Original Article

The relationship between body mass index and clinical efficacy of knee arthroplasty in patients with knee osteoarthritis

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Background: Increase body mass index (BMI) is often accompanied by metabolic diseases such as diabetes, which will increase the uncertainty of total knee arthroplasty (TKA) efficacy and the risk of postoperative complications. The present study was to study the relationship between increase BMI and clinical efficacy of knee arthroplasty in patients with knee osteoarthritis.

Methods: A total of 97 patients (36 males and 61 females) with knee osteoarthritis (KOA) who underwent TKA surgery were selected. According to the preoperative body mass index (BMI), the patients were divided into a normal group (n=42), overweight group (n=35), and obese group (n=20). All patients received TKA after admission. Seven days after surgery, the American Knee Society (AKS) and the Hospital for Special Surgery (HSS) scales were used to evaluate the recovery of knee function. The recovery was poor if the scores of AKS and HSS were less than 70.

Results: Seven days after TKA, the scores of AKS and HSS in different BMI groups were significantly different, and decreased with the increase of BMI (P<0.05). Age, increased BMI, diabetes, preoperative range of motion (ROM), intraoperative blood loss, postoperative C-reactive protein (CRP), postoperative posterior slope angle (PSA), postoperative infection, and postoperative deep vein thrombosis (DVT) of lower extremities were related to AKS score <70 (P<0.05). Diabetes, preoperative ROM, intraoperative blood loss, postoperative CRP, postoperative PSA, and postoperative infection were related to HSS score <70 (P<0.05). Increased BMI, diabetes, postoperative CRP, postoperative infection, and postoperative DVT were independent risk factors for AKS score <70 (HR =3.458, 1.152, 2.960, 1.023, 3.589, P<0.05). Increased BMI, diabetes, postoperative CRP, and postoperative infection were independent risk factors for HSS score <70 (HR =6.891, 1.263, 1.967, 1.235, P<1.235). The area under the curve (AUC) (95% CI) of BMI in diagnosing AKS <70 was 0.740 (0.641–0.839). The AUC (95% CI) of BMI in diagnosing HSS <70 was 0.809 (0.723–0.894).

Conclusions: The increase of BMI is an independent risk factor for the poor recovery of knee function after TKA in patients with KOA.

Keywords: Knee osteoarthritis (KOA); total knee arthroplasty (TKA); increase body mass index (increase BMI); knee function recovery

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Introduction

Osteoarthritis (OA) is a disease caused by cartilage loss of synovial joints and is characterized by periarticular hyperosteogeny, also known as degenerative OA and hyperosteogeny. Knee osteoarthritis (KOA) is the most common form of OA, accounting for about 80% of OA (1). Total knee arthroplasty (TKA) is one of the most effective surgical treatment methods for KOA, with a high surgical success rate of about 95%. However, it is reported that some patients are prone to postoperative surgical site infection and lower limb deep vein thrombosis (DVT), which affects the recovery of joint function (2). Increased body mass index (BMI) aggravates the mechanical load of the knee joint and is a risk factor for KOA (3). Moreover, increased BMI is often accompanied by metabolic diseases such as diabetes, and these comorbidities can increase the uncertainty of the efficacy of TKA and the risk of postoperative complications. In addition, previous study showed that increased BMI was associated with postoperative pain after TKA (4). However, few study reported the relationship between increased BMI and clinical efficacy of TKA in patients with KOA. We hypothesized that increased BMI may be an influencing factor in the recovery of knee function in KOA patients undergoing TKA. The present study was to study the relationship between BMI and clinical efficacy of TKA in patients with KOA. We present the following article in accordance with the STARD reporting checklist (available at https://atm.amegroups.com/article/view/10.21037/atm-22-819/rc).

Methods

A total of 97 KOA patients treated with TKA surgery at the First Affiliated Hospital, Hengyang Medical School, University of South China from February 2019 to October 2021 were retrospectively enrolled in this study, including 37 males and 60 females. The age range was 42 to 75 years, and the average age was 57.63±5.47 years. The inclusion criteria were as follows: (I) compliance with the KOA clinical diagnostic criteria (5); (II) the disease course was >1 month; (III) the Kellgren-Lawrence classification was grade IV (6); (IV) TKA treatment with no contraindications, and the operation was completed by the same group of doctors. The exclusion criteria were as follows: (I) with traumatic knee arthritis or inflammatory arthritis; (II) history of knee replacement; (III) with ankle or hip OA; (IV) intraarticular drug injection within 6 months; (V) with malignancy, ankylosing spondylitis, gout arthritis, or coagulopathy; (VI) severe liver and kidney injury; (VII) pregnancy and lactation. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the First Affiliated Hospital, Hengyang Medical School, University of South China (No. 2019-109). Individual consent for this retrospective analysis was waived.

Groups

Preoperative height and weight were collected and BMI was calculated as BMI = weight/height^2 (kg/m^2). Patients with BMI <24 kg/m^2 were included in the normal group (n=42), patients with 24 kg/m^2 ≤BMI <28 kg/m^2 were included in the overweight group (n=35), and patients with BMI ≥28 kg/m^2 were included in the obese group (n=20) (7).

Operation methods

The patient took the supine position. After general anesthesia, the install approach was used to strip the periosteum from 1/3 of the interior of the patella. We turned the patella outward to reveal the whole knee joint, fully loosened the soft tissue, and corrected various knee deformities. We removed the worn or injured surface of the lower thigh bone and the upper end of the small leg bone, then repaired the joint surface into a shape suitable for joint replacement, and selected the suitable size joint prosthesis to bond with the bone. Then we rinse the operation cavity and stop bleeding thoroughly. Finally, we closed the incision. After surgery, we closely observed the patient's vital signs, rationally used antibiotics to prevent infection, and strengthened the nutrition of the patients.

Evaluation of joint function recovery

At 7 d after the operation, the American Knee Society (AKS) scale (8) and the Hospital for Special Surgery (HSS) scale were used to evaluate the joint function recovery (9). The total points of the AKS and HSS scales were 100, and the higher the total points, the better the knee recovery. HSS score included pain, function, activity, muscle strength and flexion deformity score. AKS included knee score and functional score. BMI: Weight (kg)/[height (M)]^2.

Table 1 Relationship between knee functional recovery parameters after TKA in different BMI groups

Data	Normal (n=42)	Overweight group (n=35)	Obese group (n=20)	χ^2/F value	P value
Gender, n (%)				1.851	0.396
Male	18 (42.86)	13 (37.14)	5 (25.00)		
Female	24 (57.14)	22 (62.86)	15 (75.00)		
Age (years) (mean ± standard deviation)	57.06±5.39	57.89±5.44	58.37±5.70	0.450	0.639
Postoperative 7 d AKS score	89.75±8.96	78.89±10.32[a]	71.54±7.45[ab]	29.784	<0.001
Postoperative 7 d HSS score	75.96±6.43	69.60±4.21[a]	62.73±4.59[ab]	43.016	<0.001

When compared with the normal group, [a] indicates P<0.05; when compared with the overweight group, [b] indicates P<0.05. TKA, total knee arthroplasty; BMI, body mass index; AKS, the American Knee Society; HSS, the Hospital for Special Surgery.

Data collection

Parameters of knee function recovery after TKA in patients in different BMI groups were compared. General clinical data such as gender, age, BMI, underlying diseases, disease course, range of motion (ROM) of knee flexion activity, operation time, intraoperative blood loss, preoperative C-reactive protein (CRP), postoperative posterior slope angle (PSA), postoperative infection, and DVT complications were also collected to perform univariate and multivariate analyses of knee function recovery after TKA surgery.

Statistical methods

Data analysis was performed by SPSS 26.0. Quantitative data was expressed by mean ± standard deviation, the *t*-test was used to analyze the differences between two groups, while differences between multiple groups were analyzed by ANOVA. Qualitative data was expressed by n (%), and the Chi-square test was performed for inter-group comparisons. The factors affecting knee function recovery after TKA were analyzed by univariate and multivariate logistic analyses. P values <0.05 were considered as statistically significant (two-sided). Receiver operating characteristic (ROC) curves were drawn to analyze the predictive value of BMI levels on knee function recovery after TKA.

Results

Relationship between knee functional recovery parameters after TKA in different BMI groups

There were no significant differences in general clinical data such as gender and age among different BMI groups (P>0.05). However, at 7 d after TKA, AKS and HSS scores of different BMI groups were significantly different, which decreased with increasing BMI (P<0.05), as shown in *Table 1*.

Univariate and multivariate analyses of knee function recovery after TKA

Univariate analysis showed that age, BMI, diabetes, preoperative ROM, intraoperative blood loss, postoperative CRP, postoperative PSA, postoperative infection, and postoperative DVT were associated with AKS score <70 points (P<0.05). Age, BMI, diabetes, preoperative ROM, intraoperative blood loss, postoperative CRP, postoperative PSA, and postoperative infection were related to HSS score <70 (P<0.05). Multivariate analysis showed that BMI, diabetes, postoperative CRP, postoperative infection, and postoperative DVT were independent risk factors for AKS score <70 (P<0.05). BMI, diabetes, postoperative CRP, and postoperative infection were independent risk factors for HSS score <70 (P<0.05), as shown in *Table 2*.

Predictive value of BMI level on knee function recovery after TKA

When the best cut-off value of BMI was 27.67 kg/m^2, the area under the curve (AUC) (95% CI) in diagnosing AKS <70 was 0.740 (0.641–0.839), and the sensitivity and specificity were 82.1% and 65.5%, respectively. When the best cut-off value of BMI was 27.12 kg/m^2, the AUC (95% CI) in diagnosing HSS <70 was 0.809 (0.723–0.894), and the sensitivity and specificity were 83.7% and 70.4%, respectively (*Figure 1*).

Table 2 Univariate and multivariate logistic analyses of knee function recovery after TKA

Clinical factors	AKS score <70 points				HSS score <70 points			
	Univariate factors		Multivariate factors		Univariate factors		Multivariate factors	
	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value	HR (95% CI)	P value
Age	1.245 (1.001–2.326)	0.048	–	–	1.143 (1.098–1.765)	0.039	–	–
Gender	0.632 (0.478–1.125)	0.368	–	–	0.778 (0.692–1.044)	0.543	–	–
BMI	6.474 (2.567–8.393)	<0.001	3.458 (1.392–6.895)	<0.001	5.372 (1.486–6.370)	<0.001	6.891 (3.547–10.230)	<0.001
Hypertension	1.014 (0.962–1.351)	0.095	–	–	0.945 (0.830–1.070)	0.307	–	–
Diabetes	1.333 (1.214–2.860)	0.032	1.152 (1.078–2.096)	0.039	1.502 (1.136–2079)	0.023	1.263 (1.058–2.142)	0.004
Course of the disease	0.878 (0.604–1.109)	0.128	–	–	1.007 (0.800–1.084)	0.334	–	–
Preoperative ROM	0.620 (0.320–0.832)	0.046	–	–	0.364 (0.036–0.792)	0.017	–	–
Prothrombin time	0.947 (0.900–1.042)	0.236	–	–	0.361 (0.239–1.156)	0.478	–	–
International normalized ratio	0.735 (0.560–1.893)	0.465	–	–	0.998 (0.903–1.547)	0.832	–	–
Platelet count	1.019 (0.948–1.663)	0.096	–	–	1.009 (0.638–1.238)	0.258	–	–
Albumin	1.542 (0.706–2.361)	0.151	–	–	0.607 (0.542–1.325)	0.099	–	–
Hemoglobin	0.944 (0.568–1.014)	0.069	–	–	1.278 (0.984–1.589)	0.788	–	–
Operation time	1.000 (0.999–1.143)	0.237	–	–	0.562 (0.458–1.020)	0.073	–	–
Intraoperative blood loss	1.799 (1.233–1.969)	0.008	–	–	1.459 (1.278–2.096)	0.009	–	–
Postoperative CRP	3.256 (2.210–4.347)	<0.001	2.960 (1.475–6.967)	<0.001	2.796 (1.564–5.568)	<0.001	1.967 (1.356–5.452)	<0.001
Postoperative PSA	0.832 (0.660–0.956)	0.05	–	–	0.984 (0.524–1.000)	0.019	–	–
Postoperative infection	1.244 (1.189–1.785)	<0.001	1.023 (1.000–2.023)	<0.001	1.862 (1.056–3.694)	<0.001	1.235 (1.201–2.567)	0.005
Postoperative DVT	2.047 (1.201–3.668)	<0.001	3.589 (2.140–7.625)	<0.001	1.010 (0.963–1.475)	0.080	–	–

TKA, total knee arthroplasty; AKS, the American Knee Society; HSS, the Hospital for Special Surgery; BMI, body mass index; ROM, range of motion; CRP, C-reactive protein; PSA, postoperative posterior slope angle; DVT, deep vein thrombosis.
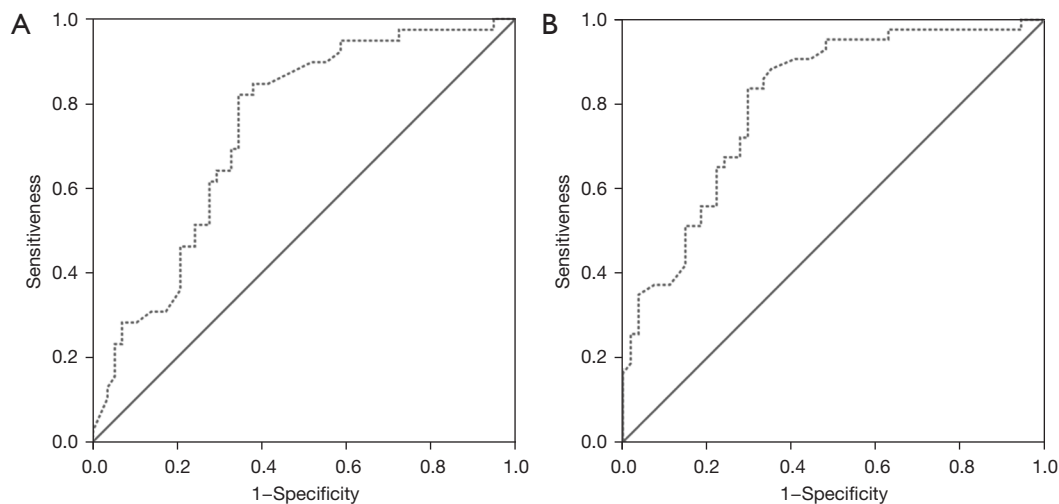
Figure 1 ROC curve of BMI level in evaluating knee function recovery after TKA. (A) AKS score <70 at 7 days after surgery; (B) HSS score <70 at 7 days after surgery. ROC, receiver operating characteristic; BMI, body mass index; TKA, total knee arthroplasty; AKS, the American Knee Society; HSS, the Hospital for Special Surgery.

Discussion

KOA is the degeneration of knee cartilage with subchondral bone hyperplasia and osteophyte formation, which secondarily causes injury and inflammatory reactions of the synovium, joint capsule, and soft tissue (10). The knee joint gradually loses cartilage, and the structure of the bone and soft tissue around the joint changes, resulting in joint pain, swelling, deformity, and serious disability (11). The number of KOA patients increases every year with aging. TKA treatment is usually considered in advanced KOA patients, and TKA is able to improve knee function and relieve joint pain in KOA patients, with a low 5-year revision rate (12). Increase BMI is one of the known risk factors for KOA and is closely associated with disease progression (13). However, the relationship between Increase BMI and the recovery of knee function after TKA has not been elucidated.

BMI is a common international standard measure of human weight loss and health (14). The results of this study showed significant differences in AKS and HSS scores among different BMI groups after TKA. The AKS and HSS scores decreased with increased BMI, indicating worse postoperative recovery of knee function in patients with higher BMI levels. Previous study found that increase BMI increases the load on the knee joint and increases serum and tissue pro-inflammatory cytokines and adipokines (15). We hypothesized that increase BMI may be a factor influencing joint function recovery after surgery. The results of the multivariate analysis showed that

increased BMI, diabetes, postoperative CRP, postoperative infection, and postoperative DVT were the independent risk factors for poor joint recovery after TKA. Obese patients have larger lower limb loads and less rehabilitation training, thus leading to poor knee function recovery. Previous study has shown that BMI levels are negatively associated with lower limb muscle strength and muscle mass, and that obese people with reduced muscle mass are prone to limited activity, all of which limit the recovery of knee function (16). Hyperglycemia leads to the reduction of blood vessels at the incision, the decrease of phagocyte number and phagocytic capacity, the decrease of leukocyte chemotaxis and protein synthesis ability, the decrease of immune responses, and limits the formation of fibroblasts and collagen. Therefore, the incision is prone to disruption of the wound and infection, which seriously affects the incision healing (17).

When the body is infected or tissue is damaged, the plasma CRP level increases sharply. Therefore, detecting CRP levels is beneficial for understanding the postoperative complications. A previous study showed that elevated preoperative CRP level is associated with poor postoperative recovery of joint function, which is consistent with the results of our study (18). Postoperative infection caused delayed incision closure, increased the inflammation of the body, and aggravated inflammation of the knee joint (19). Postoperative DVT increased patients' pain, prolonged hospitalization, increased medical costs, and

caused pulmonary embolism and even death (20). When the best cut-off value of BMI was 27.67 kg/m^2, the AUC (95% CI) in diagnosing AKS <70 was 0.740 (0.641–0.839), and the sensitivity and specificity were 82.1% and 65.5%, respectively. When the best cut-off value of BMI was 27.12 kg/m^2, the AUC (95% CI) in diagnosing HSS <70 was 0.809 (0.723–0.894), and the sensitivity and specificity were 83.7% and 70.4%, respectively, indicating that BMI has good predictive value for the recovery of knee function after TKA.

Limitations

The main deficiency of this study was that this was a retrospective clinical study with a relatively small number of cases.

Conclusions

The increase of BMI is an independent risk factor for the poor recovery of knee function after TKA in patients with KOA. It has good predictive value for the recovery of knee function after TKA.

Acknowledgments

Footnote

Reporting Checklist: The authors have completed the STARD reporting checklist. Available at https://atm.amegroups.com/article/view/10.21037/atm-22-819/rc

Data Sharing Statement: Available at https://atm.amegroups.com/article/view/10.21037/atm-22-819/dss

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://atm.amegroups.com/article/view/10.21037/atm-22-819/coif). 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. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Ethics Committee of the First Affiliated Hospital, Hengyang Medical School, University of South China (No. 2019-109). Individual consent for this retrospective analysis was waived.

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