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Total Knee Arthroplasty with Non-Stemmed Tibial Components among Obese Patients: Clinical and Radiologic Evaluation and Review of Literature

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ABSTRACT

Objective: This study aimed to evaluate the radiologic and clinical outcomes of TKA with non-stemmed tibial components in relation to their body mass index (BMI).
Methods: In this retrospective cohort study, the outcome of TKA with non-stemmed tibial components based on their BMI was evaluated (BMI<30 vs. BMI≥30). The patients' function was assessed using the International Knee Documentation Committee (IKDC) and Lysholm knee questionnaires. Radiologic evaluation for probable signs of loosening was performed using two quantitative scoring systems by Ewald and Bach *et al.* Moreover, we reviewed the current literature on the application of non-stemmed tibial components in obese patients.
Results: Twenty-one patients (two men and 19 women) with BMI≥30 and a mean age of 65.1±9.5 years, and 22 patients (three men and 19 women) with BMI<30 and a mean age of 63.6±8.5 years were studied. The mean follow-up periods with BMI≥30 (47.0±19.8 months) and BMI<30 (49.2±18.7 months) were comparable (p=0.618). No patients in either group experienced clinical loosening. Besides, none of the patients had any kind of revision surgery. The patients in both BMI groups had comparable IKDC scores (both the total score and its sub-scores; p>0.05). Furthermore, the total Lysholm knee scores were similar in both groups (p=0.122). Using both scoring systems, the peri-prosthetic bone radiolucency near the tibial components was similar in both groups (p>0.999).
Conclusion: The present study found no significant difference in the radiologic or clinical outcome of non-stemmed TKA in patients with BMIs under and over 30.

Keywords: Knee prosthesis, Obesity, Aseptic loosening, Lysholm knee score, Body mass index.

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Introduction

Knee osteoarthritis is a rising issue that worsens with age and has a substantial impact on the elderly's quality of life [1]. In the early stages of osteoarthritis, conservative treatments such as anti-inflammatory medicines and exercises are used. Total knee arthroplasty (TKA) is the preferred treatment for the advanced stages with severely painful joints [2, 3]. The prevalence of obesity is growing all over the world. Obesity increases not only the risk of developing knee osteoarthritis but also the complication rate of TKA surgery [4, 5]. It was shown that TKA complications such as periprosthetic infections and aseptic loosening were correlated with obesity [6]. To lessen the possibility of aseptic loosening, surgeons have traditionally preferred to apply stemmed tibial components to obese patients. Stemmed tibial components have a longer lever arm, which may increase the stiffness and stability of the component within the tibial bone [7]. Recent studies, however, have shown conflicting findings on the effectiveness of stemmed components versus non-stemmed ones. The stemmed components have several drawbacks, such as higher costs and more post-operative leg pain [8, 9]. On the other hand, in some centers such as ours, the stemmed components are not always available, and if so, they are not covered by insurance companies. The purpose of this study was to share our experience in applying non-stemmed tibial components for TKA in obese patients.

Materials and Methods

In this retrospective cohort study, the patients who underwent primary total knee arthroplasty in Chamran hospital of Shiraz, Iranfrom 2014 to 2020 were investigated. Using the patients' weight and height from their medical data, the BMI was estimated. The cut-off value of BMI≥30 was chosen to compare the outcome, since it has previously been investigated in relevant studies. The patients' baseline characteristics, as well as their medical information, were obtained. The participants had to have had surgery at least two years before the study. All patients were given ten identical sessions of post-operative physiotherapy exercises. All the patients who underwent surgery with non-stem tibial components were included in the study, and those with long-stem tibial components were excluded. In addition, individuals with concomitant neuromuscular diseases, previous history of lower extremity injury, or unreachable patients for follow-up were excluded from the study. The study protocol was reviewed and approved by the local committee. This study protocol was approved by the local Ethics Committee of AJA University of Medical Sciences, Tehran, Iran.

The patients were evaluated clinically utilizing the International Knee Documentation Committee (IKDC) and Lysholm knee questionnaires [10]. The IKDC and Lysholm questionnaires are two standard scoring systems used to evaluate the pain and function of individuals with knee diseases. Standard standing anteroposterior and lateral X-rays were taken. Ewald's [11] and Bach *et al.* [12] scoring systems were used to evaluate radiologic images for probable signs of loosening. The radiographic evaluation system of the knee society, originally introduced by Ewald, reported the sum of the width (in millimeters) of the radiolucent lines in each predefined zone in anteroposterior and lateral radiographs as a continuous variable (Figure 1).

We used its modified version provided by Bach *et al.,* in which the width of each radiolucent line in the medial, lateral, anterior, or posterior aspects of the tibial component was increased; regardless of its location contrary to the Ewald scoring system that defined specific zones. Then, it was classified into one of these three categories: no radiolucent line, <4 mm, or ≥4 mm wide radiolucent line (discrete variable).

Statistical Analysis

The data were analyzed using SPSS software, version 21.0 (SPSS Inc., Chicago, IL, USA) and expressed as mean±SD (standard deviation), and

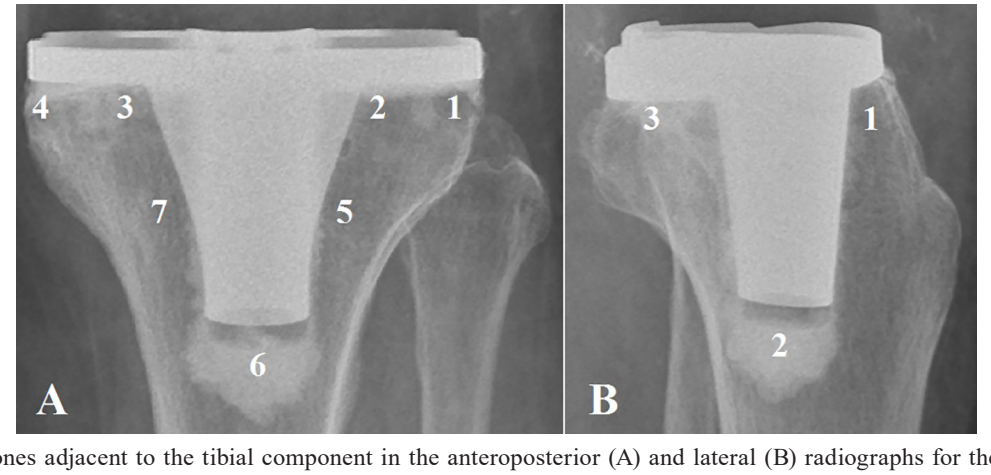

Fig. 1. The zones adjacent to the tibial component in the anteroposterior (A) and lateral (B) radiographs for the knee society radiographic evaluation system.

frequency (percentage). Statistical analyses between the patients with different BMI were performed using Mann-Whitney, Independent samples T-test, and Chi-square tests. A *p*-value of <0.05 was considered statistically significant.

Results

As shown in Table 1, 21 patients (two men and 19 women) with a BMI over 30 with a mean age of 65.1±9.5 years were evaluated. Obese class I (30≤BMI<35) was assigned to 19 (90.5%) patients with BMI more than or equal to 30, obese class II (35≤BMI<40) was assigned to one (4.8%) patient, and obese class III (BMI≥40) was assigned to one (4.8%) patient. The control group consisted of 22 patients (three men and 19 women) with a BMI less than 30 and a mean age of 63.6±8.5 years. Six (27.3%) of the patients with a BMI<30 were classified as normal, and 16 (72.7%) as overweight. Each group included nine right-side operated knees. Both groups with BMI over 30 (47.0±19.8 months) and under 30 (49.2±18.7 months) had a comparable mean of follow-up times (p=0.618). Two patients in each group smoked cigarettes. The prevalence of comorbidities in each group did not differ significantly.

Table 2 compares the clinical and radiologic outcomes in each BMI group. None of the participants in both group experienced clinical loosening. In addition, none of the patients had any kind of revision surgery. The patients in both BMI groups had similar IKDC scores (the total score and its sub-scores), and there was no statistically significant difference between them. As shown in Table 2, the total Lysholm knee scores were similar in both groups (p=0.122). Besides, using two quantitative methods of Ewald and Bach *et al.,* the peri-prosthetic bone radiolucency near the tibial components was comparable in both groups (p>0.999).

Discussion

The present study aimed to compare the clinical and radiologic outcomes of non-stemmed TKA prostheses in obese patients. According to the findings of the present study, there was no significant difference in the outcomes of the patients with a BMI under 30 and those above 30. For complex TKA cases, such as those with compromised proximal tibia as a result of revision surgery, stemmed tibial components are taken into consideration. Besides, they are applied in individuals who are obese or osteopenic patients, as well as patients with severe coronal plane deformities [13]. It was reported that stemmed components enhanced prosthesis stability and relieved the stress on the proximal area of the tibial bone and the cement-prosthesis interface [7, 14]. However, some disadvantages of stemmed tibial components were reported. A long-stemmed prosthesis increases the amount of stress shielding, which accelerates proximal tibial bone osteoporosis, and probably causes a peri-prosthetic fracture. Moreover, some individuals had pain from the stem tip [15]. According to Secrist et al., patients with a posterior offset of the proximal tibial bone might have limited usage of stemmed tibial components, since they impinged on the posterior wall of the tibia [16]. Impingement of the tibial stem component might result in baseplate malposition, cement mantle reduction, or perioperative fracture [16].

A previous study that evaluated the outcome of TKA in obese patients with non-stemmed tibial components reported different results (Table 3). According to several investigations, the application of stemmed tibial components reduced the rate of aseptic loosening in obese patients. Based on an RCT by Elzohairy *et al.* and a retrospective cohort study by Samy *et al.,* obese patients had impaired function [17, 18]. Although Fournier *et al.*

Table 1. Baseline characteristics of the patients who had undergone total knee arthroplasty based on their body mass index

Variable	Value		*p*-value
	BMI<30 N=22	BMI≥30 N=21	
Age, mean±SD†	63.6±8.5	65.1±9.5	0.643
Sex, n (%)ǂ			
Men	3 (13.6)	2 (9.5)	>0.999
Women	19 (86.4)	19 (90.5)	
Side, n (%)ǂ			
Right	9 (40.9)	9 (42.9)	0.897
Left	13 (59.1)	12 (57.1)	
Follow-up length†	49.2 (18.7)	47.0 (19.8)	0.618
Cigarette smoker, n (%)ǂ	2 (9.1)	2 (9.5)	>0.999
Comorbidity, n (%)ǂ			
Hypertension	8 (36.4)	12 (57.1)	0.172
Diabetes mellitus	4 (18.2)	6 (28.6)	0.420
Cardiovascular diseases	6 (27.3)	3 (14.3)	0.457
Rheumatic arthritis	1 (4.5)	3 (14.3)	0.345
Hypothyroidism	2 (9.1)	0 (0)	0.488

SD: Standard deviation; BMI: Body Mass Index; †Mann-Whitney test; ‡Independent samples T-test; ǂChi-square test

Table 2. Comparison of the clinical and radiological measurements of the patients, who had undergone total knee arthroplasty based on their body mass index

Variable	Value		*p*-value
	BMI<30 N=22	BMI≥30 N=21	
Clinical Assessment, mean±SD			
IKDC score			
Symptoms†	28.5±7.1	31.2±6.5	0.163
Sports Activities‡	20.9±6.8	23.9±8.4	0.279
Function‡	12.0±2.9	12.2±4.2	0.065
Total‡	61.4±11.7	67.3±15.2	0.389
Lysholm knee score			
Limp†	4.4±1.0	4.2±1.3	0.835
Using cane or crutches†	4.3±1.3	3.9±1.5	0.278
Locking †	14.5±1.5	14.1±2.4	0.570
Giving way†	24.5±1.5	23.6±2.8	0.185
pain†	20.0±3.8	21.4±3.9	0.212
Swelling†	7.3±3.3	8.1±3.4	0.242
Climbing†	5.2±3.3	6.6±3.6	0.190
Squatting†	2.3±1.8	2.9±2.1	0.382
Total‡	82.5±9.3	84.7±12.4	0.122
VAS pain score†	1.3±1.0	1.0±1.1	0.300
Radiologic Assessment, n (%)			
Ewald scoring system‡			
≤4 mm	18 (81.8)	17 (81)	>0.999
4–9 mm	4 (18.2)	4 (19)	
>10	0 (0)	0 (0)	
Bach et al. scoring system‡			
None	3 (13.6)	4 (19.0)	>0.999
≤4 mm	15 (68.2)	14 (66.7)	
>4 mm	4 (18.2)	3 (14.3)	

SD: standard deviation; BMI: Body Mass Index; IKDC: International Knee Documentation Committee; VAS: Visual Analogue Scale; †Mann-Whitney test; ‡Independent samples T-test; ǂChi-square test

found similar functional outcomes in both types of prostheses, the rate of aseptic loosening was higher in non-stemmed ones [17]. The three mentioned investigations applied the Knee society score (KSS) for functional assessment. A relevant large cohort study by Hinman *et al.* examined the incidence of aseptic loosening among 111,937 patients [18]. Patients with non-stemmed and long-stem BMIs were matched, rather than just obese patients. The BMI mean for non-stemmed and stemmed groups were 33.3±5.8 and 33.4±6.8, respectively. They found that long-stemmed tibial components had a decreased rate of aseptic loosening. Other studies, however, found no significant difference in aseptic loosening between non-stemmed and stemmed prostheses. In two RCT studies, non-stemmed TKA outcomes of 134 and 60 obese patients (BMI>30) and long-stemmed TKA control groups were compared. Mohammad *et al.* found no statistically significant difference in the function or radiology [8]. Furthermore, Parratte *et al.* found no significant difference in pain, function, or quality of life [19]. In a prospective cohort study on 28 patients with BMI over 35, who underwent non-stemmed prosthetic surgery, good functional, clinical, and radiological outcomes were observed [20]. Steere *et al.* conducted a retrospective cohort study and evaluated radiologic outcomes in at least two years post-operative X-rays and compared non-stemmed and stemmed prostheses on morbidly obese patients [9]. In both prostheses, the presence of radiolucent lines was comparable using two radiologic scoring systems. Longawa *et al.* retrospectively studied 534 patients with BMI greater than 35 that were operated on with non-stemmed tibial components and observed no aseptic loosening [21].

We found no evidence of an increased rate of aseptic loosening in obese patients treated with non-stemmed prostheses. To strengthen the reliability of the findings of the present study, we used two standard radiologic scoring systems to detect occult signs of loosening beside the patients' clinical outcomes. Besides, the length of the follow-up period to measure loosening was sufficient (an average of four years). The small sample size, however, might have an impact on the findings, and further investigations with a larger study population could explain any small discrepancies.

The present study found no significant difference in the radiologic or clinical outcomes of non-stemmed TKA in patients with BMI under and over 30. Thus, we prefered to use non-stemmed tibial components for TKA in obese patients.

Table 3. The previous studies evaluated the outcome of total knee arthroplasty using a non-stemmed tibial component in obese patients

Author (year)	Methodology	Number of non-stemmed	BMI, kg/m²	Age, mean, years	Sex (M:F)	Number of long-stemmed	Outcome assessment method	Outcome
Parratte *et al.* (2016) [19]	RCT	60	>30	68 (9)	68:52	60	NKSS, KOOS, VAS, SF-36	NS
Angers-Goulet M *et al.* (2017) [20]	Prospective cohort	28	≥35	65.2	45:46	-	KSS, KSRESS	good functional, clinical, and radiological outcomes
Steere JT *et al.* (2018) [9]	Retrospective cohort	128	≥35	62 (8.7)	102:79	50	KSRESS, PBS	NS
Fournier G *et al.* (2020) [17]	Retrospective cohort	105	>30	69.5 (7.3)	85:20	35	KSS	Similar function but a higher rate of aseptic loosening in non-stemmed prosthesis
Samy AM *et al.* (2020) [22]	Retrospective cohort	92	>30	65.2 (5)	34:48	99	KSS, KSFS	higher functional outcome in stemmed prosthesis
Elzohairy MM *et al.* (2020) [23]	RCT	88	≥35	55.69 (8.45)	52:36	92	KSS, KSRESS	higher functional outcome of stemmed prosthesis
Longawa, L *et al.* (2020) [21]	Retrospective cohort	534	>35	67.8	28:72	-	Aseptic loosening occurrence	No aseptic loosening happened
Garceau, SP *et al.* (2022) [24]	Retrospective cohort	850	>35	64.7	57.4:42.6	500	Aseptic loosening occurrence	Earlier aseptic loosening occurrence in non-stemmed prosthesis
Mohammad MM *et al.* (2022) [8]	RCT	134	≥30	57 (4)	46:88	130	KSS, KSRESS, and its modified version	NS
Present study	Retrospective cohort	21	≥30	65.1 (9.5)	2:19	-	IKDC, Lysholm, KSRESS, and its modified version	NS

M: F: male to female ratio; RCT: randomized controlled trial; VAS: visual analog pain score; SF-36: Quality of life questionnaire; KSS: Knee Society Scores; KSFS: Knee Society functional scores; NS: no significant difference between the outcome of Total knee arthroplasty using non-stemmed and stemmed tibial component; KOOS: Knee Injury and Osteoarthritis Outcome Score; KSRESS: Knee Society Roentgenographic Evaluation and Scoring System; PBS: percentage based score; IKDC: International Knee Documentation Committee

Declaration

Ethics approval and consent to participate: The study protocol was approved by the ethics committee of AJA University of Medical Sciences (IR.AJAMED.REC97001800). Besides, written informed consent was obtained from all participants.

Consent for publication: All the authors gave their consent for the publication.

Conflict of Interest: None declared.

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Authors' Contribution: AA: statistical analysis, interpretation of results, preparing draft**;** EF: study concept, study design, revision of the manuscript; SAH: data gathering, interpretation of data, revision of the manuscript**;** MT: data gathering, interpretation of data, revision of the manuscript**;** BPT: data gathering, data analysis, preparation of the manuscript**;** SS: data gathering, interpretation of results, preparation of the manuscript

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