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A BMI above 30 results in satisfying outcomes in patients undergoing fixed-bearing lateral unicompartmental knee arthroplasty

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Abstract

Purpose The purpose of this study is to analyse the effect of BMI on clinical outcomes of cemented fixed-bearing lateral unicompartmental knee arthroplasty (UKA) on a 2- to 12-year follow-up.

Methods Between January 2010 and January 2020, a total of 103 lateral UKAs were implanted. The Oxford Knee Score (OKS) and the Western Ontario and McMaster University Osteoarthritis Index for pain, stiffness, function, and total score were administered to estimate patients' overall health status pre- and post-operatively. Results were considered good or excellent for WOMAC values > 85 points and OKS > 40 points. Survivorship, described with Kaplan–Meier method, was defined as the lack of revision at the latest follow-up. Complications or further operations were recorded. p values of < 0.05 were considered significant.

Results One hundred one lateral UKAs were assessed at a mean follow-up of 77.8 months. No patients underwent revision, but 2 patients (2, 0%) developed aseptic loosening of the implant 2 and 5 years after surgery but for clinical reasons neither undergo revision (5-year survivor 97.2%). Overall satisfaction was generally high, with excellent scores in all WOMAC subscales and OKS for all BMI groups. Considering the pain subscale (WOMAC pain), patients with normal weight and overweight achieve excellent results more frequently [10 (25.64%) vs 10 (23.81%) $p = 0.026$] than obese patients ($n = 0$); on the other hand, considering the quality of life (WOMAC QoL), obese patients most frequently reach excellent values, even statistically significant [$n = 15$ (75.00%) $p = 0.040$].

Conclusion Although obesity has historically been described as a contraindication to UKA, improved outcomes with modern UKA implant designs have challenged this perception. Therefore, the classic contraindication of UKAs in patients with BMI > 30 kg/m^2 may not be justified. According to the present study, lateral UKA patients with BMI > 30 kg/m^2 had satisfactory patient-reported outcome measures compared to non-obese patients on a long term with survival rates comparable to medial UKA. Obese patients should not be excluded from the benefit of lateral UKA surgery.

Keywords Body mass index · Obesity · Mid-long-term outcomes · Lateral unicondylar knee arthroplasty

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Abbreviations

BMI	Body mass index
CI	Confidence intervals
NS	Not statistically significant
OKS	The Oxford Knee Score
PROM	Patient-reported outcome measure
RCT	Randomised controlled trial
SD	Standard deviation
TKA	Total knee arthroplasty
WOMAC	Western Ontario and McMaster University Osteoarthritis Index
UKA	Unicompartmental knee arthroplasty

Introduction

The number of knee replacements performed annually is rapidly increasing, with many overweight and obese patients now needing joint replacements [1, 17]. Unicompartmental knee arthroplasty (UKA) offers some important advantages for the management one compartment knee's osteoarthritis, both in terms of good clinical outcomes, and in terms of low incidence of adverse events and complications [28, 29, 36, 37]. According to the (1989) Kozinn and Scott criteria, body weight over 82 kg is a contraindication to UKA [16], but, more recently, many of the "traditional" contraindications have been questioned, including a high BMI [3, 26, 33]. Compared to other types of knee arthroplasty there is a lack of studies available about lateral UKA, especially when a 15-year survivorship is considered [19]. This because lateral UKA is less frequent (lower incidence of isolated lateral osteoarthritis [25] but also because of reluctance in surgical indication), shorter follow-up and limited data about implant survivorship and complications [24, 35, 44]. Studies of the effect of BMI on UKA outcomes have given conflicting results [7, 21, 24], and currently little is known about the effect of obesity on the clinical outcome of lateral UKA[19]. In the present study, our primary endpoint is the rate of survival and peri-postoperative complications, while a secondary endpoint was to compare the effect of BMI on the subscales of reported patients outcome measures. The study hypothesis is that patients who underwent a lateral UKA with a high BMI have a higher rate of peri-postoperative complications, a higher revision rate, and worse clinical outcomes compared to those with a BMI within the normal range.

Materials and methods

Consecutive patients who underwent lateral UKA with the cemented metal backed Unicompartmental High Flex Knee System prosthesis (ZUK, Lima Corporate®) were included in the retrospective analysis, with a minimum 2-year follow-up. Between January 2010 and January 2020, a total of 103 lateral UKAs were implanted; of these, 2 patients were lost to follow-up. Finally, 101 knees were assessed in 96 patients (Fig. 1). All operations were performed or directly supervised by a senior surgeon (PV) with extensive experience in UKA, in the same institute. The clinical sheet and the surgery records were checked for any intraoperative (fracture of the lateral tibial condyle, intercondylar eminence fracture, rupture of the lateral collateral ligament, TKA conversion) or postoperative (aseptic loosening of the femoral component, polyethylene bearing dislocation, suprapatellar bursitis, periprosthetic fracture, delayed healing of the surgical wound) complications or further operations. All patients were contacted by telephone for a post-operative structured interview that included assessment of the status of the implant and need for revision surgery, weight changes that led the patient to move from one BMI group to another, and to collect data on patient outcome measures. These included the Oxford Knee Score (OKS) and the Western Ontario and McMaster University Osteoarthritis Index for pain, stiffness, function, and total

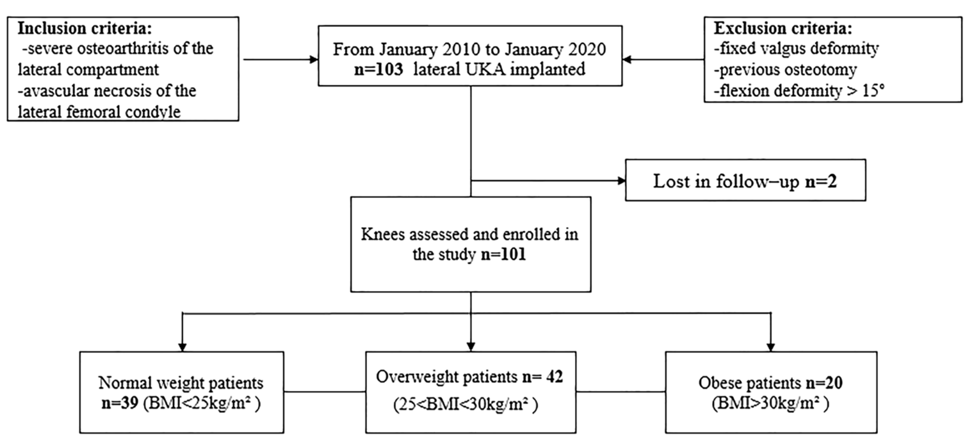

Fig. 1 Patients enrollment flowchart

score. [22] Results were considered good or excellent for WOMAC values higher than 85 points and OKS higher than 40 points. [2] All the scores were administered by an orthopaedic surgeon who was not involved in the surgical procedure. Patients who could not be contacted by telephone were sent a written questionnaire to complete. Informed consent was obtained by each patient enrolled in the study. Finally, each patient's BMI was calculated at the time of surgery and at the last follow-up. Survivorship was defined as the lack of revision at the latest follow-up. Patients who received bilateral intervention were considered as receiving two independent procedures.

All patients included presented severe osteoarthritis of the lateral compartment with full thickness articular cartilage loss or avascular necrosis of the lateral femoral condyle. In all patients, the anterior cruciate ligament and the medial and lateral collateral ligaments were functionally intact, the valgus deformity was manually correctable and there was no evidence of osteoarthritis in the medial compartment. Osteoarthritis of the patellofemoral joint was not considered a contraindication unless there was deep eburnation. Exclusion criteria were fixed valgus deformity, previous osteotomy, or a flexion deformity > 15° (Fig. 1). All procedures were performed using a midline incision and a lateral parapatellar approach; the tibial and femoral cuts were made using the appropriate guides. The vertical cut was placed tightly against the tibial spine, as this allows the tibial component to cover the largest possible area of the tibial plateau. Thereafter, anatomical positioning of the femoral component was performed to avoid a variation in the height of the joint line, and selection of the thickness of the insert was performed with the knee in full extension. After removal of the trial components, the tibial surface was prepared for the pegs, and the tibial component was cemented in place before the femoral component was implanted. Physiotherapy started early after surgery, mainly focused, in this initial phase, on the recovery of the full range of motion with full weight bearing supported by two crutches. The independent ethics committee of the IRCCS Istituto Clinico Humanitas has authorised the present retrospective study no. 40/22.

Statistical analysis

For the descriptive nature of the study, no power analysis was performed a priori, and all patients' data fulfilling inclusion and exclusion criteria were included in the analysis. Data were reported as number and percentage, or mean and standard deviation, or median and range, as appropriate. We have limited the number of decimals to one throughout the manuscript.

Patients were categorised into three BMI groups at the time of surgery: (1) Normal weight (≥ 18.5 to < 25 kg/m2), (2) Overweight (BMI ≥ 25 to < 30 kg/m2), (3) Obese (BMI ≥ 30 kg/m^2) [39]. The dichotomous dependent variable was post-operative outcome score (excellent vs good), while independent variables were BMI (≤ 25 vs 25 < BMI < 30 vs ≥ 30 kg/m^2) and the pre-operative clinical score. The adherence of continuous variables to Gaussian distribution was assessed with Shapiro–Wilk test. Differences among groups were explored with chi square test, with Fisher correction if necessary, or ANOVA or Kruskal–Wallis test, as appropriated. To assess implant survival and cumulative failure rate for both reoperation and revision (failure) endpoints the Kaplan–Meier method was utilised. Given that more than half of the patients have a follow-up of less than 5 years, results were expressed as 5-year survival. Statistical analyses were all performed in Stata version 14 (STATA Corp, TX). p values of < 0.05 were considered significant.

Results

The baseline characteristics and the composition of BMI groups are summarised in Table 1. No patient experienced peri-or postoperative complications. Considering the whole cohort of patients, UKA survival analysed with Kaplan–Meier method was 97.2% (n = 99) at 5 years. No patients underwent prosthetic revision, but 2 patients (2, 0%), 1 in the normal weight group and 1 in the overweight group, underwent UKA failure: both developed aseptic loosening of the implant 2 and 5 years after surgery (5-year survival 100% in obese group, versus 96.6% in non-obese group.) (Fig. 2). Given their age and comorbidities, neither wished to undergo revision. Moreover, another patient had a

Table 1 Demographics

	All	Normal weight (BMI < 25 kg/m^2)	Overweight (25 < BMI < 30 kg/m^2)	Obesity (BMI > 30 kg/m^2)	*p*
Total number of knees	101	39	42	20	
BMI (mean ± SD)	26.3 ± 3.7	22.7 ± 1.6	27.1 ± 1.4	31.6 ± 2.0	
Age (mean ± SD)	71.0 ± 8.9	71.8 ± 9.5	71.7 ± 8.3	68.1 ± 8.5	NS
Sex (M)	14 (13.8%)	2 (5.1%)	9 (21.4%)	3 (15.0%)	NS
Follow up (months) Mean ± DS and median (range)	77.8 ± 36.1 70 (24–145)	83.8 ± 39.1 88 (24–144)	74.8 ± 36.5 58.5 (25–145)	72.5 ± 28.7 64 (24–123)	NS

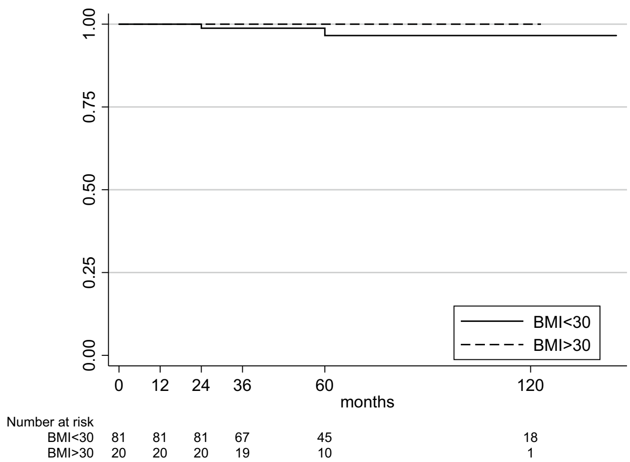

Fig. 2 Kaplan–Meier survival curve for patients with BMI less and higher 30

periprosthetic fracture and underwent internal fixation with plate and screw.

The WOMAC and OKS were administered to 96 patients (5 with a bilateral UKA). The mean and median postoperative OKS and WOMAC subscales improved in all BMI groups (Table 2) compared to each group's respective preoperative scores. Specifically, patients with high BMI achieved good results in all WOMAC subscales, while normal weight or overweight patients tended to achieve excellent results more frequently [30.77% ($n = 12$) vs 26.19% ($n = 11$) of overweight and 10.00% ($n = 2$) of obese] (Table 2). Considering the pain subscale (WOMAC pain), patients with normal weight and overweight achieve excellent results more frequently [10 (25.64%) vs 10 (23.81%) $p = 0.026$] than obese patients ($n = 0$); on the other hand, considering the quality of life (WOMAC QoL), obese patients frequently reach excellent scores, even statistically significant [$n = 15$ (75.00%) $p = 0.040$].

The obesity groups had the lowest preoperative PROM scores comparing with the other BMI groups, resulting in statistically significant increase in all scores and subscales (Table 2).

Discussion

The most important finding in this study is that obese patients with a BMI > 30 kg/m^2 have good clinical outcomes after lateral UKA. Overall satisfaction in our patient cohort was generally high, with excellent scores across all WOMAC and OKS subscales at 2- to 12-year follow-up after surgery. Furthermore, the 5-year survival rate of lateral UKAs of the patient cohort was higher in obese patients than in normal weight patients. Recent registry studies showed an increase in the use of medial UKA, while the use of lateral UKA has remained constant over time [19] with a ratio of

Table 2 Scores of the three BMI groups

	All	Normal weight (BMI < 25 kg/m^2)	Overweight (25 < BMI < 30 kg/m^2)	Obesity (BMI > 30 kg/m^2)	*P*
n	101	39	42	20	
Pre-OKS	19.8 ± 3.4	20.6 ± 3.5	20.0 ± 3.3	17.8 ± 2.3	0.013
Post-OKS	41.7 ± 3.8	41.4 ± 4.4	42.0 ± 3.8	41.8 ± 2.5	NS
Delta from pre	21.9 ± 4.7	20.7 ± 4.9	22.0 ± 4.6	24.1 ± 4.0	0.057
Pre-WOMAC-Stiffness	35.0 ± 6.3	37.7 ± 5.8	35.3 ± 5.9	29.0 ± 3.3	< 0.001
Post-WOMAC-Stiffness	79.5 ± 7.8	80.0 ± 9.6	79.6 ± 7.1	78.4 ± 5.4	NS
> 89	7 (6.9%)	4 (10.2%)	2 (4.8%)	1 (5.0%)	NS
Delta from pre	44.5 ± 9.9	42.3 ± 11.2	44.3 ± 9.4	49.4 ± 6.3	0.009
Pre-WOMAC Pain	36.2 ± 5.8	36.8 ± 5.6	38.1 ± 4.7	31.2 ± 5.5	< 0.001
Post-WOMAC Pain	80.0 ± 8.6	79.8 ± 10.5	80.9 ± 8.4	78.2 ± 3.7	NS
> 88	20 (19.8%)	10 (25.6%)	10 (23.8%)	0	0.026
Delta from pre	43.710.3	43.1 ± 13.1	42.8 ± 8.5	46.9 ± 7.0	NS
Pre-WOMAC QoL	35.4 ± 5.9	35.7 ± 5.7	37.7 ± 5.5	30.2 ± 3.8	< 0.001
Post-WOMAC QoL	81.3 ± 8.7	79.4 ± 10.6	82.0 ± 8.0	83.6 ± 4.5	NS
> 82	62 (61.4%)	18 (46.1%)	29 (69.0%)	15 (75.0%)	0.040
Delta from pre	45.9 ± 10.1	43.8 ± 11.8	44.3 ± 8.8	53.3 ± 4.7	< 0.001
Pre-WOMAC	35.7 ± 4.9	36.4 ± 4.6	37.4 ± 4.3	30.7 ± 3.6	< 0.001
Post-WOMAC	81.0 ± 7.2	80.6 ± 8.4	81.2 ± 7.4	81.3 ± 3.2	NS
> 85	25 (24.7%)	12 (30.8%)	11 (26.2%)	2 (10.0%)	NS
Delta from pre	45.3 ± 8.5	44.2 ± 10.1	43.9 ± 7.5	50.7 ± 8.5	< 0.001

1–10 between lateral and medial unicompartmental prostheses. This difference may be caused by the more challenging nature of lateral compared to medial UKA, the lower incidence of isolated lateral OA, the different anatomy and kinematics of the lateral compartment [14, 23, 25, 27], and the differences in volume of surgical procedures [9, 25, 30]. To complicate lateral UKA, some cofactors [11], including body weight, have been shown as modifiable risk factor for knee osteoarthritis and disease progression but also for dislocation, aseptic loosening, superficial, deep infection and revision surgery [10, 12, 20, 32]. As most populations worldwide are suffering from the pandemic of obesity, various studies evaluated the influence of high BMI on the outcome of medial UKA. In a series of 79 patients, early implant failure in 22% of patients at a mean follow-up of 40.2 months (range 24–49 months) was reported. The failures resulted from tibial loosening, tibial plateau fracture, persistent medial pain, progressive arthritis and sepsis. UKAs in patients with a BMI greater than 32 kg/m^2 were associated with a reduced survivorship [4]. Similarly, a higher (12.5%) failure rate was evident in the more obese group of UKA patients [5]. In recent meta-analysis, obesity was a well-defined risk factor for conversion to TKA after UKA, especially at 10 years of follow-up. To prevent this issue, some surgeons propose TKA instead of UKA in obese patients with unicompartmental osteoarthrosis, although obesity increases risk of revision even after TKA[15, 32]. Conventionally, patients with higher BMI were thought to have poorer outcome with risk of early implant failure but this is not necessarily true for lateral UKA. In the present study, the PROM scores reported by obese patients ranged from good to excellent, comparable to those of normal and overweight people, but with lower initial scores. Survival reached a rate of 100% at 12 years for patients with a BMI > 30 kg/m^2. At 3 and 5 years after surgery, the only two patients who experienced failure were of normal weight and overweight. Late failures were most commonly caused by osteoarthritis progression but, in the present series, with a maximum follow-up of 12 years, no significant clinical progression of osteoarthritis in the medial compartment had occurred. The length of follow-up in most studies may not be sufficient to observe medial osteoarthritis progression and increased revision rate in obese patients [6]. A similar study showed that obesity had no adverse outcome in UKA patients, with 10-year survival rates of 93% [7]. In 178 patients, the outcome of UKA was not influenced by patient age, BMI and early degeneration of the patello-femoral joint [38]. Tabor et al. reported higher survivorship in obese patients compared with those who were not obese in a 20-year follow-up study of 82 patients [31]. In a meta-analysis, the risk ratios for all-cause revision surgical procedures were 1.19 ($p = 0.02$) in severely obese (BMI > 35 kg/m^2), 1.93 ($p < 0.001$) in morbidly obese (BMI > 40 kg/m^2), and 4.75 ($p < 0.001$) in super-obese (BMI > 50) patients compared to patients with a normal BMI [8]. In this study, patients had an average BMI of 31.1 kg/m^2 with only one patient reaching 38 kg/m^2. Most patients had BMI between 30 and 33, i.e. class 1 obesity. Probably, with class 2 or 3 obesity, the risks associated with obesity, poorer outcome, early implant failure, wound or prosthetic infection, increase dramatically. There are several hypotheses that could justify the stability of these implants and the high survival and satisfaction rates of the lateral UKAs in patients with BMI higher than 30 kg/m^2: obese patients are likely to perform less physical activity than non-obese patients, therefore imparting less use to their implant; reduced physical activity may compensate for the increased load of the obese patients in terms of prosthesis survival. Instead, people with a normal weight, demanding a more active lifestyle and frequently, as in our cohort, continue to practice amateur sports, tennis, skiing, hiking: this may amplify every sensation of pain [6, 35]. Furthermore, a recent biokinematic study shows that in lateral UKA the rotational kinematics of the native knee was restored but not after medial UKA [34]. Finally, the obese patients tended to be younger at surgery time with high satisfaction rates [18]; in our work, the highest BMI group present slightly lower mean age and lowest preoperative scores but also a greater improvement in scores compared to other groups as shown in Table 2. Patient selection and education is mandatory to obtain long-lasting results with lateral UKAs especially in obese patients.

Limitations

Our work has several limitations, the most important being the relatively small number of obese patients included in the study. In addition, all patients, given the restrictions related to the sars-cov-2 pandemic, were evaluated through PROMs and a telephone interview, making our work susceptible to a possible patient's assessment bias. Another limitation is the lack of intermediate follow-up. On the other hand, this is one of the few studies that focus on lateral UKAs by comparing the outcome of obese patients with those of normal weight on 2- to 12-year follow-up and provides evidence that high BMI does not lead to inferior patient-reported or survival outcomes and supports the recommendation that a BMI threshold should not be considered a contraindication with respect to these outcomes.

Conclusion

Although obesity has historically been described as a contraindication to UKA, improved outcomes with modern UKA implant designs have challenged this perception. Therefore, the classic contraindication of UKAs in patients with BMI > 30 kg/m^2 may not be justified. According to the present study, lateral UKA patients with BMI > 30 kg/m^2 had no inferior patient-reported outcome measures compared to non-obese patients on a long term with survival rates comparable to medial UKA. Obese patients should not be excluded from the benefit of lateral UKA surgery.

Author contributions LG made substantial contributions to study conception, acquired the data, design, and wrote the paper. EM performed the statistical analysis. AQ, EP, and FR interpreted the results and revised the manuscript critically. NM and PV conceived the study, participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

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Data availability statement The data that support the findings of this study are available on request from the author LG. The data are not publicly available because them containing information that could compromise research participant privacy.

Declarations

Conflict of interest All authors declare to have no competing interests relating to the present paper.

Ethical approval The present study was performed in accordance with the Ethical Standards of the 1964 Helsinki Declaration and its later amendments, and IRB approval was obtained as attached documents.

Informed consent All subjects were advised of the study objectives and the confidentiality of their data, but that their medical records may be reviewed for study purposes by authorised individuals other than their treating physician. It is emphasised that participation is voluntary and that the subject can refuse further participation in the protocol whenever he wishes. Documented informed consent was obtained for all subjects included in the study in accordance with national and local regulatory requirements.

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