ORIGINAL RESEARCH PAPER | Volume - 11 | Issue - 01 | January - 2022 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

THE IMPACT OF BODY MASS INDEX ON FUNCTIONAL OUTCOME OF TOTAL KNEE ARTHROPLASTY: A PROSPECTIVE OBSERVATIONAL STUDY.

Orthopaedics

Dr. Sukanya Palit* Department of Anatomy Calcutta National Medical College And Hospital Kolkata 700020 West Bengal, India. *Corresponding Author

Dr. Kaushik Banerjee Department of Orthopaedics R. G. Kar Medical College And Hospital Kolkata 700020 West Bengal, India.

Dr. Avijit Hazra Department of Pharmacology Institute of Postgraduate Medical Education & Research Kolkata 700020 West Bengal, India.

ABSTRACT

BACKGROUND: Increasing body mass index (BMI) is a risk factor for severe osteoarthritic knees requiring total knee arthroplasty (TKA). We evaluated the impact of BMI on functional outcomes in TKA by comparing the improvement in knee function and quality of life after TKA in non-obese versus obese patients.

METHODS: We studied 396 patients (contributing 709 knees with Kellgren-Lawrence grade 4 osteoarthritic changes) undergoing TKA in a tertiary care hospital in eastern India; 83 were unilateral and 626 were bilateral cases. Patients were grouped into two cohorts based on BMI – non-obese cohort (BMI < 25 or 25 – 29.9 kg/m^2) and obese cohort (BMI 30.0 – 34.9, 35.0 – 39.9, or ≥ 40 kg/m^2). Hip-knee-ankle (HKA) angle was measured in all patients, and functional outcome evaluation was done by Knee Society Score (KSS), Knee Society Pain Score (KSS-P), Oxford Knee Score (OKS), Lower Extremity Functional Scale (LEFS), and Public Health Questionnaire-9 (PHQ-9). Assessments were done at baseline, 6 months and then annually for 3 years. Statistical analysis was done using Mann-Whitney U test for comparison of outcome of TKA between the two cohorts; Freidman's ANOVA, for comparison of changes within groups; p value for significance was indicated at p<0.05.

RESULTS: There was improvement in functional outcomes after TKA in both obese (170 patients, 306 knees) and non-obese (226 patients, 403 knees) cohorts. However, significant differences in functional outcome were found, in favor of the non-obese cohort ($p < 0.001$ for KSS, KSS-P, OKS, LEFS and PHQ-9 at all assessments), indicating faster improvement. HKA angle after TKA was also significantly better in non-obese than in obese patients ($p = 0.023$).

CONCLUSION: Higher BMI has a negative impact on the functional outcomes of TKA. Counseling and motivating obese patients for weight-loss prior to TKA can improve functional outcomes. The use of long-stem tibial implants for primary TKA can also be considered in obese knees to improve outcomes in such patients.

KEYWORDS

body mass index, obesity, total knee arthroplasty, functional outcome

BACKGROUND:

Increasing Body Mass Index [BMI] and obesity is a global problem, associated with osteoarthritis, which causes knee pain & deformity, with gait problems. Total knee arthroplasty [TKA] is the most successful intervention in knee osteoarthritis to provide a painless stable knee with desired range of motion (ROM) that enables a normal lifestyle after surgery [1].

Obesity is defined according to the BMI; patients with BMI of 30 kg/m^2 or more are considered obese.[2]. Obese patients often report at an earlier age for TKA, due to unacceptable knee pain or immobility, than their non-obese counterparts.[3]. Multiple studies have reported poorer outcomes and higher failure rates of TKA in obese patients, with increased rates of postoperative complications,[4]; few have reported no difference in outcomes of TKA between the two groups ,[5]. Higher BMI is associated with diabetes, hypertension, ischemic heart disease, that impair quality of life, causing poorer TKA outcomes.[6].

Increased BMI causes excessive joint overloading in obese knees, early damage of articular cartilage, leading to distortion of joint biomechanics [7]. Dyslipidemia associated with obese patients may release pro-inflammatory adipokines and cytokines, which enhances cartilage destruction,[8,9]; for which obese patients are advised weight loss prior to TKA, to improve the outcomes thereafter.

As there are no studies that have looked at the effect of higher BMI on the outcomes of TKA in Indian patients, we conducted a prospective observational study to assess the impact of BMI on functional outcome in TKA for advanced knee osteoarthritis, in terms of joint pain, stability, ROM and physical activity, together with patient satisfaction and quality of life after TKA.

MATERIALS AND METHODS:

The study was a collaborative effort of three centers, although patient recruitment and the operative intervention and follow-up was carried out at a single tertiary care hospital over a period of 4 years. Institutional ethics committee approval was obtained beforehand, and all patients included in the study provided written informed consent after being appraised of study purpose, risks and benefits, in a language which they could comprehend.

Patients recruited were of either sex, in the age group 45-85 years, with severe osteoarthritic varus or valgus knees (Kellgren-Lawrence Grade 4 osteoarthritic changes),[10], with or without fixed flexion deformity. These patients attended the Orthopedics out-patient department (OPD), with knee pain, joint deformities, antalgic waddling gait and often with walking aids. Patients with rheumatoid arthritis, Charcot's joints, severe kyphoscoliosis, or critical comorbidities likely to interfere with scheduled follow-up were excluded.

BMI was calculated in kg/m^2 after measuring height with a stadiometer and weight with a digital weighing scale. Following the classification proposed by World Health Organization (WHO), [2] patients were categorized into non-obese (BMI < 25 or 25 – 29.9 kg/m^2) and obese (BMI 30.0 – 34.9, 35.0 – 39.9, or ≥ 40 kg/m^2) cohorts.

Standing long-leg films/ orthoscanograms of patients undergoing TKA were used for measuring Hip-Knee-Ankle (HKA) angle, both preoperatively and postoperatively (**Figure: 1**). All measurements of HKA Angle were done on these digital radiographs, using angle tools, as per standard protocol,[11]. The HKA Angle is the angle measured between the mechanical axis of the femur (a line joining the center of the femoral head with the center of the femoral intercondylar notch) and the mechanical axis of the tibia (a line joining the tibial interspinous point with the center of the tibial plafond) in weight-bearing long-leg films. A deviation of ± 3 degrees in the HKA angle was considered normal. Bone mineral density scans by dual energy X-ray absorptiometry (DEXA) of the lower lumbar spine and dual femur were done in patients suspected to have osteopenia or low bone mass. ROM in the affected knee was measured by goniometer and walking aids were noted. Patients underwent a thorough preanesthetic check-up during which the status of their chronic ailments (like hypertension, diabetes mellitus, hyperthyroidism, dyslipidemia, ischemic heart disease) was recorded.

Patients underwent TKA under spinal anesthesia with femoral nerve block. All operations were carried out by the same surgical team, using a midline medial para-patellar approach with ligament balancing and gap balancing techniques. Medial release for varus knees, lateral release for valgus knees, posterior capsular release for fixed flexion deformity were done with patellar resurfacing. Surgery was performed using tourniquet; a standard implant was used (DePuy, PFC Sigma, Johnson & Johnson), which was posterior stabilized, cemented, cruciate sacrificing and fixed bearing type. Antibiotics and low molecular weight heparin / warfarin were administered postoperatively to minimize the risk of infection and thromboembolism. Patients were usually discharged after 5 days for unilateral TKA or 10 days for bilateral TKA, and were free to report for follow-up whenever required. For study purpose, they were followed up post-operatively at 6 months, 1 year, 2 years and 3 years. However, the 3-year follow up data is not available for all subjects.

Functional and quality of life outcomes were assessed through Knee Society Score (KSS), [12], Knee Society Pain Score (KSS-P), [12], Oxford Knee Score (OKS),[13], Lower Extremity Functional Scale (LEFS),[14] and Public Health Questionnaire-9 (PHQ-9),[15]. The KSS is a 200-point scoring system, comprising 100 points for a function score (KSFS) and 100 points for a knee score (KSKS). Pain was assessed with KSS-P score, with 50 points; here 0 indicates severe/constant pain, while 50 indicates a painless joint. The original version of OKS has been used here, comprising 12 questions, each scored from 1 to 5, making a maximum total score of 60; here 12 is taken as the best outcome and 60 is the worst. LEFS used is a 20-point scale related to knee function, with 4 points each; a painful knee needing TKA would score 9-10, whereas a painless knee after TKA would score close to 80 [lower score indicates greater disability]. Regarding PHQ-9 Scoring, 1-4 indicates minimal depression, 5-9 indicates mild depression, 10-14 indicates moderate depression, 15-19 indicates moderately severe depression, 20-27 indicates severe depression. The scoring assessments were done at baseline [pre-operatively] and at all scheduled follow-up visits [post-operatively] by a single rater with the use of assistants when required.

All patients undergoing TKA were counseled pre-operatively for pain management and weight loss; and post-operatively for active lifestyle changes after surgery (for implant survival), and also for compliance with physiotherapy & rehabilitation (for early mobilization after TKA). Most patients suffer latent depression due to chronic knee pain, fixed flexion deformities and walking disabilities, which are detrimental to normal lifestyle. Quality of life before and after TKA was assessed with PHQ-9 score, which also reflects patients' compliance to physiotherapy, for recovery after TKA.

Sampling in the present study was purposive in nature. All patients attending the TKA clinic in the orthopedic outpatient were recruited if they consented to be in the study. The recruitment period extended over 2 years, while the postoperative follow-up was for 2-3 years. Sample size for the study was calculated based on the proportion of operated knees likely to achieve satisfactory outcome with respect to all anatomical and functional parameters evaluated. Conservatively assuming this to be 50% and an indefinitely large target population, the sample size was estimated to be 600 knees, keeping 4% margin of error and 95% confidence level. Allowing 15% margin for dropouts, the recruitment target was 706 knees. Sample size calculation was done using Raosoft sample size calculator (http:// www. raosoft. com/ sample size.html).

Statistical analysis was done using MedCalc version 15.8 [Mariakerke, Belgium:

MedCalc Software bvba; 2015] software. Sample characteristics have been summarized as mean and standard deviation (SD), when normally distributed, or as median and interquartile range (IQR), when skewed; 95% confidence interval (CI) values have been presented where relevant. Normality of data distribution was assessed by Kolmogorov- Smirnov goodness-of-fit test. Age and weight were compared between groups by Student's independent samples t test. HKA angle and functional outcome variables were skewed and were compared between non-obese and obese groups by Mann-Whitney-U test. Comparison over time within a group was done by Friedman's analysis of variance (ANOVA). HKA angle change from preoperative to postoperative state was assessed for statistical significance by Wilcoxon's matched pairs signed rank test. Cut-off for statistical significance was taken as $p < 0.05$.

Ethical Considerations:

Ethics Committee Approval document was obtained from all three hospitals before commencement of the study. All patients were informed before participation in the study and a written informed consent document form, pertaining to ICMR [Indian Council Of Medical Research] Guidelines, was taken from all patients included in the study.

The questainnaires used were in form of scoring systems KSS, OKS, KSS-P, LEFS, PHQ-9; the patients were explained about the purpose of interview, that their participation was voluntary, they would be informed about the benefits of the study and they could withdraw from the study at any point of time they wanted. They were assured of the confidentiality of data, and all radiological investigations were done in the hospital with their prior consent, with full permission of the hospital ethics approval board.

RESULTS:

Over the study period, 420 patients (contributing 737 knees) consented to be part of the study, although 16 patients (contributing 28 knees) were lost to follow-up, resulting in 709 evaluable knees from 396 patients – 83 unilateral and 313 bilateral cases.

The non-obese cohort (BMI < 30 kg/m^2) comprised 226 patients with 403 knees and the obese cohort (BMI ≥ 30 kg/m^2) had 170 patients with 306 knees. All patients were followed up for 2 years post-operatively, but 3-year follow-up data is available for 232 knees (57.57%) from non-obese cases and 172 knees (56.21%) from obese cases.

The male-female ratio was 63 : 340 (84.37% females) in the non-obese cohort and 37 : 269 (87.91% females) in the obese cohort ($p = 0.179$). Age was 66.5 ± 6.73 years (mean ± SD) and 63.8 ± 6.42 years ($p < 0.01$) and weight was 62.9 ± 8.68 kg and 77.4 ± 9.70 kg ($p < 0.001$), in the non-obese and obese cohorts, respectively. Thus the two cohorts were fairly balanced with respected to age and gender but, as expected, showed marked difference in mean weight amounting to 14.42 kg (95% CI 13.06 to 15.78 kg).

Of the 709 knees undergoing TKA, 682 knees were with varus deformity and 27 knees were valgus. Of these 682 varus knees, 385 were in the non-obese cohort and 297 were in the obese cohort. **Table :1** presents a comparison of the HKA angles in varus knees in the two cohorts. Thus there is a distinction between the two groups in terms of their anatomical outcome following surgery, with the correction being marginally better in the non-obese group.

Table:1. Comparison of Hip-Knee-Ankle (HKA) angle between non-obese and obese cases undergoing total knee arthroplasty

HKA angle (degrees)	**Non-obese group (n = 385 knees)**	**Obese group (n = 297 knees)**	***p* value**
Preoperative Range Median (IQR)	– 45.2 to – 1.6 – 14.7 (– 18.3 to – 11.1)	– 46.6 to – 1.2 – 14.6 (– 18.8 to – 11.1)	0.884
Postoperative Range Median (IQR)	– 17.2 to + 12.75 – 6.5 (– 9.1 to – 4.6)	– 18.8 to + 4.3 – 7.0 (– 9.6 to – 5.0)	0.029
Change in HKA angle Range Median (IQR)	– 38.7 to + 13.3 – 7.8 (– 11.3 to – 4.7)	– 28.6 to + 8.0 – 7.0 (– 11.5 to – 3.7)	0.109

- Abbreviations: IQR = Interquartile range
- Change from pre-operative to post-operative state is statistically significant ($p < 0.001$ by Wilcoxon's matched pairs signed rank test) in both groups.
- p value in the last column is from intergroup comparison by Mann-Whitney U test.

Comparison of functional outcome scores (KSS, KSS-P, OKS, LEFS, PHQ-9) over time in the two groups is depicted in **Table: 2**.

Table: 2. Changes in functional outcome scores over the 3-year study period compared between non-obese and obese cases undergoing total knee arthroplasty

Functional outcome	Non-obese group (n = 403 knees)	Obese group (n = 306 knees)	*p* value
Knee Society Score			
Baseline	69.00 (60.00 to 80.00)	68.00 (57.00 to 81.00)	0.981
6 months	110.00 (100.00 to 120.00)	100.00 (90.00 to 100.00)	< 0.001
1 year	130.00 (120.00 to 150.00)	110.00 (110.00 to 120.00)	< 0.001
2 years	150.00 (130.00 to 170.00)	120.00 (120.00 to 130.00)	< 0.001
Study end (3 year)	160.00 (130.00 to 180.00)	130.00 (120.00 to 130.00)	< 0.001
Within group *p* value	< 0.001	< 0.001	
Change at 6 months	43.00 (32.00 to 55.00)	30.00 (22.00 to 41.00)	< 0.001
Change at 1 year	65.00 (50.00 to 76.00)	44.50 (36.00 to 57.00)	< 0.001
Change at 2 years	83.00 (63.00 to 97.00)	57.00 (47.00 to 69.00)	< 0.001
Change at study end	94.50 (70.00 to 107.00)	64.00 (54.00 to 75.50)	< 0.001
Knee Society Pain Score			
Baseline	10.00 (10.00 to 10.00)	10.00 (10.00 to 10.00)	0.910
6 months	45.00 (30.00 to 50.00)	45.00 (30.00 to 45.00)	< 0.001
1 year	45.00 (30.00 to 50.00)	45.00 (30.00 to 45.00)	< 0.001
2 years	45.00 (30.00 to 50.00)	45.00 (30.00 to 45.00)	< 0.001
Study end (3 year)	45.00 (30.00 to 50.00)	40.00 (30.00 to 45.00)	< 0.001
Within group *p* value	< 0.001	< 0.001	
Change at 6 months	35.00 (20.00 to 40.00)	35.00 (20.00 to 35.00)	< 0.001
Change at 1 year	35.00 (20.00 to 40.00)	35.00 (20.00 to 35.00)	< 0.001
Change at 2 years	35.00 (20.00 to 40.00)	35.00 (20.00 to 35.00)	< 0.001
Change at study end	35.00 (20.00 to 40.00)	30.00 (20.00 to 35.00)	< 0.001
Oxford Knee Score			
Baseline	54.00 (53.00 to 56.00)	55.00 (53.00 to 56.00)	0.025
6 months	26.00 (24.00 to 28.00)	28.00 (26.00 to 28.00)	< 0.001
1 year	22.00 (22.00 to 24.00)	24.00 (24.00 to 26.00)	< 0.001
2 years	18.00 (18.00 to 20.00)	22.00 (20.00 to 22.00)	< 0.001
Study end (3 year)	18.00 (16.00 to 20.00)	20.00 (20.00 to 22.00)	< 0.001
Within group *p* value	< 0.001	< 0.001	
Change at 6 months	-28.00 (–30.00 to –27.00)	–27.00 (–29.00 to –26.00)	< 0.001
Change at 1 year	-32.00 (–34.00 to –30.00)	–30.00 (–32.00 to –28.00)	< 0.001
Change at 2 years	-35.00 (–37.00 to –34.00)	–33.00 (–35.00 to –32.00)	< 0.001
Change at study end	-36.00 (–38.00 to –34.00)	–34.00 (–36.00 to –32.00)	< 0.001
LEFS			
Baseline	18.00 (14.00 to 21.00)	16.00 (14.00 to 20.00)	0.032
6 months	50.00 (48.00 to 54.00)	46.00 (44.00 to 48.00)	< 0.001
1 year	54.00 (50.00 to 56.00)	50.00 (48.00 to 50.00)	< 0.001
2 years	58.00 (54.00 to 60.00)	52.00 (52.00 to 54.00)	< 0.001
Study end (3 year)	60.00 (56.00 to 62.00)	54.00 (52.00 to 56.00)	< 0.001
Within group *p* value	< 0.001	< 0.001	
Change at 6 months	33.00 (30.00 to 36.00)	29.00 (27.00 to 32.00)	< 0.001
Change at 1 year	37.00 (34.00 to 39.00)	33.00 (30.00 to 36.00)	< 0.001
Change at 2 years	40.00 (37.00 to 42.00)	37.00 (33.00 to 39.00)	< 0.001
Change at study end	42.00 (39.00 to 44.00)	37.00 (35.00 to 40.00)	< 0.001
PHQ-9			
Baseline	5.00 (5.00 to 5.00)	6.00 (6.00 to 6.00)	< 0.001
Study end (3 year)	0.00 (0.00 to 2.00)	2.00 (2.00 to 4.00)	< 0.001
Within group *p* value	< 0.001	< 0.001	
Change at study end	5.00 (3.00 to 5.00)	4.00 (2.00 to 4.00)	< 0.001

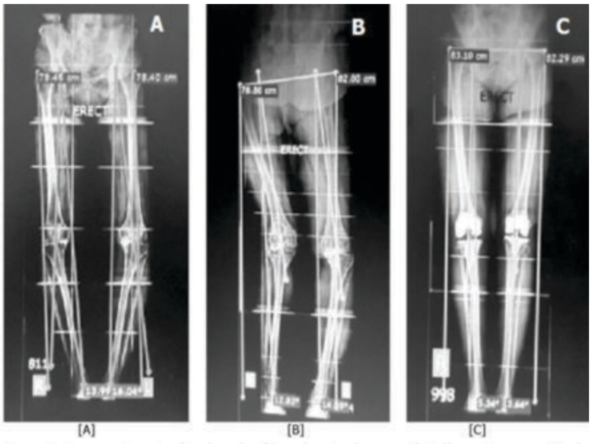

Figure 1. Preoperative standing long leg films showing knees with Kellgren-Lawrence Grade 4 osteoarthritic changes and varus or valgus deformities [A], [B], to be corrected by total knee arthroplasty and post-operative standing orthoscanograms showing correction of deformities. [C]

[A] Bilateral varus Hip-Knee-Ankle (HKA) angle; [B] Windswept knees with valgus (right) and varus (left) HKA angle. [C] Postoperative film showing corrected HKA angle.

Figure: 1. Preoperative long leg films showing knees with Kellgren-Lawrence Grade 4 osteoarthritic changes and varus or valgus deformities [A], [B], to be corrected by total knee arthroplasty, and post-operative film showing correction of deformities [C].

Abbreviations: LEFS = Lower Extremity Functional Scale; PHQ-9 = Public Health Questionnaire-9.

- Values denote Median (Interquartile range).
- For study end visit n = 232 and 172 respectively in non-obese and obese groups.
- *p* value in the last column is for intergroup comparison by Mann-Whitney U test.
- The *p* value for within group comparison is from Wilcoxon's matched pairs signed rank test for PHQ-9 and Friedman's analysis of variance for other parameters.

The KSS, which is a composite score reflecting pain, alignment, mobility and stability, was comparable between the groups at baseline and showed a steady improvement over time in the non-obese cohort.Improvement also occurred in the obese cohort but a slower pace, reflected in the statistically significant differences in median score in favor of the non-obese cohort at all postoperative time points. KSS changes are shown graphically in **Figure: 2**. KSS-P, however, plateaued at 6 months indicating that by this time most patients experience adequate pain relief. The differences between obese and non-obese cohorts were small with respect to this parameter but the

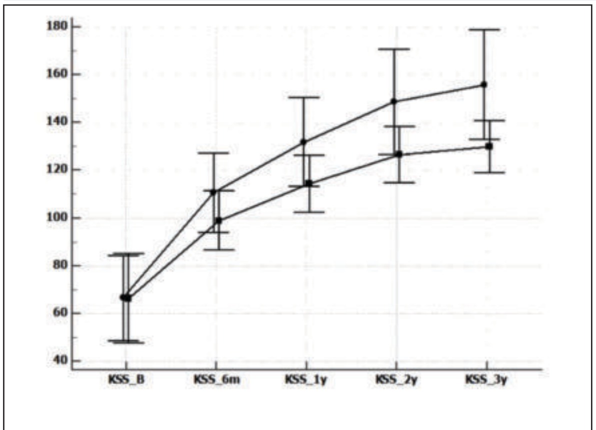

Figure 2. Line diagram depicting improvement of Knee Society Score (KSS) over the 3-year post-operative follow-up period following total knee arthroplasty.
Improvement is more rapid in non-obese (round marker) than in obese (square marker) patients.
Error bars represent standard deviation.

Figure: 2. Line diagram depicting improvement of Knee Society Score (KSS) over 3-year post-operative follow-up period following TKA.

Improvement is more rapid in non-obese (round marker) than in obese (square marker) patients.

Error bars represent standard deviation.

OKS is a patient reported outcome measure that is specifically intended to assess function and pain after total knee replacement surgery from the patient's, rather than the surgeon's, perspective. It also showed a steady decline (improvement) in both groups, but again at a faster pace in the non-obese cases leading to statistically significant differences with their obese counterparts.

The LEFS is also a patient-reported outcome measure for the assessment of lower extremity function in adults. Though it is not specific for knee osteoarthritis or TKA, it has been used in these situations to provide a summary assessment integrating a range of day-to-day activity involving lower extremity mobility. Consistent with the other functional outcome measures used in this study, it also showed faster improvement in the non-obese patients (**Figure: 3**).

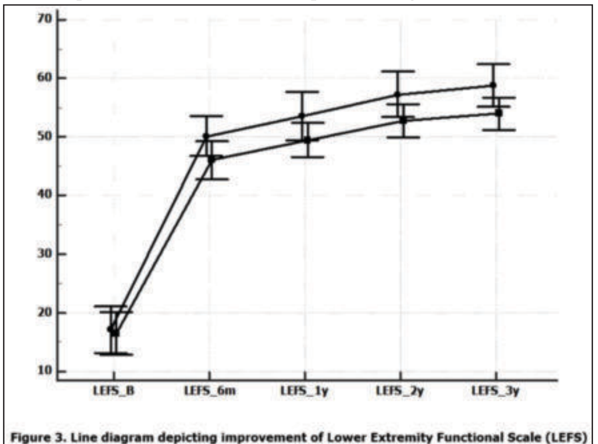

Figure 3. Line diagram depicting improvement of Lower Extremity Functional Scale (LEFS) over the 3-year post-operative follow-up period following total knee arthroplasty.
Improvement is sharp in the first 6 months and more rapid in non-obese (round marker) than in obese (square marker) patients.
Error bars represent standard deviation.

Figure: 3. Line diagram depicting improvement of Lower Extremity Functional Scale (LEFS) over 3-year post-operative follow-up period following TKA.

Improvement is more rapid in non-obese (round marker) than in obese (square marker) patients.

Error bars represent standard deviation.

Finally, the PHQ-9 is a multipurpose instrument for screening, diagnosing and monitoring the severity of depressed mood, that incorporates American Psychiatric Association Diagnostic and Statistical Manual 4th edition (DSM-IV) depression diagnostic criteria with other major depressive symptoms into a brief self-reported tool reflecting overall satisfaction with life. As expected, the baseline PHQ-9 score was better in non-obese subjects and improved sharply after surgery, in contrast to obese patients.

In essence therefore, the functional outcome of TKA was significantly better in the non-obese cohort than the obese cohort in this study.

DISCUSSION

This study involved a large sample of 396 patients undergoing TKA (709 evaluable knees) over a long-term follow-up span of 2-3 years, where the entire sample was divided into obese and non-obese cohorts; and the functional outcome after TKA was assessed by KSS, OKS, KSS-P, LEFS & PHQ-9 scoring systems. Even though preoperative scores were similar or almost similar in both cohorts, the postoperative functional outcome scores and ROM improved considerably over 2-3 years in the non-obese cohort compared to the obese cohort. These findings replicate other studies, which have thrown light on the negative impact of obesity on the outcomes of TKA,[16-18].

Mean age for patients in the non-obese cohort was 66.5 years, whereas obese patients had a mean age of 63.5 years, at the time of reporting for primary TKA, which shows that obese patients reported earlier for TKA, presumably due to increased knee pain, deformities, gait disturbances, which impede a normal lifestyle. Such findings have been corroborated by other studies too, which have indicated earlier implementation of TKA in obese individuals to improve their lifestyle. According to James et al, [19], a significant statistical decline was observed in functional outcome scores in the last follow-up, but this was not the case in the present study, as pain and knee function improved considerably in all patients after TKA, from 6 months to 1 year, 2 years and up to 3 years.

Obesity has been associated with several postoperative complications after TKA, like superficial wound infection, reduced postoperative ROM, periprosthetic inflammation leading to component loosening, which have a definite negative impact on the outcomes of TKA. Amin et al, [17], concluded that lower KSS scores and higher rates of perioperative complications like wound sepsis are seen in morbidly obese patients, compared to the non-obese population. However incidence of thromboembolic manifestations was practically nil in this study due to proactive use of low-molecular weight heparin / warfarin post-operatively and early ambulation of patients.

In accordance with our results, Baker et al,[18], reported no difference in OKS scores in different grades of obesity; but Ayyar et al,[20],reported the same postoperative improvement in OKS Scores in both obese and non-obese groups, in contrast to our findings.

The poorer improvement in outcome scores after TKA in obese patients leads to reduced patient satisfaction and increased duration of hospital stay. This can be explained by the fact that the obese and the morbidly obese patients have reduced mobilization post-operatively, which reduces their compliance to physiotherapy and rehabilitation and also increases the chances of thromboembolic manifestations, [21]. Poor mobilization of obese patients in immediate postoperative phase decreases the ROM, increases postoperative pain and joint stiffness, leading to inferior functional outcome.

As evident from the present study, TKA nevertheless improves the quality of life in both obese and non-obese cohorts, by reducing joint pain and increasing joint mobility, and creating a painless stable knee; which is reflected in the significant changes in PHQ-9 scores. Reduced PHQ-9 scores in the obese cohort is due to reduced functional outcome after TKA, which is manifested by a poorer quality of life in these patients, but nevertheless the benefits of TKA cannot be denied in obese patients.

Excessive joint overloading after TKA is often associated with obesity, which results in excessive wear and tear of the polyethylene insert, accounting for reduced knee function and decreased values of postoperative KSS, KSS-P, OKS and LEFS Scores. Aseptic loosening of components with increased chances of periprosthetic inflammation can be seen in morbidly obese patients, as has been observed by other researchers,[22,23]. Poor bone stock / osteopenia was seen by DEXA scans in most of the obese patients undergoing TKA, which leads to component loosening and increased incidence of peri-prosthetic fractures of femur & tibia; eventually requiring revision arthroplasty in 3 patients in the present study.

The present study also shows significant differences in postoperative HKA angle correction between the obese and the non-obese cohort. Postoperative HKA angle correction was better achieved in the non-obese cohort (correction to ± 3 degrees is considered normal), which also implies better functional outcome in the non-obese population. Earlier studies,[24, 25] suggest that excessive varus or valgus alignment is detrimental to TKA survival, and the failures due to malalignment are increased with abnormal BMI.

Therefore it is evident that obese and morbidly obese patients are definitely at risk for postoperative joint pains, TKA failures and revision arthroplasty. Bordini et al,[26], drew a similar conclusion, but some authors documented that high rates of revision TKA or worse pain outcomes after primary TKA, may not be always associated with obese patients undergoing TKA, possibly due to the lower levels of physical activity in these patients compared to the non-obese group,[27].

Limitations of our study include the fact that, although the study extended for 5 years, duration of patient recruitment span was the initial 2 years; which means that we were not able to follow-up beyond 3 years or do a Kaplan-Meier type analysis for implant survival. Future work needs to address the technological advances in this field such as exploring functional outcome following the use of long stem tibial implant for primary TKA, in morbidly obese patients with osteopenia, for better stability.

Despite these limitations, we can conclude that increasing body mass index has a negative impact on the outcomes of TKA, as evident from the differences in functional outcomes between the obese and the non-obese cohorts. In general this is the trend reported in TKA literature,[28], with few exceptions,[29]. Therefore counseling of obese patients for active weight loss ,[30], through diet restrictions and rigorous exercise regimes, especially for those who are morbidly obese, is vital to improve postoperative outcomes of total knee replacement surgery.

CONCLUSION:

The study clearly highlights the negative impact of increased BMI on the functional outcomes of TKA, for which weight loss management should be mandatorily considered prior to surgery, to increase the functional longevity of the prosthetic knee. Furthermore, as the correction of the coronal alignment [HKA Angle] cannot be performed adequately in obese knees, the prospective outcomes of TKA in obese osteoarthritic patients will not be desirable on a long-term basis. This leads to another implication that the use of long stem tibial implants for primary TKA in obese osteoarthritic knees with severe varus can improve the long-term outcomes of TKA in such patients.

Declarations:

Ethics Approval:

Ethics approval was obtained from all the hospitals from where patients were included in the study; prior to beginning the study. Ethics approval document was obtained from IPGMER, Kolkata; R.G.KAR Medical College & Hospital, Kolkata; Fortis Hospital, Anandapur, Kolkata.

Consent To Participate:

Patients gave written consent to participate in the study through informed consent document forms as per ICMR [Indian Council Of Medical Research] Guidelines.

Consent For Publication: Not applicable.

Availability Of Data And Materials: Available. Patient data has been recorded in Excel sheets for statistical analysis after obtaining proper consent. The data sets generated during and / or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests: All contributing authors, Dr. Sukanya Palit, Dr. Kaushik Banerjee, Dr. Avijit Hazra, declare that they have NO competing interests/ conflicts of interests.

Funding: The study received NO financial grant/ support from any sponsor. The hospitals concerned provided free access to patients and imaging facilities for academic purpose.

Acknowledgements:

We wish to acknowledge the contributions of the following individuals in Fortis Hospital, Anandapur, Kolkata: Dr. Ronen Roy, Senior Consultant Orthopedic Surgeon, with team members, namely Dr. Mistun Banerjee and Dr. Shirazul Kamal, whose TKA patients provided the patient pool for our study and who facilitated access to these patients.; the entire team in the Surgical Intensive Care Unit (SICU) who provided immediate postoperative care to these patients and the physiotherapists (Aditya and Ravi) who helped in mobilizing the TKA patients from second postoperative day itself, with utmost care and concern; the Chief Radiologist Dr. Salim Parvez, and his technical team for providing access to long leg films (Debashis, Tuhin) and to axial CT Scans of TKA implants (Mukul, Sandip, Abhijeet, Tarun Chatterjee) and helping in their interpretation. We are also grateful to Dr. Ananda Kishor Pal, Professor of Orthopedics, IPGME&R & SSKM Hospital, Kolkata, and Dr. Swarnendu Samanta, Senior Consultant Orthopedic Surgeon, Peerless Hospital, Kolkata, for their valuable inputs in developing the study design. Lastly, we extend our heartfelt thanks to all our TKA patients who participated in the study, for being with us for up to 3 long years, patiently submitting to all our scoring assessments and making the project a success.

Informed Consent:

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

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