2 = 50\%$; Figure 2c).

Secondary Outcomes.

Estimated blood loss. Three studies compared the estimated blood loss of the obese and normal groups[20, 26, 27]. Using a fixed-effect model shows no difference was found in estimated blood loss between obese and normal groups after MIS-TLIF (MD, -2.02; 95% CI -13.64 to 9.59; $n = 406$; $p = 0.73$; $I^2 = 0\%$ Figure 3a).

Duration of surgery. There were 6 studies related to the duration of surgery[17, 20, 26-29]. The random-effect model was used in this analysis and no significant difference was found in the duration of surgery between patients who were obese and nonobese (MD, 15.26; 95% CI -0.77 to 31.28; $n = 695$; $p = 0.06$; $I^2 = 73\%$; Figure 3b).

length of hospital stay (LOS). Five studies reported the LOS[18, 20, 26, 28, 29]. The pooled results using random-effects model indicated that obese patients have similar length of hospital stay with nonobese patients after surgery (MD, 0.37; 95% CI -0.16 to 0.90; $n = 709$; $p = 0.18$; $I^2 = 72\%$; Figure 3c).

Oswestry disability index (ODI). Two studies[18, 28] reported data on early (≤ 6 months after MIS-TLIF) and late ODI scores (≥ 24 months after MIS-TLIF). The random-effects forest plot indicated no significant difference on ODI scores between two groups whether in early postoperative period (MD, 5.1; 95% CI -2.42 to 12.63; $n = 248$; $p = 0.18$ $I^2 = 63\%$; Figure 4a) or late postoperative period (MD, 0.45; 95% CI -4.72 to 5.62; $n = 224$; $p = 0.87$ $I^2 = 29\%$; Figure 5a).

Visual analog scale (VAS). Two studies[18, 28] investigated the outcome of the VAS score in the early postoperative period (≤ 6 months after MIS-TLIF). The fixed-effects model was used when no significant heterogeneity occurred, there was no difference between obese and nonobese patients concerning BP-VAS and LP-VAS. The specific statistics were shown in Figure 4(MD, -0.08; 95% CI -0.75 to 0.59; $n = 362$; $p = 0.81$ $I^2 = 0\%$; Figure 4b) and (MD, 0.29; 95% CI -0.65 to 1.23; $n = 247$; $p = 0.55$ $I^2 = 0\%$; Figure 4c), respectively. Additionally, 3 studies[18, 28, 29] reported the outcome of late BP-VAS scores (≥ 24 months after MIS-TLIF). The random-effects forest plot shows no statistical difference was observed in late BP-VAS (MD, 1.43; 95% CI -0.73 to 3.60; $n = 249$; $p = 0.19$ $I^2 = 74\%$; Figure 5b). Additionally, the late LP-VAS score was reported in two studies[18, 28]. The forest plot using the fixed-effected model shows no significant difference in LP-VAS score in the late period after MIS-TLIF between patients who were obese and nonobese (MD, -0.26; 95% CI -0.82 to 0.31; $n = 228$; $p = 0.37$ $I^2 = 5\%$; Figure 5c).

Discussion

Our meta-analysis demonstrated that obesity had no significant influence on the duration of surgery, the estimated blood loss, and the length of hospital stay. Obese increased the risk of complications but not the intraoperative complication. Additionally, no significant effect was found in ODI, BP-VAS, and LP-VAS scores in both early and late periods after MIS-TLIF between the two groups.

Morbid obesity can be considered one of the biggest difficulties in treating spinal surgery. Obese patients with inferior clinical outcomes may require surgical treatment via MI- TLIF[32–34]. This meta-analysis found that obese patients did not cost more duration of surgery when MIS-TLIF was used. Cole et al[4] found that the use of the minimally invasive tubular traction system can significantly decrease the time required for the long distances between the skin and spine of obese patients. Minimally invasive techniques could narrow the gap in the duration of surgery between obese and nonobese patients.

Compared with nonobese patients, traditional surgery requires a larger incision to deal with the relatively thick layer of adipose tissue in obese patients, causing more estimated blood loss. However, the fixed-effects model found obesity had no significant influence on estimated blood loss. Moreover, our study showed a minimal difference between the two groups for the length of hospital stay, with obese patients at 2.87d and nonobese patients at 2.86d. The random effect forest plot demonstrated that there is no significant correlation in the length of hospital stay between obese patients and nonobese patients. This result is consistent with other studies investigating obese patients with surgery[3, 35]. Therefore, surgeons do not have to consider longer hospital stay for obese patients after MIS-TLIF.

ODI and VAS scores were used to assess the postoperative functional outcome, and there was no significant difference in the levels of BP and LP VAS and ODI scores in the early and late period after MIS-TLIF between obese and nonobese patients. Studies focusing on other fusion techniques also found no difference in VAS and ODI scores between obese and nonobese patients[36–38]. However, our study for pain and ODI after MIS-TLIF was based on the limited number of studies included. Large retrospective trials are required to compare the pain and ODI in obese patients and nonobese patients following MIS-TLIF.

Obesity was related to a higher incidence of complications. Many previous studies assumed that obese patients had a higher incidence of complications than patients who were of normal weight[12, 15, 16]. Nevertheless, several studies suggested no increased intraoperative complications rate in the obese with MIS-TLIF[39]. Therefore, complication results were further collected during the intraoperative period and postoperative period. We found that the difference was significant in postoperative complications and was not meaningful in intraoperative complications. Buyuk et al[18] and Krüger et al[29], whose studies were enrolled in the meta-analysis, had specific records of intraoperative complications. Among the obese MIS-TLIF groups, the intraoperative complication rate was reported as 2.3% (2/84) in the obese groups, including 2 durotomies and 1 genitourinary; for the normal MI TLIF groups, the intraoperative complication rate was reported as 3.8% (3/78), including 3 durotomies. A previous study demonstrated that obesity correlated marginally with the incidental durotomy[40]. However, according to our integrated data, the incidence of durotomy was 3.8% (3/78) in the normal group and 1.2% (1/84) in the obese group. We concluded that obese patients were at a higher complication risk particularly in the postoperative period and that the adverse events were mostly related to comorbidities of the obese population rather than the surgery itself. In our meta-analysis, long-term postoperative complications between the two groups were not analyzed due to the lack of data from the selected literature. The difference in long-term postoperative complications could better explain the effect of obesity on MIS-TLIF. Therefore, we suggested that long-term postoperative complications should also be used as a standard measure of outcome in future research.

LIMITATIONS

Nonetheless, the current study has several limitations. Firstly, all enrolled studies were retrospective observational studies; such study designs could have unidentified biases or confounders. Secondly, heterogeneity was significant in some statistical analyses, possibly caused by different baseline among the trials and various outcome measurements in the studies. Thirdly, the non-standard definition of “normal weight” that occurred in certain studies may cause some unavoidable differences in study populations. Despite these limitations, this meta-analysis was based on comparable characteristics between obese groups and normal groups and the results should be verifiable.

Conclusion

Obesity has no significant influence on the duration of surgery, estimated blood loss, length of hospital stay, ODI, and VAS scores on patients following MIS-TLIF. MIS-TLIF could offer comparable outcomes between obese and non-obese patients with degenerative lumbar disease, though the obese group had a higher risk of postoperative adverse events. It's important to evaluate the high risk of postoperative complications of obese patients before undergoing MIS-TLIF.

Abbreviations

MIS-TLIF: Minimally invasive transforaminal lumbar interbody fusion; BMI: Body mass index; CI: Confidence interval; NOS: Newcastle–Ottawa Scale; WMD: Weight mean difference; OR: Odds ratio; ODI: Oswestry Disability Index; SD: Standard deviation; VAS: Visual analog scale; CI, Confidence interval.

Declarations

Ethics approval and consent to participate

Since our study is a meta-analysis, an Ethical Review Committee Statement is not required.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

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Authors' contributions

XXH and WJQ contributed equally

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XXH and WJQ designed the study, interpreted and analyzed the patient data, and wrote the paper. All authors read and approved the final manuscript. All authors have read the journal policies and have no issues relating to journal policies. All authors have seen the manuscript and approved to submit to your journal. The work described has not been submitted elsewhere for publication, in whole or in part.

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Tables

Table 1

Quality assessment using Newcastle–Ottawa scoring

Study	Selection	Comparability	Outcome
Buyuk et al	□□□□	□	□□□
Goh et al	□□□□	□□	□□□
Krüger et al	□□□□	□□	□□
Lau et al	□□□	□	□□□
McAnany et al	□□□□	□□	□□
Narain et al	□□□	□	□□□
Rosen et al	□□□□	□	□□
Senker et al	□□□	□	□□
Yoo et al	□□□□	□□	□□

Assessment of the quality of studies according to Newcastle-Ottawa scale

Table 2

Details of included studies

Study	Year	Design	Type of fusion surgery	Number of patients		supplement	Definition of obesity used (BMI) kg/m ²	
				Obese	Normal		Obese	Normal
Buyuk et al ²⁴	2019	Retrospective	TLIF (MIS form)	70	64		≥ 30	≥30
Goh et al ²⁷	2018	Retrospective	TLIF (MIS form)	32	156	overweight BMI=25–29.9kg/m ² (not used in analysis)	≥ 30	≥25
Krüger et al ²⁸	2019	Retrospective	TLIF (MIS form)	14	14		≥40	20-25
Lau et al ²⁰	2013	Retrospective	TLIF (MIS form)	56	21	overweight BMI=25–29.9kg/m ² (not used in analysis) obese class II–III BMI≥35kg/m ² (combined with obese in analysis)	≥ 30	≥25
McAnany et al ²³	2016	Retrospective	TLIF (MIS form)	19	19		≥ 30	≥30
Narain et al ²¹	2018	Retrospective	TLIF (MIS form)	121	52	obese class II–III BMI≥35kg/m ² (combined with obese in analysis) overweight BMI=25–29.9kg/m ² (not used in analysis)	≥30	≥25
Rosen et al ²⁵	2008	Retrospective	TLIF (MIS form)	35	38	overweight BMI=25–30kg/m ² (not used in analysis)	≥30	≥25
Senker et al ²²	2011	Retrospective	TLIF (MIS form)	27	20	overweight BMI=25–30kg/m ² (not used in analysis)	≥ 30	≥25
Yoo et al ²⁶	2019	Retrospective	TLIF (MIS form)	85	101	obese class II–III BMI≥35kg/m ² (combined with obese in analysis)	≥30	≤29.9

Table 3
Demographics

Study	Population studied	Mean age (yrs)(SD)		Gender (% male)		Mean BMI (SD) kg/m ²	
		Obese	Normal	Obese	Normal	Obese	Normal
Buyuk et al	American	64(11)	64(10)	48.6	42.6	35 (4)	25 (3)
Goh et al	Singaporean	58.8(8.8)	57.9(12.7)	25.0	32.7	33.1(2.8)	22.3(1.9)
Krüger et al	Germans	60.4(13.0)	60.4(13.2)	35.7	35.7	43.2(3.0)	23.5(1.0)
Lau et al	American	58.8 [Not stated]	51.4 (Not stated)	44.4	28.6	37.4 (Not stated)	23.4 (Not stated)
McAnany et al	American	60.26(1.64)	60(3.26)	36.8 [1.64]	52.6	36.66(1.31)	24.42(0.82)
Narain et al	Chicagoan	52.3(12.68)	50.44(14.0)	53.7	44.23	Not stated	
Rosen et al	Chicagoan	Not stated		Not stated		Not stated	
Senker et al	American	Not stated		Not stated		Not stated	
Yoo et al	Chicagoan	50.8(10.7)	51.8(11.3)	62.3	57.4	Not stated	

Table 4

Pool of outcomes of included studies

Study	Complication	Vas back	Vas leg	ODI	Duration of surgery	Estimated blood loss	Length of hospital stay
Buyuk et al	Yes	Yes	Yes	Yes			Yes
Goh et al		Yes	Yes	Yes	Yes		Yes
Krüger et al	Yes	Yes			Yes		Yes
Lau et al	Yes						
McAnany et al					Yes		
Narain et al	Yes				Yes	Yes	Yes
Rosen et al	Yes						
Senker et al	Yes				Yes	Yes	
Yoo et al					Yes	Yes	Yes
Total	6	3	2	2	6	3	5

Figures

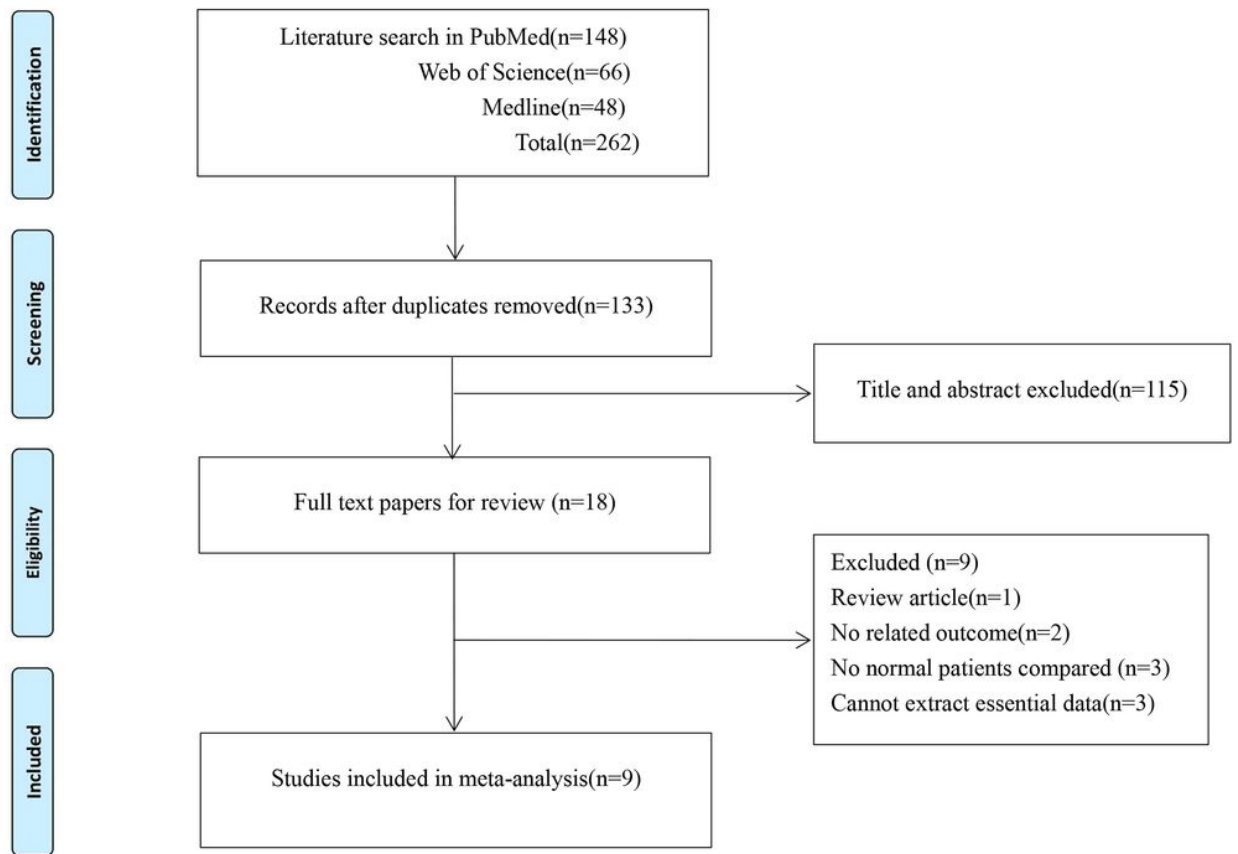
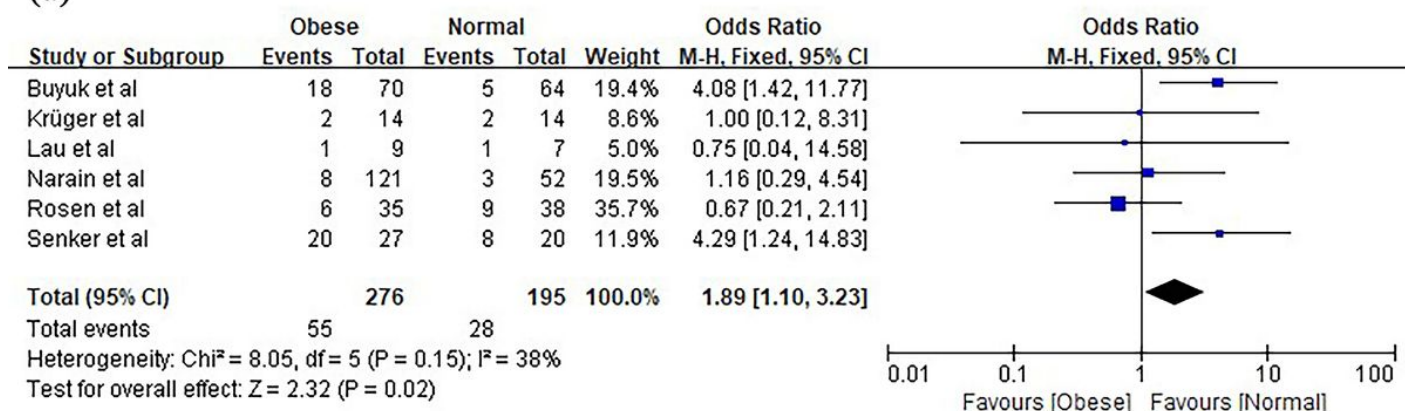


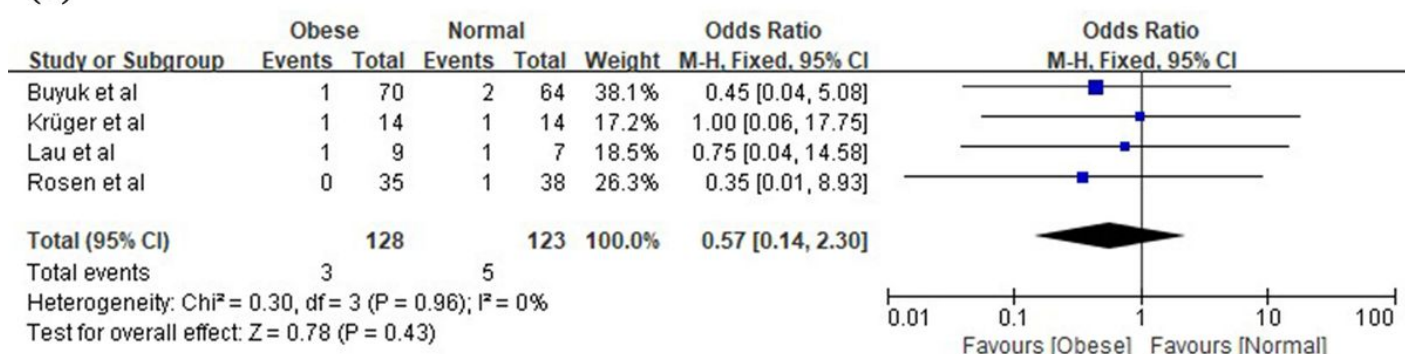
Figure 1

Flow diagram of the study selection process.

(a)



(b)



(c)

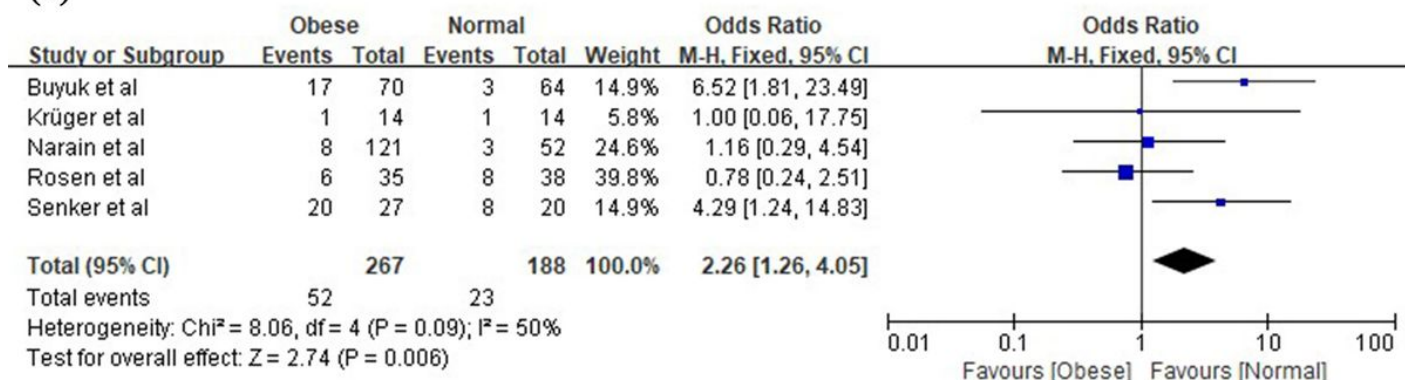


Figure 2

Forest plot of complication (a), intraoperative complication (b), postoperative complication (c) between two groups.

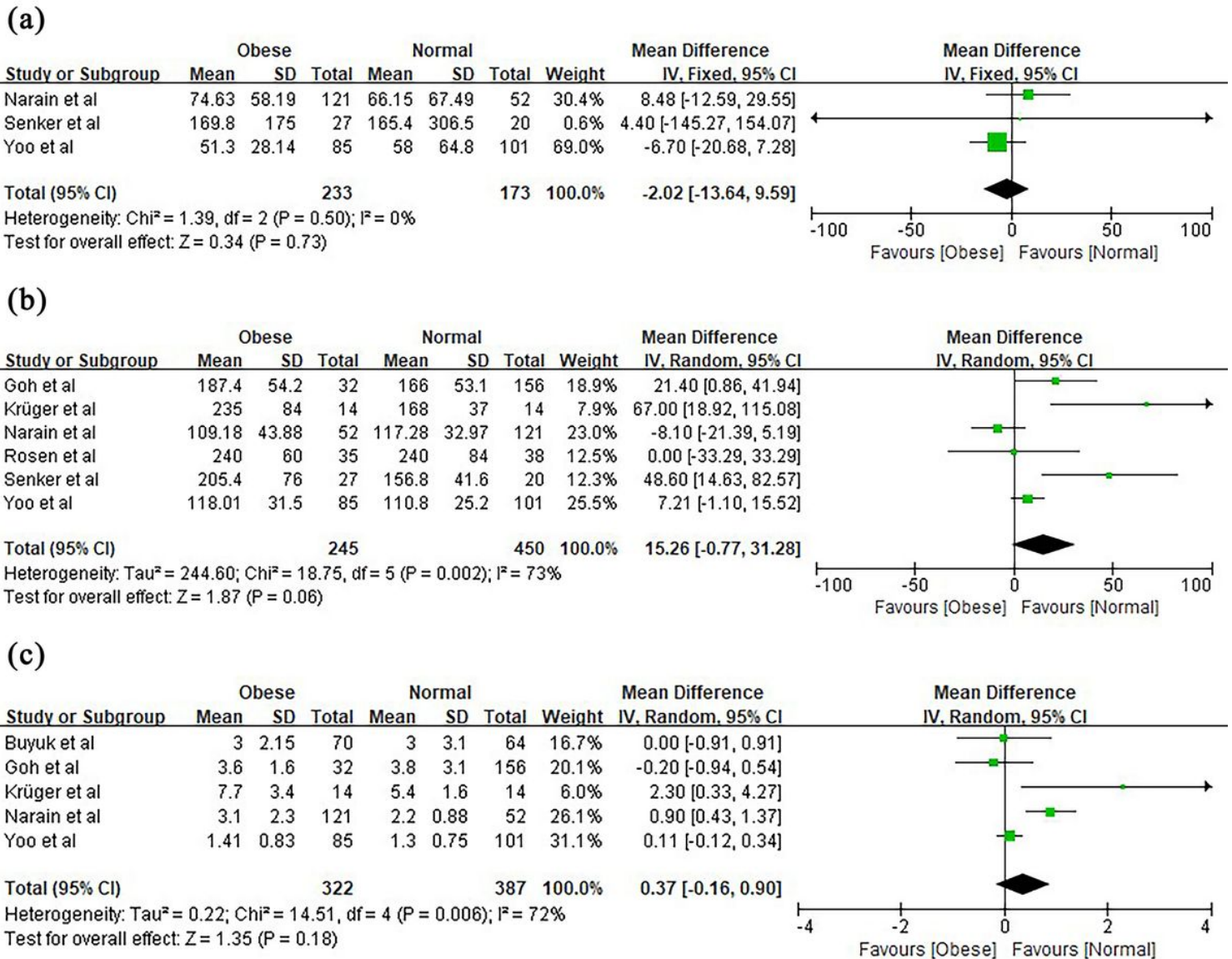
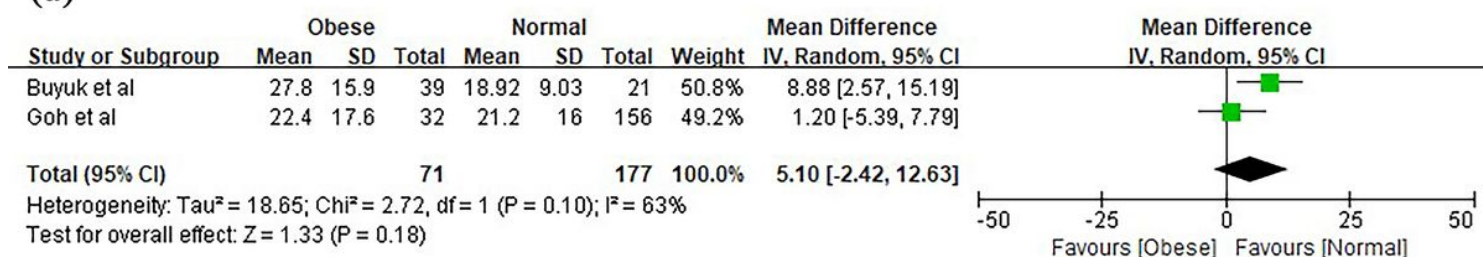


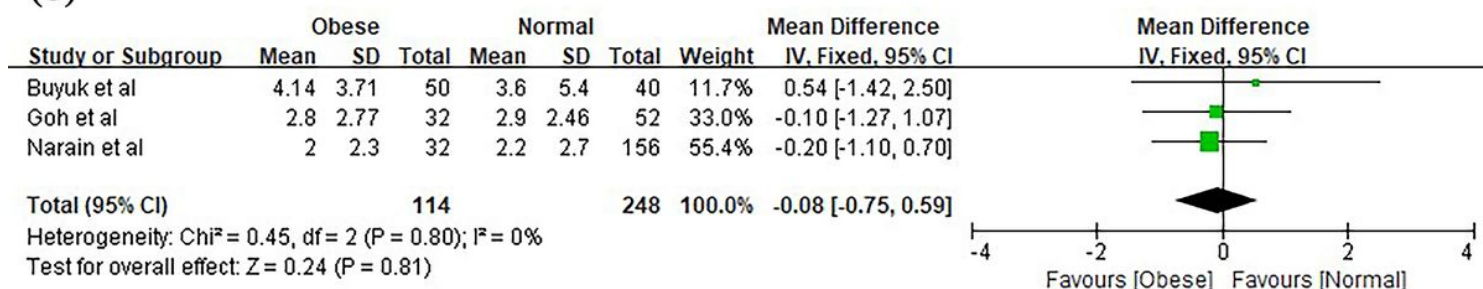
Figure 3

Forest plot of estimated blood loss (a), duration of surgery (b), Length of hospital stay (c) between two groups.

(a)



(b)



(c)

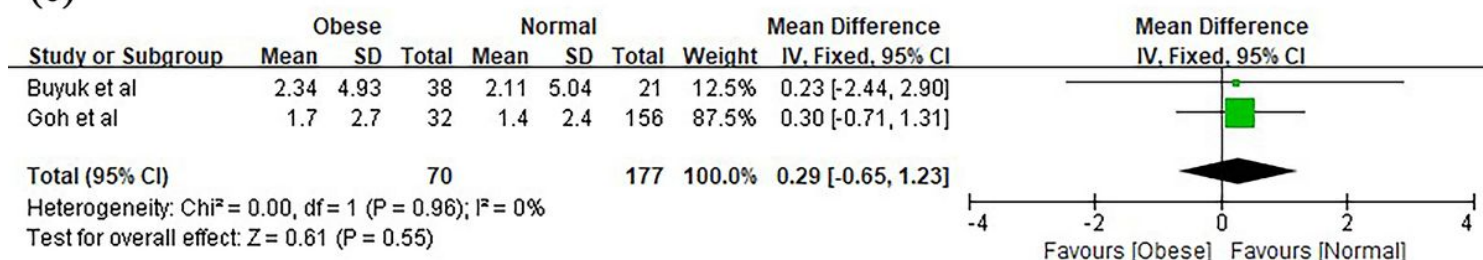


Figure 4

Forest plot of Oswestry disability index (ODI) (a), BP-VAS score (b), LP-VAS score (c) at postoperative early period (≤ 6 months) between two groups.

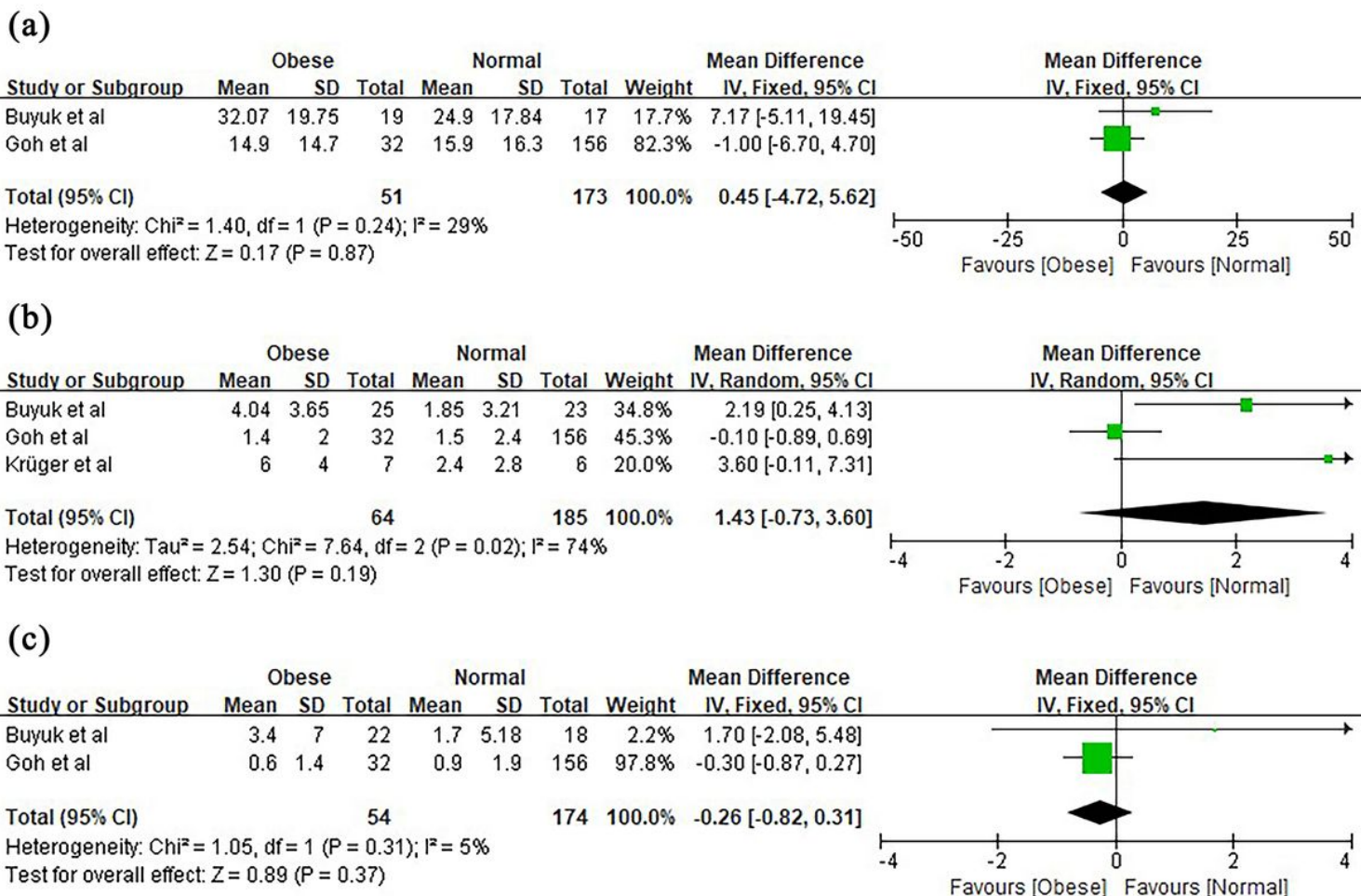


Figure 5

Forest plot of Oswestry disability index (ODI) (a), BP-VAS score (b), LP-VAS score (c) at postoperative late period(≥ 24 months) between two groups.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile1PRISMA2009checklist.docx](#)