Influence of body mass index on function outcome after total knee replacement☆

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Abstract

BACKGROUND: Some studies have considered the influence of body mass index (BMI) on the function following total knee replacement (TKR), but the cases were few and follow-up time is short in most of them.

OBJECTIVE: To analyze the function outcome influenced by BMI after TKR.

METHODS: A total of 320 osteoarthritis patients who were admitted in Department of Bone and Joint at Peking University People's Hospital, were involved in this study. They all received primary knee joint patellar resurfacing, including both knees replacement in 200 case of 520 knees, left 219 and right 301. The involved 320 patients underwent primary TKR performed by a single surgeon with the same type of prosthesis (Scorpio posterior stable prosthesis). The patients were divided into four groups based on obesity (overweight group, BMI 25.1-27.0 kg/m^2; obese group, BMI 27.1-30.0 kg/m^2; morbidly obese group, BMI > 30 kg/m^2; control group, BMI < 25 kg/m^2). According to the Hospital for Special Surgery (HSS) rating scale, their knee score and functional scores were recorded before replacement and at follow-ups, as well as maximal range of flexion and extension, complications. Preoperative and postoperative assessment was based on the HSS score.

RESULTS AND CONCLUSION: A total of 320 patients received clinical recheck at 28.3 months (range 12-46 months). Compared with control group, patients in overweight, obese and morbidly obese groups had lower preoperative functional score (P < 0.05), but knee scores were not significantly different for any patient group. The postoperative mean HSS score of all the groups rose significantly at the last follow-up. These differences were not statistically significant among groups (P > 0.05). The rate of perioperative complications was significantly higher in the obese and morbidly obese patients (P < 0.05). Of the 181 knees in obese and morbidly obese patients, 14 knees (9.2%) had a wound complication, 1 knee (0.5%) had an infection, and 2 knees (1.3%) had an avulsion of the medial collateral ligament. The infected case developed within ten weeks after the operation, and was associated with a wound complication. Among 266 knees in the overweight patients, 6 knees (2.3%) had a wound complication. There was 1 knee (1%) of the 81 knees in the control group had a wound complication. No death or pulmonary embolism cases were observed in perioperative period. It is suggested that BMI has no obvious influence on the functional outcome following TKR in the short-term.

INTRODUCTION

Total knee replacement (TKR) is an effective way to achieve good therapeutic effect for long term, many authors have reported more than 95% success rate within 10 years [1]. TKR indication has been extended to patients at lower age, greater body mass index (BMI) and greater activity. These factors must be taken into consideration of the best treatment for patients, thus providing patients with accurate information in the preoperative consultation. Some studies discussed the influence of BMI on postoperative function in TKR, but most of the studies have small number of cases, short follow-up time, and all types of prosthesis, surgical technique and follow-up methods. This study performed a large sample experiment using the same prosthesis installed by the same group of surgeons with the same technique, with aim to determine the influence of BMI on the function of TKR surgery.

SUBJECTS AND METHODS

Design: Retrospective case analysis.

Time and setting: All cases were colleced from Department of Bone and Joint at Peking University People's Hospital.

Participants

A total of 320 patients with osteoarthritis were recruited from Department of Bone and Joint at Peking University People's Hospital, including 64 males and 256 females. They aged 54 to 85 years. Inclusion criteria: Those received follow-up and were informed of the experiment. Exclusion criteria: Those of unrelated death, loss of follow-up and incomplete information. All patients received primary knee patella replacement, of which 200 cases replaced in both knees, totally 520 knees, 219 in left knee and 301 in right knee. The test proposal was approved by the Medical Ethics Committee.

Materials

Prosthesis is Scorpio posterior stabilized knee prosthesis, bone cement fixed. The product was composed of femoral condyle, tibial plateau, tibial pad and patellar components. Tibia pad and patellar components were produced using super-high molecular polyethylene material. Tibia pad was covered with Co-Cr-W-Ni forged alloy wire with image developing role. Sterile packaging. This prosthesis was applied for knee pain and disabling joint disease induced by the following causes: osteoarthritis, rheumatoid arthritis, post-traumatic arthritis; post-traumatic loss of knee function; moderate varus, valgus or deformity. Producer's name: Howmedica Osteonics Corp, agents: Stryker (Beijing) Healthcare Products Co., Ltd.

Technique routes

Preoperative preparation

The preoperative BMI, knee score, function score,

maximal range of flexion and extension of patients in each group were determined; patients accompanied with internal medicine diseases received active treatment. As for hypertension cases controlled below 150/100 mm Hg and diabetic case controlled below 8 mmol/L, insulin was continued to be used during and after replacement to control blood sugar levels.

Replacement method

The replacement was completed in patients under general anesthesia by the same team of surgeons. Operative approach was anterior knee median incision and medial peripatellar approach. Anterior and posterior cruciate ligament was excised in operation. As for varus patients, medial collateral ligament was released, resecting the proximal tibia medial and distal femur medial osteophyte. The posterior joint capsule osteophytes and corpus liberum were cleaned in all patients. Proximal tibial osteotomy was performed perpendicular to the long axis of the tibia and backward 5°-10°. As for the varus and neutral position patients, the knee joint distal femur was subjected into 5° valgus osteotomy. Anterior femoral osteotomy was done at 3° extorsion, and soft tissue release to make flexion-extension gap a symmetry. All patients underwent patellar displacement, patellar thickness was measured before and after replacement. The postoperative patellar thickness was equal to or slightly less than the preoperative patellar thickness (difference 1-3 mm), patellofemoral track was tested after the prosthesis was fix well. The lateral patellar retinaculum was released untile “No thumb Test” appeared. Prostheses were fixed antibiotics vacuum mixing bone cement, incisions were sutured at flexion.

Rehabilitation after replacement

At 3 days after surgery, drainage tubes were removed and patients received rehabilitation treatment by the same physical therapist. Knee continuous passive motion device was initially set as 30°-60°, 1 hour once, twice per day. According to the situation in patients, daily ascending 10°, until the patients were discharged upon suture removal 2 weeks after the replacement. At 4 days after surgery, patients began walking with the help of health care workers or family members. At discharge, all patients can reach 90°-120° of flexion activity. Patients were instructed to continue nursing and rehabilitation training at home after discharge, including walk training and straight leg raising to increase quadriceps muscle strength training and range of passive motion. At 6 weeks and 3 months after surgery, the patients were rechecked in out-patient clinic and were further guided for self-rehabilitation training.

Physical measurements

The heights were measured after taking off shoes, and the body weight was measured by deducting clothes weight, the quality readings were accurate to 0.5 cm and 0.5 kg, respectively. BMI was calculated using the following formula[2]: Body mass index (kg/m^2) = body weight (kg) / height (m)^2. Preoperative measurement of BMI was given once.

Experiment groups

According to the WHO standard[2], normal BMI is 19-25 kg/m^2, mean 22 kg/m^2. According to BMI, the patients were divided into 4 groups, overweight group: BMI 25.1-27.0 kg/m^2, obese group: BMI 27.1-30.0 kg/m^2, morbidly obese group: BMI > 30 kg/m^2, control group: BMI < 25 kg/m^2 (lower body mass < 20 kg/m^2).

Functional assessment

According to the 1989 New York Hospital for Special Surgery (HSS) score, knee score and function score were recorded.

Main outcome measures

At an accuracy of 1° using a protractor, maximal passive knee flexion range of the patients in supine hip flexion position of about 60° was measured and recorded. One end of the protractor was placed on the line between the highest point of the lateral malleolus and the superior mid-point of the tibia, while the other end on the line between the greater trochanter of femur and the femoral condyle. All intraoperative and postoperative complications were recorded. Wound complications and knee deep infection need to carefully identify, by opening skin edge, excessive wound exudate or wound probing debridement [3].

Design, enforcement and evaluation

All authors received formal training and were contributable for this article.

Statistical analysis

The statistical processing was done by the first author using SPSS 10.0 software.

RESULTS

Follow-up visits

Totally 320 patients were involved in the follow-up by out-patient clinic recheck for a range of 12-46 months, average 28.3 months.

Intent-to-treat analysis

The analysis was performed according to the principle of intentionality.

BMI distribution in patients

The BMI distributed in 320 patients was 17.0-35.1 (26.1± 4.5) kg/m^2. Among 320 patients, there were 166 cases (258 knees) as overweight group, 63 patients (131 knees) as obese group, 30 patients (50 knees) as morbidly obese group, 61 patients (81 knees) control group, and 3 patients with low body mass (Figure 1).

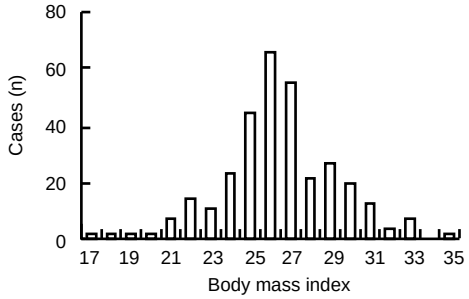

Figure 1 Body mass index distribution in 320 patients following replacement

Knee score, function score, maximal range of flexion and extension in patients before and after TKR (Table 1)

Table 1 Knee score, function score, maximal range of flexion and extension before and after knee replacement ($\bar{x}\pm s$)

Item	Overweight (258 knees)	Obese (131 knees)	Morbidly obese (50 knees)	Control (81 knees)
Preoperative base-line				
Knee score (point)	42.0±5.8	40.8±5.9	38.8±7.7	44.9±6.2
Function score (point)	36.5±6.0	31.7±6.7	30.3±7.6	40.1±5.8
Range of flexion (°)	90±11	88±9	88±10	92±13
Range of extension (°)	4±5	6±5	10±7	5±3
Postoperative				
Knee score (point)	88.9±6.3	89.4±7.1	86.5±6.5	90.5±8.2
Function score (point)	84.9±7.5	85.8±6.9	79.8±8.1	80.9±7.3
Range of flexion (°)	110±11	95±10	90±8	115±12
Range of extension (°)	1±3	1±2	3±3	1±3
Mean 'absolute' improvement				
Knee score (point)	46.6±4.6	49.6±6.2	48.7±7.8	46.6±7.1
Function score (point)	48.4±5.7	54.1±3.2	49.5±4.8	50.8±5.4
Range of flexion (°)	20±9	7±5	2±3	22±8
Range of extension (°)	3±1	5±3	7±3	4±3

Preoperative function scores in overweight, obese, and morbidly obese groups were lower compared with control group ($P < 0.05$), but knee joint score had no significant difference. In the final follow-up, both score and function score of each group were significantly improved, the increment of each group was not significantly different ($P > 0.05$). Although the maximal range of flexion and extension in overweight, obese and morbidly obese groups was smaller than in the control group, the absolute value of the improvement was still equal ($P > 0.05$).

Complications and adverse effects

The perioperative complications were significantly increased in obese group and morbidly obese group ($P < 0.05$). Among 181 knees, 14 (9.2%) had wound complications, 1 (0.5%) had infection, 2 (1.3%) had medial collateral ligament injury. The infection occurred 10 weeks after surgery, and was associated with wound complications; in 258 knees of overweight group, 6 knees (2.3%) had wound complications, no infections or medial ligament injury; the control group had a knee in 81 knees (1%) accompanying wound complications, no infection or medial collateral ligament injury. The difference was significant regarding wound complications in the obese and morbidly obese groups compared with the other two groups ($P < 0.05$), and no perioperative deaths or pulmonary embolism cases were found.

DISCUSSION

BMI closely related to the occurrence of osteoarthritis

Up to 2/3 of the elder people at 65 years of age or older suffer from osteoarthritis and lead to disability of disease. With the aging of the population, the incidence of osteoarthritis rises[4]. Jensen *et al*[5] retrospectively studied 115 osteoarthritis cases underwent TKR, results found that 37% of the patients involve osteoarthritis due to obesity. A lot of evidence demonstrate that the overweight people are prone to knee osteoarthritis, that is the increasing body weight is prior to the occurrence of knee osteoarthritis. Hart *et al*[6] investigated more than 1 000 women, X-ray shows a relationship between osteoarthritis of the knee and the BMI, higher BMI indicates higher incidence of knee osteoarthritis. From the morphology view, Jan[7] described osteoarthritis patients are taller, heavier, with stronger muscle strength, belonging to another population of obese. This experiment showed patients of normal BMI accounted for only 19.1%, overweight patients 80.9%, of which obese patients 29.1%, indicating that general BMI is closely related with the occurrence of osteoarthritis, therefore, the majority of patients candidate for TKR because of osteoarthritis are obesity.

Follow-up time necessary for knee function and motion range

König *et al* [8] observed 276 cases of osteoarthritis underwent TKR because of osteoarthritis. Knee score markedly increased and remained stable levels at 2 years postoperation, while function scores reached a peak at 2 years and then decreased. This is mainly due to function scores are influenced greatly by the walking distance, age, BMI, while knee scores were not subjected to the above-mentioned factors. As for the knee joint flexion range after TKR in the functional rehabilitation, would increase over time in short-term, and has no significant change 1 year later.

The clinical follow-up results of Lizaur *et al*[9] showed significant difference in knee flexion range between postoperation and 3 months, between 3 months and 6 months, between 6 months and 1 year; while no significant difference was observed between 1 year and 2 years, between 2 years and more than 2 years. Malkani *et al*[10] also found no significant difference between 1 year and 10 years. Therefore the maximum flexion range after TKR requires at least 1 year of follow-up.

In this experiment, the patients were followed up for 12 to 46 months, at an average of 28.3 months, which is convincible for the knee score, function score and range of motion.

Postoperative complications in obese patients following TKR

TKR aims at the elderly, the majority of surgical patients implementing TKR in 1985/1990 in the United States were osteoarthritis patients over the age of 65 years[11]. Osteoarthritis causes pain and loss of function, reduces quality of life. Joint replacement is acceptable for those osteoarthritis patients in who pains cannot be relieved and functional activities can not be improved by drugs, and those can obtain satisfactory clinical efficacy. However, obesity has been considered as constraints of TKR, and may increase the perioperative complications, including infection, extended hospital stay, increased venous thrombosis. Overweight patients are advised to discourage for TKR or informed of unsatisfactory replacement results. It has been reported that obese is associated with postoperative prosthesis loosening of replacement and obese increased the chance of reoperation[12-13]. Some studies have shown that

obesity could benefit patients from TKR, even morbidly obese patients[14]. Wound complications do not increase[15-16], and there is no significant difference in the range of motion, knee score, patellofemoral complications between obese and non-obese cases. The confusion and lack of statistical data lead to that many joint surgeons tend to prevent obese patients from TKR[13].

Very different literature reports result from some of the authors may not notice the different activity after TKR. McClung *et al* [17] have evaluated the relationship between BMI and activity levels after joint replacement, results show that a higher BMI indicates lower activity, they less use their joints, which reduces the anticipated prosthesis wear, that is to say the wear is the result of use, not a matter of time. These articles neglected activity in the evaluation of TKR, the prosthetic wear and the postoperative evaluations after TKR should include the impact of obesity on activity.

This test is an observation and a clear result of the follow-up, the preoperative prediction and assessment of postoperative function have been performed in obese patients, to unify understanding of clinical doctors and patients, and to obtain active patients.

BMI unrelated to TKR

Deshmukh *et al*[18] pointed out: Obesity has been considered to have a negative impact on TKR patients, overweight patients may be discouraged from TKR surgery, but body mass never be conclusively proved to influence the surgical results. He conducted a follow-up of 1-12 months among 180 osteoarthritis patients underwent TKR surgery operated by the same doctor. Results concluded that BMI is not a negative effect on TKR. Stickles *et al*[19] studied the relationship between BMI and functional recovery after TKR, after postoperative 1-year follow-up, the linear regression statistical analysis showed that, obese patients similar with other patients, obtained the same functional improvement and satisfaction after TKR, but a larger BMI increased the up-down stairs difficulty at 1 year postoperation. Hawker *et al* [13] conducted a follow-up to in 193 cases of 242 311 patients after TKR surgery for 2-7 years in North America between 1985 and 1989. All subjects, regardless of age, BMI and postoperative time, reported no or less pain, 85.2% of patients were satisfactory on postoperative function. At 2-7 years, all patients reported significant and sustained pain relief and functional improvement. The results proved that age and obesity have no negative impact on functional activities after TKR. Spicer *et al*[20] divided 285 cases underwent TKR for osteoarthritis into two groups according to BMI = 30. There were no significant differences in KSS score, revision rate, 10-year survival rate and linear imaging lucency line between the two groups, only the incidence of focal osteolysis was 5 times higher than normal group at BMI > 40.

The present experiment results showed: The preoperative functional score in obese group was lower than that in control group, but the knee joint score was fair. In the final follow-up, both the knee score and functional score were significantly increased after TKR in overweight, obese, morbidly obese and control groups. The difference of the level of increase was not statistically significant among groups. Although the maximal range of flexion and extension in obese group was smaller than that in control group, it is still one of the most intuitive indicators in patients, but the range of motion accounts for a small proportion of the scores, therefore less affecting HSS score, and the absolute value is equal, so there was no significant difference.

Characteristics of this study

TKR leads to positive and immediate improvements in the quality of life of patients. No matter age, sex, affected side and BMI, a simple BMI has no impact on the functional recovery after TKR. Obese only increases the difficulty in surgical operation and postoperative care in patients, thus requiring a higher technique for surgeons.

This study is unique in that it controls a number of other confounding factors and determined the influence of BMI on TKR function, while other studies failed to do so. Another feature is the stability of TKR quality (the same group of surgeons, the same prosthesis, and the same disease).

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体质量指数对全膝人工关节表面置换后功能的影响☆

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摘要

背景：目前有一些研究考虑到了体质量指数对全膝人工关节表面置换后功能的影响，但是大部分病例数较少，随访时间较短。

目的：观察体质量指数对全膝人工关节表面置换后功能的影响。

方法：选择北京大学人民医院骨关节科收治的骨关节炎患者 320 例，均接受初次膝关节髌骨置换，其中双膝置换 200 例，共 520 个膝关节，左膝置换 219 个，右膝置换 301 个。由同一组医生采用同一种假体(均为 Scorpio 后稳定型膝关节假体)对 320 例患者行全膝人工关节表面置换治疗。按体质量指数分为 4 组(超重组：体质量指数 25.1~27.0 kg/m^2，肥胖组：体质量指数 27.1~30.0 kg/m^2，病理性肥胖组：体质量指数> 30 kg/m^2，对照组：体质量指数< 25 kg/m^2)。按 1989 年美国纽约特种外科医院评分标准(HSS)，记录置换前及随访时膝关节评分和功能评分，以及膝关节最大屈曲度、伸直度数和并发症。

结果与结论：320 例患者均通过门诊复查进行随访，随访时间 12~46 个月，平均 28.3 个月。置换前超重组、肥胖组、病理性肥胖组功能评分较对照组低(P < 0.05)，但关节评分无显著性差异。在最后的随访中发现，无论膝评分和功能评分各组置换后均明显提高，各组提高的幅度无显著性差异(P > 0.05)。肥胖组和病理性肥胖组围置换期并发症明显增高(P < 0.05)，181 膝中有 14 膝(9.2%)合并伤口并发症，1 膝(0.5%)感染，2 膝(1.3%)内侧副韧带损伤，感染发生于置换后 10 周内并与伤口并发症有关；而超重组 258 膝中有 6 膝(2.3%)合并伤口并发症；对照组 81 膝中有 1 膝(1%)合并伤口并发症。围置换期无死亡和肺栓塞病例。提示体质量指数对全膝人工关节表面置换后早期的功能恢复无明显影响。

关键词：体质量指数；全膝人工关节表面置换；功能随访；并发症
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