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Research Article

The Effect of Body Mass Index on Components Size in Patients With Total Knee Replacement

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Abstract

Introduction: Nowadays, one of the most common practices in orthopedic surgery is the Total Knee Arthroplasty. Logistic equipment, including prostheses, is the cornerstone of this surgical procedure. Clearly having a general overview of the size of consumable prostheses, the surgeons will act more confidently.

Materials and Method: This descriptive-analytic study employed a census method based on the inclusion criteria of the medical records of all patients who underwent knee replacement surgery in Besat Hospital of Hamedan in 1395 (2016-17) in terms of body mass index, age, gender, and size of tibial and femoral components. Data were analyzed by SPSS software version 16.

Results: A total of 214 patients were included: 21.5% male and 78.5% female. The mean age of patients was 67.95 years, and the mean body mass index was 27.98 kg/m2. As for the assessment of the size of components, most tibial components were of medium size (49.5%) and femoral components were of small size (65.9%). It was seen that there was an inverse correlation between tibial component and body mass index (BMI), and a direct and significant correlation between tibial component and height and weight in terms age and gender ($p<0.05$). Nevertheless, the correlation between femoral component and weight was statistically significant only at ages under 65 years and it was indirect ($p=0.02$).

Conclusion: Determining factors of the size of components used in joint replacement surgery include body mass index (BMI), weight and height of the patients for tibial surgeries, and weight of the patients for femoral ones.

Keywords: Body mass index (BMI); tibial component; femoral component

Abbreviations: OA: Osteoarthritis; BMI: body mass index; TKA: Total knee arthroplasty

Introduction

Knee joint is one of the main joints of human body which is usually affected by various progressive degenerative and inflammatory diseases, which ultimately lead to the destruction of articular cartilage (arthrodial cartilage) and its dysfunction [1]. Osteoarthritis (OA)is the most common form of knee arthritis that slowly and progressively causes damage to the knee joint and is a major contributor to functional disability [2,3]. The prevalence of osteoarthritis is high among the elderly and women [4]. It is estimated that knees, with prevalence of 41%, are the most frequently affected joints by osteoarthritis among adults [5]. Obesity is the most accelerating cause of this disease. Other important predisposing factors include: old fractures that cause irregularities in articular surfaces; previous illnesses that have damaged the articular surfaces (especially the end stages of rheumatoid arthritis or septic arthritis); previous intra-articular mechanical damage, such as meniscus tear or osteo chondritis dissecan; andtibial dislocation relative to the femur (in long-lasting cases of genu varum or genuvalgum for any reason) [6]. Progression of osteoarthritis causes the destruction of cartilage, bone, and its adjacent soft tissue (ligaments, capsules, tendons, and muscles) which ultimately leads to knee deformity, ligamentous instability or instability [7].

gradually causes various deformities in knee joint and makes it painful while walking. It also disrupts skeletal alignment and increases the risk of Osteo arthritisfalling and fractures. The disease usually affects both limbs and this mutuality can exacerbate functional disorders [8]. Osteoarthritis causes major health and social problems in the elderly and brings a heavy economic burden on the health and social welfare system [9].

Progression of the disease in this weight-bearing joint leads to significant disability and reduced functional capacity in a wide range of daily activities. The main causes of this functional decline in the patients are weakness of the quadriceps muscle, deep-seated perturbation and poor stability [10,11,12].

Common therapies for reducing pain and improving patients' function include lifestyle changes and daily habits, rehab Rehabilitation and medicine therapy [13]. Patients with symptoms of pain, joint instability, reduced range of motion and deformity, and lack of response to conservative treatment need to have a surgery, which may include knee joint replacement. In spite of reducing the patients' pain and improving the quality of their life, this surgery is a costly process with relatively high complications. Therefore, accurate preoperative planning for reducing costs and probable complications is so important for these patients. The planning procedure includes the preparation of medicine, equipment and operating room. Logistic equipment, including prostheses, is the cornerstone of this surgical procedure. Clearly having a general overview of the size of consumable prostheses, the surgeons will act more confidently. Since the results of various studies regarding body mass index, component size and surgical complications are controversial and sufficient studies have not been done in this field, this study aimed to examine the effect of BMI on the size of components used in patients undergoing knee joint replacement surgery.

Method

This descriptive-analytic study examined all patients suffering from severe knee joint osteoarthritis who had came to the orthopedic clinic and after clinical examination, had undergone arthroplasty surgery. The required data for patients' medical records and surgical description were extracted and recorded in the checklist. Preoperative data, including preoperative examinations, lateral and patellar radiographies, and lower limb alignment were documented. Preoperative counseling was done and its information was recorded. In the alignment graph, the angle between the mechanical axis of femur and tibia was measured. The BMI of the patients after recording height and weight was calculated using SPSS software. The patients transferred to the operating room and received anesthetic injections. Their consciuosness was assessed and the size of tibial and femoral component used for them was measured by the the classic anterior midline approach after incising tibia and femur. Finally, the joint replacement was completed using a cement prosthesis (ZIMMER, NEXGEN LPS, WARSAW, US), and the day after surgery, patients were prepared for recovery and discharged with appropriate equipment. The common size of the femoral component used for patients was 8. To facilitate the analysis, the sizes 1 to 3 were classified in the small group, the sizes 4 and 5 in the medium group and the sizes 6 to 8 in the large group. Moreover, body mass index (BMI) was classified in very fat (35≤), fat (34.9-30), normal (24.9-20), and thin (20>), based on the WHO standard categorization. Then, the relationship between BMI and size of measurements was measured using statistical analysis.

The inclusion criteria of the study were all patients with severe knee joint osteoarthritis who were candidates for joint replacement surgery, along with their satisfaction for participation in the study, and exclusion criteria were the incompleteness of the data recorded in the case, the patients' discontent and their unwillingness to co operatation.

Statistical analysis

The collected data were entered into computer and analyzed using SPSS version 16.0 statistical software. Quantitative data were described using mean and standard deviation; qualitative data were described in the form of tables, charts and frequency ratios. In the analytical section, Pearson correlation coefficient (PCC) was used to determine the correlation between quantitative variables and the size of tibial and femoral components; Spearman's correlation coefficient was used to determine the correlation between ranked variables and the size of tibial and femoral components. The significance level in this study was considered as 0.05.

Results

Descriptive data of the 214 patients examined in the study are as follows

In terms of gender, the highest frequency belongs to the female group of 168 (78.5%) and the frequency of male group is 46 (21.5%). In terms of age, mean age of the participants of this study was 67.95 years. The minimum age was 32 years and maximum age was 94 years. The most frequent ages among patients undergoing knee joint replacement surgery was 60 to 69 years (46.26%). As for BMI of the patients undergoing knee joint replacement surgery, the mean body mass index was 27.89 kg/m^2 (range 17.58-44 kg/ m^2; standard deviation 4.49 kg/m^2). The highest frequency was in the overweight group (25-29.9) (Table 1).

Table 1: Frequency of BMI in patients undergoing knee replacement surgery.

Body mass index (BMI)	Number	Percent
Less than 20	2	0.9
20-24.9	54	25.2
25-29.9	96	44.9
30-34.9	51	23.8
Equal to 30 and higher	11	21
Total	214	100

In terms of component size frequency, most tibial components were of medium size (49.5%) and most femoral components were of small size (65.9%). For used tibial components (small-medium-large) classified by various categories of BMI, no statistically significant rank correlation was observed between the size of used tibial component and BMI (P=0.097).

According to the results of one way ANOVA test, a statistically significant difference was observed between the mean BMI and the size of used tibial component (P=0.005). The results of Tukey follow-up test showed that the mean BMI in small component (P=0.006) and in medium component (P=0.013) were significantly more than the mean BMI in large component (Table2).

Table 2: Comparison of mean BMI in terms of the type of used tibial component.

Size	Number	Mean	Standard deviation	Minimum	Maximum	P value
Small	71	28.58	4.68	21.23	42.81	
Medium	106	28.18	4.6	17.58	44	0.005
Large	37	25.77	3.06	21.5	32.61	
Total	214	27.89	4.49	17.58	44	

For used femoral components (small-medium-large) classified by various categories of BMI, no statistically significant rank correlation was observed between the size of used femoral component and BMI (P=0.570) (Table3).

Table 3: Comparison of mean BMI in terms of the type of used femoral component.

Size	Number	Mean	Standard deviation	Minimum	Maximum	P value
Small	141	28.27	4.68	17.58	44	
Medium	12	26.05	2.9	22.47	31.8	0.156
Large	61	27.4	4.22	18.45	39.06	
Total	214	27.89	4.49	17.58	44	

According to the results of one way ANOVA test, no statistically significant difference was observed between the mean BMI and the size of femoral component (P=0.156).

As for the relation between the size of tibial and femoral component and weight in terms of gender and age, a direct and significant was observed between tibial component and weight in terms age and gender (p<0.05). Nevertheless, the correlation between femoral component and weight was statistically significant only at ages under 65 years (p=0.02) (Table 4).

Table 4: Correlation coefficient of the relationship between the size of tibial and femoral component and weight in terms of age and gender.

Component	Variable	R	P. value
Tibia	Male	0.42	0.004
	Female	0.22	0.006
	Under 65 years	0.26	0.01
	Above 65 yeras	0.42	<0.001
Femur	Male	0.24	0.1
	Female	-0.07	0.4
	Under 65 years	-0.24	0.02
	Above 65 yeras	-0.03	0.73

Moreover, for the relation between the size of tibial and femoral component and height in terms of gender and age, a direct and significant was observed between tibial component and heightin terms age and gender (p<0.05). Nevertheless, the correlation between femoral component and height was not statistically significant (p<0.05) (Table 5).

Table 5: Correlation coefficient of the relationship between the size of tibial and femoral component and height in terms of age and gender.

Component	Variable	R	P value
Tibia	Male	0.55	<0.001
	Female	0.37	<0.001
	Under 65 years	0.49	<0.001
	Above 65 years	0.72	<0.001
Femur	Male	-0.18	0.23
	Female	-0.08	0.31
	Under 65 years	-0.06	0.56
	Above 65 years	-0.02	0.81

Discussion

Knee joint is one of the main joints of human body which is usually affected by various progressive degenerative and inflammatory diseases, which ultimately lead to the destruction of articular cartilage (arthrodial cartilage) and its dysfunction [1]. Nowadays, knee joint replacement arthroplasty is a helpful method for the patients with severe knee joint degradation and the elderly

with multiple joint pain and in many cases has had desirable results for up to ten years after the surgery.

In this study, there was no statistically significant difference between mean BMI and the size of femoral component. Also, the correlation between femoral component with height was not statistically significant. There was an inverse correlation between the size of tibial component and BMI and a significant correlation between the size of tibial component and height and weight in terms of gender and age. There was no statistically significant correlation between the size of femoral component and BMI and height, but a significant and direct correlation was observed between the size of the femoral component and weight at the age under 65 years.

According toa study by Sershon et al. about the effect of body mass index on the accuracy of measuring the size of components (templating), there was no significant relation between between body mass index and measuring the size of femur acetabular components [14]. Similarly, this study didn't find any statistically significant relation between body mass index and the size of femoral component. However, there was a statistically significant and direct correlation between the size of the femoral component and weight at the age under 65 years. The results of one-year research of Stickles et al. on patients with knee joint surgery showed that in terms of postoperative satisfaction, there was no difference between the obese and non-obese patients [15].

Another study by Collins et al. in 2012 regarding the effect of obesity on the need for re-surgery and patient's satisfaction after knee replacement, revealed that 9 months after the surgery, obese (BMI>30) and non-obese patients' level of satisfaction was good. There was no need to re-surgery among two groups, however obese patients showed a lower functional performance scores than non-obese patients [16]. Jackson et al. conducted a study in 2009 which followed535 patients for 9 years. The results showed that obese patients had lower functional performance scores than non-obese patients [17]. Two different studies conducted by Nunes et al. examined the effective factors on the final outcome of Total knee arthroplasty (TKA) during 3 years and 7 years follow-up respectively [18,19]. McElroy et al. developed a structured review in 2013 and their patients were followed up for at least 5 years. The results showed that BMI>30 had lower functional performance scores and lower complications and only few of them used partial prosthesis [20]. A study by Isa et al. in 2013 found that obesity had no significant effect on TKA outcomes. In this study, 210 of 174 patients were obese. According to the gained results, obese patients showed more complications than non-obese patients (10.5% vs. 3.8%). In terms of other outcomes, there was no significant difference between the two groups [21].This study, in contrary to the mentioned studies, didn't examine the realtion between patients' body mass index and their postoperative satisfaction. Nevertheless, there was a statistically significant correlation between body mass index and the size of tibial component. The fact that the mean body mass index has an inverse correlation with the size of tibial component but a significant and direct correlation with the height, is probably due to its inverse correlation with the square of the height, that is, the higher the height, the smaller will be the body mass index. However, as mentioned by previous studies, the body mass index not only determines the size of tibial component, it is also a variable predictor of the long-term result of tibia and femur joint replacement surgery. Those with a higher mass body index are more likely to give pressure to the prosthesis and feel more pain and discomfort. In result, they are more likely to have need to re-surgery.

Conclusion

In patients undergoing knee joint replacement surgery, BMI and height don't affect the size of femoral component, but at ages under 65 year, size of this component increases with weigh gain. Size of tibial component has an inverse correlation with the mean body mass index (BMI) and has a direct correlation with height and weight. Moreover, the results of this study showed that the increase in BMI is predominantly due to an increase in body fat mass.

Declarations

Ethics approval and consent to participate

The study was conducted under the auspices of the ethical board of Hamadan University of Medical Sciences and registered with the number IR. 1396.286 in the Research Ethics Committee of the University of Medical Sciences.

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Limitations of the study

This study examines the results of just one health center. It is likely that the patients who have not visited this center would be different from those who participated in the study. It is recommended to conduct a similar study with a larger sample.

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