Research Letter

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Association between bariatric surgery and outcomes of total joint arthroplasty: a meta-analysis

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Background: Total joint arthroplasty (TJA) alongside bariatric surgery (BS) is frequently operated on in obese arthritis patients. The controversy persists regarding BS before TJA, and the extent of its impact on the prognosis of TJA patients remains uncertain. To explore this, we conducted a meta-analysis.

Methods: As of 1 October 2023, the latest search on PubMed, Cochrane Library, Embase, and Web of Science was conducted to compare outcomes between patients who underwent preoperative BS and those who did not. The analysis focused on parameters such as length of stay (LOS), infection risk, venous thromboembolism, revision, transfusions, dislocations, periprosthetic fractures, knee stiffness, medical complications, and all-cause mortality in the eligible studies.

Results: This meta-analysis included 18 trials with a total of 292 196 patients. Pooled findings indicated that preoperative BS significantly shortened the LOS (MD, −0.16; 95% CI, −0.25 to 0.07; I^2=58%; P=0.0004) and increased the risk of dislocation within 90 days (OR, 1.70; 95% CI, 1.20–^{2}.42; I^2=21%; P=0.003) and all-cause mortality within 30 days (OR, 3.69; 95% CI, 1.81–7.49; I^2= 0%; P =0.0003) for TJA, in comparison with patients without BS. In the total hip arthroplasty (THA) subgroup, BS was more favorable, exhibiting significantly reduced risk of short-term revision (OR, 0.77; 95% C*I*, 0.61–0.99; I^2=0%; P=0.04) and long-term infection (OR, 0.72; 95% CI, 0.61–0.85; I^2=0%; $P\leq$0.0001). For total knee arthroplasty (TKA) patients, no significant benefit was identified. In addition, there was no statistically significant correlation between preoperative or postoperative BS and the occurrence of complications in TJA patients.

Conclusions and Relevance: Compared with the control group without BS, preoperative BS can shorten the LOS, increase the risk of dislocation within 90 days and all-cause mortality within 30 days in TJA, and reduce the risk of specific surgical complications in the THA subgroup but shows no significant difference in the TKA subgroup. There are no differences in clinical outcomes whether BS is performed before or after TJA. More high-quality trials are needed to further clarify the impact of BS on obese patients undergoing TJA.

Keywords: complications, prior bariatric surgery, total hip arthroplasty, total joint arthroplasty, total knee arthroplasty

Key Points

- **Question:** Did preoperative bariatric surgery affect total joint arthroplasty outcomes, and did bariatric surgery before or after total joint arthroplasty make a difference?
- **Findings:** In a meta-analysis of 18 studies involving 292 196 participants, compared with the control group without bariatric surgery, preoperative bariatric surgery increased the risk of dislocation within 90 days and all-cause mortality within 30 days in total joint arthroplasty and reduced the risk of specific surgical complications in the total hip arthroplasty subgroup, but showed no significant difference in the total knee arthroplasty subgroup. There were no differences in clinical outcomes whether bariatric surgery was performed before or after total joint arthroplasty. Undergoing TJA surgery within a short interval after BS showed a lower risk of TJA-related complications.

HIGHLIGHTS

- Bariatric surgery (BS) is associated with an increased risk of dislocation within 90 days and all-cause mortality within 30 days in total joint arthroplasty (TJA) patients.
- Outcomes are consistent among patients undergoing total knee arthroplasty (TKA), regardless of prior BS. Preoperative BS can reduce the risk of short-term revisions and long-term infections in total hip arthroplasty (THA) patients.
- The timing of BS, whether performed before or after TJA, does not yield significant differences in outcomes.

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- **Meaning:** The advantages and disadvantages of bariatric surgery in obese patients undergoing total joint replacement need further investigation through more high-quality randomized controlled trials in the future.

Introduction

The impact of bariatric surgery (BS) on total joint arthroplasty (TJA), including total knee arthroplasty (TKA) and total hip arthroplasty (THA), remained a topic of ongoing controversy. Therefore, we aimed to conduct a comprehensive meta-analysis to examine the effects of BS on TJA.

Obesity was not only a significant risk factor for the progression of osteoarthritis but also a crucial factor affecting the prognosis of TJA[1]. Bariatric surgery was one of the important methods for managing obesity[1], but there had been ongoing debate about its short-term and long-term effects after TJA. Three earlier published meta-analyses[2–4] found that bariatric surgery prior to TJA did not improve patient outcomes and might have even increased the short-term and long-term risks of complications, such as revisions, infections, and stiffness. However, in 2022, the latest randomized controlled trials (RCT)[5] and consensus[6] indicated that BS not only reduced perioperative and postoperative complications but also significantly decreased the number of participants requiring TKA after BS. It was also noteworthy that there was controversy over whether BS should be performed before or after TJA, and there was no relevant meta-analysis on this topic[7–9]. In summary, comprehensive answers were still lacking for the following questions: did preoperative bariatric surgery affect TJA outcomes, and did bariatric surgery before or after TJA make a difference? To address these uncertainties, we conducted this meta-analysis.

Methods

We sourced databases including PubMed, Cochrane Library, Embase, and Web of Science on 1 October 2023. Our inclusion criteria were: Patients' BMI meeting the 1991 National Institutes of Health consensus (BMI greater than 40 kg/m², or greater than 35 kg/m² with serious comorbidities) or the ASMBS/IFSO guidelines (BMI between 30 and 35 kg/m² with metabolic disease)[6], studies comparing the clinical outcomes of patients who underwent bariatric surgery before TJA with those who did not undergo bariatric surgery, or studies comparing the clinical outcomes of patients who underwent bariatric surgery before TJA with those who underwent bariatric surgery after TJA; RCT, case-control studies, or cohort studies. Our exclusion criteria were: studies lacking pertinent data for extraction or lacking a control group, and studies for which the full text could not be obtained. Our main outcomes included infection, venous thromboembolism (VTE), all-cause mortality, medical complication, need for revision, periprosthetic fracture, dislocation, need for blood transfusion. The aforementioned outcomes were categorized into short-term outcomes within 30 days, short-term outcomes within 90 days, and long-term outcomes, based on different follow-up durations. Subgroup analyses were conducted based on different follow-up times and types of TJA surgeries. Additionally, meta-regression analyses were performed on outcomes with six or more included studies based on publication year and type of TJA. Results were presented at odds ratios (OR) with 95% CI, and statistically analyses were performed using Stata 17. This meta-analysis was conducted in accordance with the Preferred Reported Items for Systematic Reviews and Meta-analysis (PRISMA) checklist, Supplemental Digital Content 1, http://links.lww.com/JS9/D183[10,11].

Results

Eighteen studies involving 292 196 participants were included (Table 1). Fifteen studies explored the impact of BS on TJA. Three studies compared the effectiveness of bariatric surgery when performed before or after TJA.

All the outcomes were showed in Figure 1. As for short-term outcomes within 30 days, BS showed a statistically significant increase in the risk of all-cause mortality (OR, 3.69; 95% CI 1.81–7.49). However, there were no statistically significant differences in infection, VTE, and medical complications (eFigure1 in Supplement, Supplemental Digital Content 2, http://links.lww.com/JS9/D184).

As for short-term outcomes within 90 days, BS showed a statistically significant higher risk of dislocation (OR 1.70; 95% CI 1.20–2.43) but a lower risk of infection (OR, 0.74;95% CI 0.58–0.93), VTE (OR 0.76; 95% CI 0.62–0.94), and medical complications (OR 0.67; 95% CI 0.45–0.99). No statistically significant differences were observed for revision, periprosthetic complications, all-cause mortality, and blood transfusion. In subgroup analyses, preoperative BS significantly reduced the risk of VTE (OR 0.70; 95% CI 0.65–0.77) in TKA patients, while there were no significant effects on infection, revision and blood transfusion. For THA patients, preoperative BS significantly reduced the risk of infection (OR 0.77; 95% CI 0.61–0.99), VTE (OR 0.66; 95% CI 0.55–0.79), and revision (OR 0.56; 95% CI 0.44–0.71), while there was no significant effect on the risk of blood transfusion (eFigure2 in Supplement, Supplemental Digital Content 2, http://links.lww.com/JS9/D184).

As for long-term outcomes, no statistically significant differences were found for infection, revision, periprosthetic fracture, and VTE. In subgroup analyses, preoperative BS had no significant effects on the risk of infection, revision, and dislocation in TKA patients. For THA patients, preoperative BS significantly reduced the risk of infection (OR 0.72; 95% CI 0.61–0.85), while there were no significant effects on the risk of VTE and revision (eFigure3 in Supplement, Supplemental Digital Content 2, http://links.lww.com/JS9/D184).

We also compared the prognosis of patients who underwent pre-TJA BS with that of patients who underwent post-TJA BS. The pooled results showed no statistically significant differences in the risk of VTE, revision, and infection.

Considering the variation in the time interval between bariatric surgery and TJA among the studies, the studies have been classified into two categories based on this interval: short interval (bariatric surgery followed by TJA within 12 months) and long interval (bariatric surgery followed by TJA within 12–36 months). However, it was found that in terms of short-term outcomes, bariatric surgery with a short interval showed a statistically lower risk of VTE (OR 0.63; 95% CI 0.50–0.79) and infection (OR 0.57; 95% CI 0.47–0.71). In long-term outcomes, bariatric surgery with a short interval showed a statistically significantly lower risk of infection (OR 0.62; 95% CI 0.48–0.81) and revision (OR 0.76; 95% CI 0.60–0.98). However, no

Table 1

Main characteristics of the included studies.

Source	Country	Study design	Sample size (INT/CON)	Age, mean (SD), year	Female (%)	BMI (INT/CON)	Follow-up, months	Surgery types	Intervention methods	Interval between surgery	Outcome measures
Bains *et al.*, 2022[12]	America	Non-matched cohort	2329/36799	60.8 (9.6)	61.08	NA/ > 40	24	THA	RYGB or SG	> 6 months	VTE; infection; dislocation; revision; blood transfusion
Dowsey *et al.*, 2022[13]	Australian	RCT	41/41	57.9 (4.9)	80.49	43.8/43.6	27	TKA	LAGB	12 months	VTE; periprosthetic fracture; knee stiffness; revision
Inacio *et al.*, 2014[14]	America	Registry	69/11134	57 (6.8)	68.09	34.6/39.9	12	TKA/THA	NA	> 24 months	Infection; revision
Kulkarni *et al.*, 2011[7]	UK	Non-matched cohort	90/53	NA	NA	NA	18	TKA/THA	NA	> 6 months	VTE; infection; revision
Liu *et al.*, 2018[15]	America	Non-matched cohort	1478/60259	NA	NA	NA	12	TKA/THA	NA	Within 24 months	Infection; dislocation; revision
Liu *et al.*, 2020[16]	America	Non-matched cohort	1478/60259	62.2 (9.8)	8.17	NA	3	TKA/THA	NA	With 24 months	VTE; infection; dislocation; periprosthetic fracture; medical complications
Martin *et al.*, 2015[17]	America	Matched cohort	91/91	57.4 (7)	81.32	37.2/51.2	60	TKA	NA	46.5 months (mean time)	VTE; infection; revision
McLawhorn *et al.*, 2018[18]	America	Matched cohort	3428/3428	NA	79.20	NA/ > 40	3	TKA/THA	NA	NA	VTE; infection; dislocation; revision; medical complications
Nearing *et al.*, 2017[19]	America	Non-matched cohort	42/43	NA	NA	37.6/36.7	12	TKA/THA	NA	NA	VTE; infection
Nearing *et al.*, 2017[8]	America	Non-matched cohort	66/566	55 (5.5)	12.97	46.3/49.6	48	TKA/THA	RYGB or SG	NA	VTE; infection; revision
Nickel *et al.*, 2016[20]	America	Non-matched cohort	5918/26616	NA	77.59	NA/ > 40	24	TKA	GB	NA	VTE; infection; revision; medical complications
Nickel *et al.*, 2018[21]	America	Non-matched cohort	1545/6918	NA	69.11	36.5/ > 40	24	TKA	NA	NA	VTE; infection; dislocation; periprosthetic fracture; revision
Ryan *et al.*, 2022[22]	America	Matched cohort	205/205	NA	81.95	36.9/44.4	72	TKA	NA	11 years (mean time)	VTE; infection; periprosthetic fracture; revision
Sax *et al.*, 2022[23]	America	Non-matched cohort	17960/87449	59.8 (8.5)	73.23	NA/ > 40	24	TKA	RYGB or SG	> 6 months	VTE; infection: dislocation; revision;
Severson *et al.*, 2012[9]	America	Non-matched cohort	86/39	NA	79.20	38.3/43.1	22	TKA	GB or LAGB	NA	VTE; infection; revision;
Wang *et al.*, 2019[24]	China	Matched cohort	12284/12284	NA	NA	NA	3	TKA/THA	NA	NA	VTE; infection; dislocation; medical complications; blood transfusion
Watts *et al.*, 2016[25]	America	Matched cohort	47/94	56.7 (11.3)	57.45	35.3/50.2	108	THA	NA	5 years (mean time)	Infection; dislocation; periprosthetic fracture; revision
Werner *et al.*, 2015[26]	America	Registry	219/11294	NA	74.26	NA	3	TKA	GB or LAGB	NA	VTE; infection; blood transfusion; medical complications

Con, control; GB, gastric bypass; Int, intervention; LAGB, laparoscopic adjustable gastric banding; NA, not available; RCT, randomized controlled trial; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; THA, total hip arthroplasty; TKA, total knee arthroplasty; VTE, venous thromboembolism.

Outcomes	studies, NO.	BS group Events, NO. /total NO.	Control group Events, NO. /total NO.	Odds Ratio(95%CI)
Short-term outcomes within 30 days				
Infection	3	15/4972	266/64253	0.85 (0.45-1.60)
VTE	3	355/7529	4458/34100	1.42 (0.69-2.91)
All-cause mortality	2	13/5987	35/37750	3.69(1.81-7.49)
Medical complication	2	2527/8554	8013/29252	1.03(0.37-2.87)
Short-term outcomes within 90 days				
Infection	10	659/45537	7726/256284	0.74 (0.58-0.93)
Revision	5	417/31180	2604/161210	0.87 (0.63-1.21)
VTE	8	731/38074	7313/222750	0.76 (0.62-0.94)
Medical complication	3	242/13981	6989/83837	0.67 (0.45-0.99)
Periprosthetic fracture	2	13/3023	140/67177	0.82 (0.45-1.47)
All-cause mortality	3	2/13831	102/83677	0.49(0.10-2.25)
Dislocation	3	89/5352	835/103976	1.70 (1.20-2.43)
Blood transfusion	5	2652/34270	16188/208085	1.15 (0.81-1.64)
Long-term outcomes				
Infection	7	1256/28032	10648/158109	0.92 (0.62-1.36)
Revision	10	981/29722	6201/229441	1.29 (0.89-1.86)
Periprosthetic fracture	4	30/1775	115/7195	1.07 (0.71-1.62)
VTE	2	2/132	3/132	0.74 (0.09-6.15)

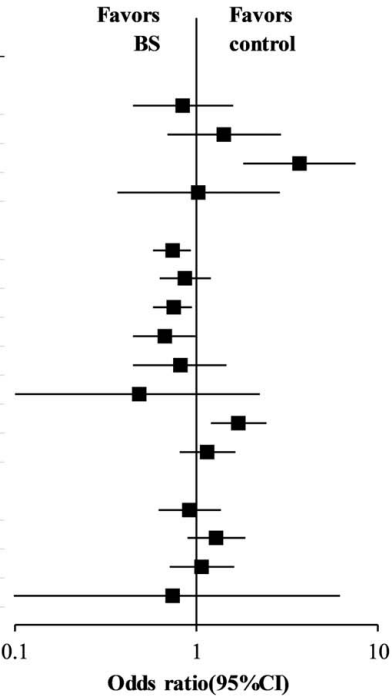

Figure 1. Forests plots of the outcomes between bariatric surgery and control group outcomes between bariatric surgery and control group using the random effects model. BS, Bariatric surgery; VTE, venous thromboembolism.

significant statistical differences were found in the aforementioned results for bariatric surgery with a long interval.

In the subgroup analyses and meta-regression, it was found that the type of TJA surgery might be a source of heterogeneity.

Discussion

Our meta-analysis showed that preoperative BS was associated with an increased risk of dislocation within 90 days and all-cause mortality within 30 days. Although our results showed that preoperative BS had a significantly lower risk of infection, revision, VTE, and medical complications at 90 days compared with controls, the robustness was poor, making it necessary to interpret these findings with caution. For patients with THA, BS can reduce the risk of short-term revision and long-term infection, but for patients with TKA, BS had no significant effects on postoperative outcomes. In addition, there was no significant difference whether BS was performed prior to or after TJA. Undergoing TJA within 1 year after BS resulted in lower risks of VTE, infection, and revision for patients. However, undergoing TJA after 1 year did not show differences in these outcomes. This could have been caused by several factors, such as significant weight loss and marked improvements in metabolic and overall health status early after BS. In contrast, weight loss might have slowed down or even reversed later, leading to less pronounced improvements in metabolic state and health status.

Our research is unique compared to previous studies[2–4] on bariatric surgery and TJA due to its broader scope, analyzing 18 articles and differentiating between TKA and THA. We identified specific risks, such as increased dislocation within 90 days and all-cause mortality within 30 days. Unlike prior studies, we provided a comprehensive evaluation of both short-term and long-term outcomes, addressing limitations such as small sample sizes and the exclusion of critical trials, thereby offering a more balanced and detailed perspective.

The impact of obesity on the progression of OA and arthroplasty has been an area of ongoing exploration. With the advent of glucagon-like peptide-1 receptor agonists like semaglutide, many studies have also begun to investigate their role in OA and arthroplasty. Current limited research suggests that GLP-1RAs may increase the risk of hip and knee joints developing into osteoarthritis, but they can alleviate pain in OA patients and improve surgery-related clinical outcomes for arthroplasty patients. More research is needed in the future to further explore this area[27–29].

Potential biases and confounding factors could influence the results of our meta-analysis comparing clinical outcomes of TJA in obese patients with and without bariatric surgery. These include selection bias from differing patient characteristics and study inclusion criteria, baseline health differences, and comorbidities. Timing issues, such as the interval between surgeries and weight loss dynamics, also play a role. Reporting bias, variations in outcome definitions, follow-up duration, surgical techniques, type of TJA and rehabilitation programs further contribute to heterogeneity. Due to limited data, we performed subgroup analysis and meta-regression on some outcomes and characteristics, finding that the type of joint replacement might be a source of heterogeneity.

It was crucial to interpret our findings cautiously due to various limitations in our study. Firstly, our findings were constrained by the limited number of available studies and the variability in study types. Secondly, the relatively small number of

studies included restricted our ability to clarify differences in associations across studies, such as populations and intervention characteristics. Specifically, there was limited data on certain clinical outcomes, and there were missing data on several study characteristics, including surgical interval and type of bariatric surgery, which could have been potential sources of heterogeneity. Thirdly, due to the limited extractable data, we could not conclusively demonstrate whether there was no difference between undergoing bariatric surgery before or after TJA across all outcomes. Fourthly, due to the small number of included RCTs, there was limited information on baseline characteristics between groups, potentially resulting in baseline imbalance; for example, patients undergoing bariatric surgery may have had more severe joint damage. Therefore, future research should focus on more high-quality randomized controlled trials to further investigate this topic.

Preoperative BS seems associated to a higher risk of dislocation within 90 days and all-cause mortality within 30 days, but it is associated with a significantly lower risk of infection, revision, VTE, and medical complications at 90 days. Undergoing TJA surgery within a short interval after BS appeared to be associated with a lower risk of TJA-related complications.

Ethical approval

As the literature included in the meta-analysis got ethics approval, no additional ethics approval was required.

Source of funding

None.

Author contribution

S.G. had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: P.L., J.H.M. Acquisition, analysis, or interpretation of data: P.L., J.H.M. Drafting of the manuscript: P.L., J.H.M. Critical revision of the manuscript for important intellectual content: all authors. Statistical analysis: P.L., J.H.M., Y.M.W. Administrative, technical, or material support: W.J.L., Y.M.W. Supervision: S.G.G.

Conflicts of interest disclosure

The authors declare no conflicts of interest.

Research registration unique identifying number (UIN)

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Guarantor

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Data availability statement

None.

Presentation

None.

Explanation for why data not available

Data will be available in the article.

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