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Mid-term outcomes of medial metal backed and all-polyethylene unicompartmental knee arthroplasty in obese patients: a retrospective propensity-matched analysis

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Abstract

Background This retrospective study compares the outcomes of unicompartmental medial fixed-bearing knee arthroplasty (mUKA), involving a cemented metal-backed (MB) or an all-polyethylene (AP) tibial component, performed in obese patients with a body mass index (BMI) > 30 with a follow-up of at least 5 years.

Methods The institutional database was mined for primary mUKAs involving an MB or an AP tibial component (MB-UKA and AP-UKA groups, respectively) performed from January 2015 to August 2019. Patient demographics and patient-reported outcome measures (PROMs) were compared and a propensity score matching (PSM) analysis (1:1) using multiple variables was conducted.

Results PSM analysis yielded 37 pairs of obese MB-UKA and AP-UKA patients. At 5 years, the Knee Society Function Score (KSFS) was 75.1 ± 10.6 in MB-UKA and 79.4 ± 9.1 in AP-UKA patients ($p = 0.029$), and the Oxford Knee Score (OKS) was 38.1 ± 4.4 in MB-UKA and 40.6 ± 5.7 in AP-UKA patients ($p = 0.011$).

Conclusion At five-year follow-up, in a matched group of obese MB-UKA and AP-UKA patients, the AP-UKA group achieved better KSFSs and OKSs. Both the AP and the MB tibial components were able to bring about a significant improvement of the most widely used PROMs.

Keywords Medial knee osteoarthritis, Unicompartmental knee arthroplasty, UKA, All-poly tibial component, Metal-backed tibial component, propensity score matching, obesity, Body Mass Index, Functional outcomes, Mid-long-term outcomes, Quality of life

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Background

Medial unicompartmental knee arthroplasty (mUKA) is an effective, well-established treatment for medial symptomatic knee osteoarthritis (KOA) [1, 2].

Compared to total knee arthroplasty (TKA), it provides better clinical results with less perioperative morbidity, enabling a faster return to activity. For these reasons, mUKA may be considered as the gold standard treatment for medial unicompartmental KOA, except in individuals where extra-articular deformity may require osteotomy [3] and in those where it is otherwise contraindicated.

Currently debated potential contraindications for UKA are a high body mass index (BMI) and obesity, since the abnormal stress on the tibial component typical of these patients may lead to premature implant failure [4]. Indeed, some works have reported higher 10-year implant revision rates in obese patients [5, 6] and a marked, though not statistically significant trend toward an increased revision rate in obese cohorts [7–9]. However, a mounting body of evidence indicates that obesity should no longer be viewed as a contraindication for UKA [10], since several systematic reviews and meta-analyses have failed to identify significant changes in revision rates and have in fact described comparable or even higher functional scores and satisfaction in obese compared to non-obese patients [7, 9, 11].

Fixed-bearing UKA involves an all-polyethylene (AP) or a metal backed (MB) tibial component. AP trays are less expensive and involve more conservative bone cuts, which is critical in case of revision to primary TKA. On the other hand, MB tibial components reduce stress at the bone interface [12] and enable the surgeon to adjust implant thickness during surgery.

Several studies have demonstrated that AP tibial components may be associated with greater stress on the bone interface, hence greater pain and inferior results, including the potential early mobilization of the tibial component [12, 13].

However, while most of the evidence for increased tibial strain stems from finite-element models and preclinical studies, the clinical results are far from conclusive [12, 14]. In fact, some works have reported excellent functional results with AP as well as MB implants [15–18], whereas other studies, including a meta-analysis, have failed to demonstrate significant functional differences between them [19, 20].

In addition, a similar pattern of tibial stress distribution has been described with radiostereometric analysis (RSA) in both implant types in TKA patients, and different authors have found that AP TKA is not inferior to MB TKA, even in patients with a BMI up to 37.5 [21, 22].

We recently reported that patients implanted with an MB component had less tibial pain, a higher forgotten joint score (FJS), and a better static sway and gait symmetry pattern, whereas we failed to demonstrate a significant difference in functional outcomes and patient-reported outcomes (PROMs) in comparison to AP implants [23].

Common sense suggests that the higher tibial strain associated with an elevated BMI could worsen the potential downsides of AP implants, thus increasing the difference with MB implants in terms of clinical and functional results.

The tested hypothesis was that, among individuals with a high BMI, functional results and PROMs would be significantly worse in AP compared to MB patients. To do this, health-related quality of life (HRQL) scores, functional outcomes and tibial pain in a selected population of obese mUKA patients implanted with an AP or an MB tibial component were compared.

Methods

Patient selection

Following the approval of the Institutional Review Board, the database of the Orthopedic Department at IRCCS Sacro Cuore-Don Calabria Hospital (Negrar di Valpolicella, Italy) was mined to identify all primary mUKA procedures conducted between January 2015 and August 2019. All patients provided their signed informed consent. There was a total number of 794 procedures, 429 involving an MB and 365 involving an AP tibial component. The data collected included patient demographics, medical history, American Society of Anesthesiologists (ASA) classification, intra- and perioperative data, any revision surgeries and clinical outcomes. Any major complications, including deep infection, pulmonary embolism, and aseptic loosening, were also examined. The indication for surgery was isolated medial unicompartmental symptomatic KOA grades III to IV according to the Kellgren-Lawrence classification [24]. Further inclusion criteria were a stable knee with an intact/competent anterior cruciate ligament, an intact or mildly degenerated but asymptomatic lateral compartment, patellofemoral changes no greater than grade II or III according to the Albach classification [25]. After physical examination and radiographic evaluation, these patients were deemed to be suitable for mUKA [26]. All mUKA procedures were performed to treat primary medial unicompartmental KOA refractory to at least 3 months of conservative treatment and still involving significant pain. Conservative treatments included physical therapy, intra-articular cortisone, rest, and anti-inflammatory medications.

Eligibility criteria

The inclusion criteria were: all mUKA patients who had a BMI > 30 and a follow-up of at least 5 years. The exclusion criteria were: Patients with primary bicompartmental or lateral KOA, a history of complex knee surgery (i.e.

high tibial osteotomy), significant trauma, inflammatory arthropathy, a diagnosis of KOA secondary to osteochondritis dissecans or avascular necrosis, symptomatic KOA in the contralateral knee, bilateral surgery and any revision surgery were excluded.

Surgical procedures and rehabilitation

The surgical procedure and the rehabilitation protocol were conducted following our previous report [23]. Briefly, all patients received a Link-Sled® fixed-bearing prosthesis (LINK, Hamburg, Germany) with a cemented MB or AP tibial component under spinal anesthesia combined with an adductor canal nerve block. The procedures were performed with an 8–10 cm limited medial midvastus approach, using a Link-Mytus® ART (Anatomic Reconstruction Technique) Instrument Set (LINK) for minimally invasive surgery. The "Cartier technique" [27] was use for the tibial cut, in order to perform a kinematic alignment for UKA [28]. Femoral preparation involved the removal of the cartilage layer using a saw blade. Then the femoral component was aligned according to condylar anatomy to achieve an equal flexion-extension gap. A tourniquet and a suction drain were used in all cases. Patients began rehabilitation on the first postoperative day. The protocol involved a 90-minute supervised session each morning and a 90-minute unsupervised session in the afternoon.

Clinical assessment

Patients were assessed preoperatively and then at 1 and 5 years using six major PROMs: the Knee Society Function Score (KSFS); the Knee Society Knee Score (KSKS) [29], the Oxford Knee Score (OKS) [30, 31], and the Physical Component Summary (PCS) of the Short Form 36 Health Survey (SF-36), which evaluates HRQL [32]. The FJS-12 [33] and the medial proximal tibial pain were assessed at 5 years. Key preoperative and postoperative variables were gathered by trained Orthopedic Department personnel.

Statistical analysis

Microsoft Excel (2019) in combination with the XLSTAT resource pack (XLSTAT- Premium, Addinsoft, New York, NY, USA) was used for data analysis. Propensity Score Matching (PSM) analysis, a statistical tool frequently adopted to minimize selection bias in retrospective cohort studies [3, 20, 34–42], was employed to reduce differences in known covariates between the cohorts [43]. The two groups were matched 1:1 by an optimal matching algorithm [44], identifying matched samples with the smallest average absolute distance across all matched pairs, to mitigate the impact of potential confounding variables [45]. Patients were deemed suitable for matching if the propensity score discrepancy between groups was within a caliper radius of 0.01 × sigma. The variables used for matching included gender, ASA (categorical data), age, BMI, preoperative KSFS, KSKS, OKS, and PCS score (quantitative data). The Shapiro–Wilk test was used to assess whether the data were normally distributed. Mean values were calculated for all continuous data and used percentage frequencies for all quantitative variables. The standardized mean difference (SMD) was calculated for all continuous and categorical variables used for matching. A non-parametric test, the Mann–Whitney test for unpaired data and the Wilcoxon signed-rank test for paired data were applied to evaluate significant differences in continuous variables between the groups. Categorical data were analyzed using the chi-square test. Differences between the MB and AP groups were assessed by comparing the SMD before and after matching. A group was regarded as imbalanced for a given covariate if the SMD exceeded 0.2 [43]. A significance level of $p<0.05$ was considered statistically significant.

Results

Patient recruitment

A total of 794 mUKA procedures with 5-year follow-up were found in the institutional database, 429 involving an MB component (MB-UKAs) and 365 involving an AP component (AP-UKAs). Application of the inclusion and exclusion criteria left 63 MB-UKAs and 58 AP-UKAs. PSM analysis successfully matched 37 patient pairs for gender, age, BMI, ASA class and preoperative KSFS, KSKS, OKS and PCS score. No patient died or was lost to follow-up. The patient selection flow-chart is reported in Fig. 1.

Patient demographic

Before PSM the two groups (63 MB-UKA and 58 AP-UKA patients) showed imbalances in age, gender and BMI (SMD=0.37, 0.27 and 0.30, respectively), which for the BMI was statistically significant ($p=0.02$). PSM analysis, where patients were matched 1:1, yielded two similar cohorts with an SMD<0.2 for all variables and no significant difference in preoperative, perioperative, or postoperative features (Table 1).

Results syntheses

In terms of preoperative data, the two groups were balanced both before and after PSM. Their preoperative KSFSs, KSKSs, OKSs and PCS scores were not significantly different either before or after matching (Table 2).

After matching, the 5-year KSFS was 75.1 ± 10.6 (range 44–85) in MB-UKA and 79.4 ± 9.1 (range 57–92) in AP-UKA patients ($p=0.029$); the 5-year OKS was 38.1 ±0.4.4 (range, 29–45) in MB-UKA and 40.6 ± 5.7 (range, 26–45) in AP-UKA group ($p=0.011$). The differences were both significant.

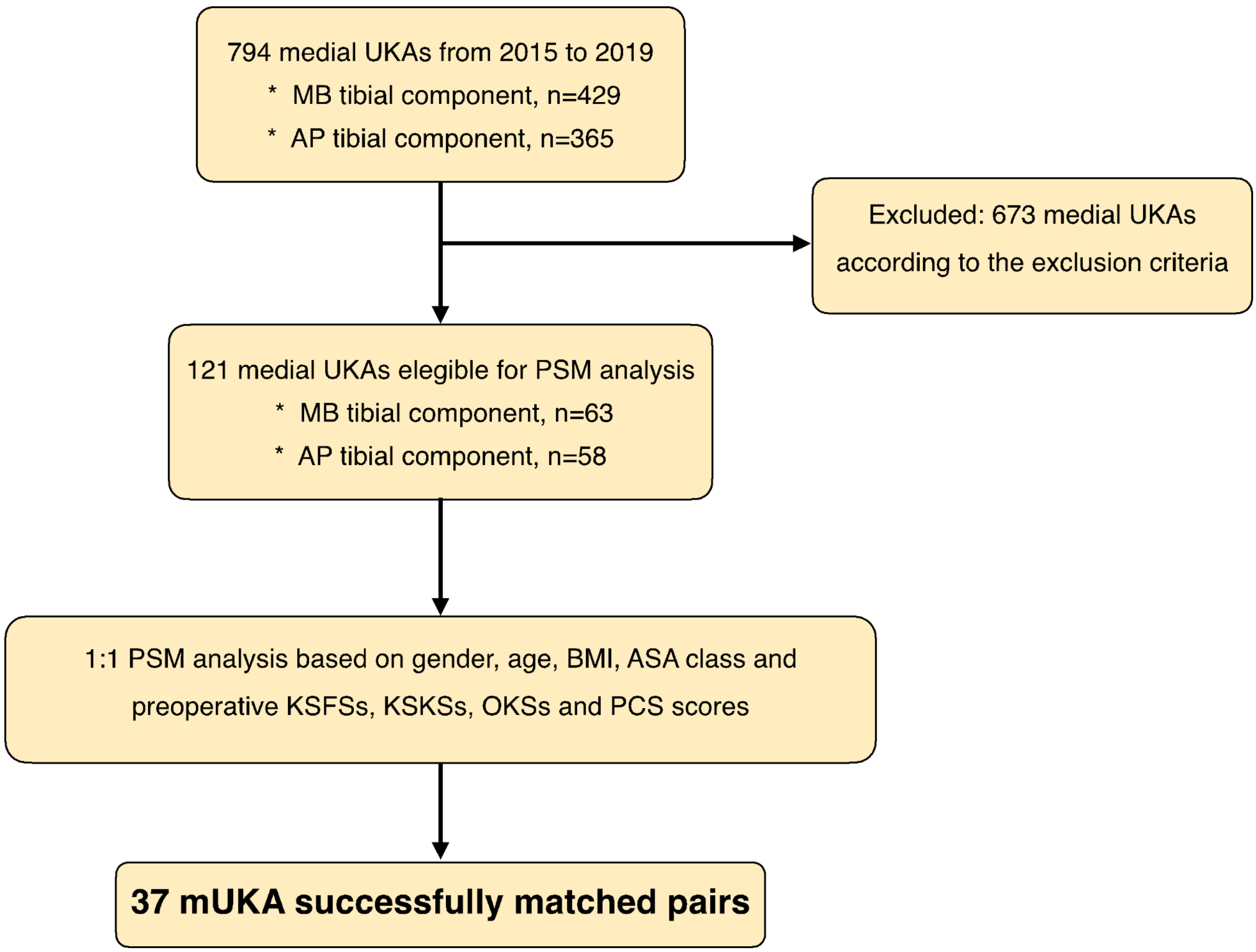

Fig. 1 Patient selection flow-chart

Table 1 Comparison of preoperative demographics of the medial UKA patients

Variable	Pre-matching cohort				Post-matching cohort			
	MB-UKA group	AP-UKA group	P-value	SMD	MB-UKA group	AP-UKA group	P-value	SMD
Age, mean (SD) [range]	65.1 (9.1) [47–87]	61.8 (8.9) [48–89]	0.093	0.37	63.3 (7.8) [48–82]	63.7 (8.5) [49–89]	0.928	0.049
Gender								
Male (%)	21 (33.3)	27 (46.6)	0.138	0.27	17 (45.9)	17 (45.9)	1	0
Female (%)	42 (66.7)	31 (53.4)			20 (54.1)	20 (54.1)		
BMI (kg/m2), mean (SD) [range]	33.1 (3.2) [30.1–44.8]	34.0 (2.8) [30.5–41.3]	0.020	0.30	33.4 (3.2) [30.1–44.7]	33.5 (2.2) [30.7–41.3]	0.562	0.036
ASA class (%)								
ASA 1	10 (15.9)	8 (13.8)	0.659	0.06	4 (10.8)	4 (10.8)	0.923	0
ASA 2	46 (73.0)	46 (79.3)		0.15	29 (78.4)	30 (81.1)		0.067
ASA 3	7 (11.1)	4 (6.9)		0.15	4 (10.8)	3 (8.1)		0.092

UKA: unicompartmental knee arthroplasty; MB-UKA: patients implanted with the metal-backed component; AP-UKA: patients implanted with the all-polyethylene component; SD: standard deviation; BMI: body mass index; ASA: American Society of Anesthesiology; SMD: standardized mean difference

Table 2 Preoperative and follow-up clinical and functional data and outcomes

Variable and time of the assessment	Pre-matching cohort				Post-matching cohort			
	MB-UKA group	AP-UKA group	*P*-value	SMD	MB-UKA group	AP-UKA group	*P*-value	SMD
KSKS								
Preoperative, mean (SD) [range]	41.2 (15.5) [20–62]	43.7 (17.5) [15–75]	0.254	0.15	41.8 (15.2) [20–62]	41.1 (17.3) [17–70]	0.889	0.04
12 months, mean (SD) [range]	82.4 (13.6) [51–96]	85.0 (12.8) [59–98]	0.168		80.6 (14.4) [51–96]	83.2 (13.0) [60–98]	0.418	
5 years, mean (SD) [range]	84.9 (8.9) [60–94]	86.4 (6.0) [66–94]	0.704		85.0 (8.8) [60–94]	86.1 (6.4) [67–93]	0.780	
KSFS								
Preoperative, mean (SD) [range]	53.9 (16.5) [32–75]	55.2 (16.1) [29–78]	0.337	0.08	53.8 (16.4) [32–74]	53.2 (16.6) [29–78]	0.904	0.04
12 months, mean (SD) [range]	73.9 (11.5) [51–89]	76.9 (11.2) [48–89]	0.059		72.7 (11.7) [51–89]	75.4 (10.5) [57–89]	0.156	
5 years, mean (SD) [range]	76.1 (11.3) [44–87]	79.2 (9.1) [57–89]	0.044		75.1 (10.6) [44–85]	79.4 (9.1) [57–92]	0.029	
PCS								
Preoperative, mean (SD) [range]	33.0 (10.6) [7–46]	31.9 (11.8) [9–51]	0.912	0.10	33.5 (10.7) [7–46]	33.5 (12.3) [9–51]	0.952	0.01
12 months, mean (SD) [range]	47.8 (9.5) [20–65]	45.9 (7.7) [27–61]	0.039		47.9 (8.1) [28–65]	45.9 (7.0) [28–53]	0.208	
5 years, mean (SD) [range]	49.6 (5.8) [29–60]	51.6 (6.4) [32–62]	0.013		49.8 (5.5) [29–60]	51.4 (6.8) [32–61]	0.099	
OKS								
Preoperative, mean (SD) [range]	24.3 (8.0) [7–38]	23.6 (8.0) [8–39]	0.497	0.10	24.2 (8.8) [7–38]	24.0 (7.8) [9–37]	0.984	0.02
12 months, mean (SD) [range]	33.2 (7.0) [20–48]	35.6 (5.5) [23–48]	0.016		33.7 (7.2) [20–48]	35.1 (5.4) [24–46]	0.363	
5 years, mean (SD) [range]	37.7 (4.3) [28–45]	40.1 (5.1) [26–48]	0.003		38.1 (4.4) [29–45]	40.6 (5.7) [26–48]	0.011	
FJS-12								
5 years, mean (SD) [range]	75.0 (21.1) [28–99]	77.8 (22.4) [28–100]	0.184		73.9 (19.9) [28–96]	76.2 (23.5) [28–99]	0.549	
Tibial pain at 5 years								
Present (%)	14 (22.22)	22 (37.9)	0.059		9 (24.3)	11 (29.7)	0.601	
Absent (%)	49 (77.78)	36 (62.1)			28 (75.7)	26 (70.3)		

UKA: unicompartmental knee arthroplasty; MB-UKA: patients implanted with the metal-backed component; AP-UKA: patients implanted with the all-polyethylene component; SMD: standardized mean difference; KSKS: Knee Society Knee Score; SD: standard deviation; KSFS: Knee Society Function Score; PCS: Physical Component Summary; OKS: Oxford Knee Score; FJS-12: Forgotten Joint Score-12

After matching, the 5-year FJS-12 and tibial pain were not significantly different. The FJS-12 was 73.9±19.9 (range 28–96) in MB-UKA and 76.2±23.5 (range 28–99) in AP-UKA subjects (p=0.549), whereas tibial pain was reported by 24.3% of MB-UKA and 29.7% of AP-UKA patients (p=0.601). None of the patients included in the analysis experienced major complications or surgical revisions during follow-up.

Discussion

Our main finding is that, in an obese population, the 5-year KSFS and OKS were higher in mUKA patients with an AP tibial component than in those wearing an MB component. There were no other significant differences in the functional outcomes and PROMs analyzed. To the best of our knowledge, this is the first study using PSM analysis to highlight differences in PROMs and tibial pain in obese patients subjected to UKA with an AP or an MB tibial component.

Obesity is a known risk factor for osteoarthritis, contributing to an increased demand for total and partial knee replacement compared to normal weight status. Yet, at variance with Kozinn and Scott's criteria [46], there is a growing belief that obesity is not an absolute contraindication for UKA [47, 48]. It is therefore imperative to establish which implant is more appropriate for these patients. Moreover, it is clearly essential to characterize more precisely the expected functional outcomes of this population. PROMs, which have become a cornerstone of UKA outcome assessment, can provide just such information. According to our study, both obese AP-UKA and MB-UKA patients showed significant improvement in all the clinical and functional outcomes considered. Moreover, their scores were actually comparable to those of a population with a lower mean BMI. These data confirm that UKA can effectively addresses KOA also in obese patients. Our findings are consistent with those of Cavaignac et al., who found no significant differences in KSKSs and KSFSs between obese and non-obese patients at an average follow-up of 11.6 years [49].

The higher KSFSs and OKSs found in our AP-UKA group compared to the MB-UKA counterpart contrast with a recent publication by Foo et al. [50] who reviewed 347 obese UKA patients, 237 with an AP and 185 with an MB tibial component. Although the authors found no significant differences in functional outcomes, subgroup analysis highlighted that at two years the more severely obese patients (BMI > 35) wearing an AP tibial component had a worse KSKS, whereas the KSFS, OKS and PCS score were not significantly different [50]. It is reasonable to surmise that these differences may partly be due to different implant design and follow-up duration. Moreover, their populations were non-homogeneous for gender, as significantly more females were included in the AP subgroup, whereas in our study gender and BMI were among the variables matched 1:1.

Our study is the first to compare the FJS in obese AP-UKA and MB-UKA patients. Interestingly our FJS-12 values are comparable to those of other works that did not address specifically an obese population. Indeed, Kim et al. compared the FJS scores of 100 TKAs and 100 UKAs at a mean follow-up of two years, reporting a score of 67.3 ± 19.8 in UKA patients [51]. In a similarly designed study, Zuiderbaan et al. found an FJS score of 73.9 ± 22.8 at one year and of 74.3 ± 24.8 at two years in a cohort 65 UKA patients, with no statistically significant difference between them [52].

Unlike the data reported for TKA by Singh et al. [53], Dai et al. recently found that the preoperative BMI negatively correlated with the FJS, suggesting that patients with more severe obesity had greater difficulty forgetting their UKA. The authors reported an FJS of 78.9 ± 12.5 in 188 UKA patients with a maximum follow-up of three years. The relationship between FJS and BMI was significant both one and three years after surgery, where an increase in FJS was associated with a BMI < 30.

With regard to tibial pain, even though the AP-UKA patients described a higher incidence of pain, the difference between the groups was not significant. This finding is apparently in contrast with our previous data regarding the general population [23]. Although the authors are unable to explain this difference, it might be due to the higher bone mineral density that obese patients display in several bone districts, including the proximal tibia [54], which may reduce the difference in strain patterns.

The main strength of our study is that all procedures were performed by highly experienced surgeons working at a specialized, high-volume knee prosthetic surgery center. All patients followed identical preoperative and postoperative protocols, underwent the same implantation procedure with the same prosthetic implant, and followed a standardized rehabilitation protocol. Moreover, despite its retrospective design, selection bias and potential confounders were minimized by PSM. The study is not without limitations. First of all, patient number and follow-up duration. Secondly, patients' BMI was recorded only before surgery, so any postoperative weight changes are not considered, unlike other studies [55, 56]. Weight may well have affected patient outcomes, even though the literature indicates that most hip or knee surgery patients largely maintain their weight [57, 58]. In addition, the retrospective nature of the analysis is in itself a limitation, despite the application of PSM analysis.

Our findings do not bear out our working hypothesis, since tibial pain and PROMs were not worse in obese mUKA patients wearing an AP compared to an MB tibial component. Rather, our data demonstrate that both components afford similar improvement in functional outcomes, even though the AP-UKA group had better KSFSs and OKSs. The authors feeling is that our findings can help characterize a population where AP UKA can be performed most cost-effectively. Larger sample sizes and longer follow-ups are needed to establish which tibial component provides better clinical results in obese patients in the short, medium, and long term.

Conclusions

At five-year follow-up, in a matched group of obese MB-UKA and AP-UKA patients, the AP group achieved better KSFSs and OKSs. Despite this difference, both the AP and the MB tibial components were able to bring about a significant improvement of the most widely used PROMs.

Abbreviations

mUKA	Medial unicompartmental knee arthroplasty
MB	Metal-backed
AP	All-polyethylene
BMI	Body mass index
PROMs	Patient-reported outcome measures
PSM	Propensity score matching
KSFS	Knee Society Functional Score
OKS	Oxford Knee Society
KOA	Osteoarthritis of the knee
TKA	Total knee arthroplasty
RSA	Radiostereometric analysis
FJS-12	Forgotten Joint Score-12
HRQL	Health-related quality of life
ASA	American Society of Anesthesiologists
KSKS	Knee Society Knee Score
PCS	Physical component summary
SF	Short Form
SMD	Standardized mean difference
SD	Standard deviation

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Author contributions
Conceptualization, CZ, GP and LDB; methodology, LDB, MS and MB; validation, GP, DS and APG; formal analysis, LP, DS and APG; writing—original draft preparation, LDB, MS, MB and GP; writing— review and editing, APG, LP and CZ; supervision, CZ. The author(s) read and approved the final manuscript. All authors have given final approval of the version to be published. All authors read and approved the final manuscript.

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Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board. Informed consent was obtained from all individual participants included in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Price A, Beard D, Thienpont E. Uncertainties surrounding the choice of surgical treatment for bone on bone medial compartment osteoarthritis of the knee. Knee. 2013.
2. Noticewala MS, Geller JA, Lee JH, Macaulay W. Unicompartmental knee arthroplasty relieves pain and improves function more than total knee arthroplasty. J Arthroplasty. 2012;27:99–105.
3. Screpis D, Piovan G, Baldini M, Amarossi A, Natali S, Iacono V, et al. Higher activity level after opening wedge high tibial osteotomy compared to medial unicompartimental knee arthroplasty in a selected cohort of advanced age: a propensity score-matched analysis. Knee. 2023;40:183–91.
4. Gunst S, Fessy MH. The effect of obesity on mechanical failure after total knee arthroplasty. Ann Transl Med. AME Publishing Company; 2015.
5. Xu S, Lim W-AJ, Chen JY, Lo NN, Chia S-L, Tay DKJ et al. The influence of obesity on clinical outcomes of fixed-bearing unicompartmental knee arthroplasty A TEN-YEAR FOLLOW-UP STUDY.
6. Scott CEH, Wade FA, MacDonald D, Nutton RW. Ten-year survival and patient-reported outcomes of a medial unicompartmental knee arthroplasty incorporating an all-polyethylene tibial component. Arch Orthop Trauma Surg. 2018;138:719–29.
7. Lua J, Kripesh A, Kunnasegaran R. Is unicompartmental knee arthroplasty truly contraindicated in an obese patient? A meta-analysis. J Orthop Sci [Internet]. 2023 [cited 2024 Aug 24];28:1317–24. https://pubmed.ncbi.nlm.nih.gov/36336639/
8. Hui HJ, Loke WJ, James WLH. The Influence of Obesity on Unicompartmental Knee Arthroplasty Outcomes: A Systematic Review And Meta-Analysis. Arch Bone Jt Surg [Internet]. 2021 [cited 2024 Aug 24];9:618–32. https://pubmed.ncbi.nlm.nih.gov/35106326/
9. Musbahi O, Hamilton TW, Crellin AJ, Mellon SJ, Kendrick B, Murray DW. The effect of obesity on revision rate in unicompartmental knee arthroplasty: a systematic review and meta-analysis. Knee Surgery, Sports Traumatology, Arthroscopy [Internet]. 2021 [cited 2024 Aug 13];29:3467. /pmc/articles/PMC8458170/
10. Giordano L, Maffulli N, Morenghi E, Quaglia A, Prospero E, Rosa F, et al. A BMI above 30 results in satisfying outcomes in patients undergoing fixed-bearing lateral unicompartmental knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2023;31:1106–12.
11. Cavaignac E, Lafontan V, Reina N, Pailhé R, Warmy M, Laffosse JM et al. Obesity has no adverse effect on the outcome of unicompartmental knee replacement at a minimum follow-up of seven years. Bone Joint J [Internet]. 2013 [cited 2024 Aug 12];95-B:1064–8. https://pubmed.ncbi.nlm.nih.gov/23908421/
12. Small SR, Berend ME, Ritter MA, Buckley CA, Rogge RD. Metal backing significantly decreases tibial strains in a medial unicompartmental knee arthroplasty model. J Arthroplasty. 2011;26:777–82.
13. Furnes BO, Espehaug B, Lie S, Vollset S, Engesieter L. Failure Mechanisms After Unicompartmental and Tricompartmental Primary Knee Replacement with Cement [Internet]. 2007. Available from: www.Jbls.org.
14. Scott CEH, Eaton MJ, Nutton RW, Wade FA, Evans SL, Pankaj P. Metal-backed versus all-polyethylene unicompartmental knee arthroplasty: Proximal tibial strain in an experimentally validated finite element model. Bone Joint Res [Internet]. 2017 [cited 2024 Aug 13];6:22. /pmc/articles/PMC5301904/
15. van der List JP, Kleeblad LJ, Zuiderbaan HA, Pearle AD. Mid-term outcomes of metal-backed unicompartmental knee Arthroplasty Show superiority to all-polyethylene Unicompartmental and total knee arthroplasty. HSS J. 2017;13:232–40.
16. Heyse TJ, Khefacha A, Peersman G, Cartier P. Survivorship of UKA in the middle-aged. Knee. 2012;19:585–91.
17. Hutt JRB, Farhadnia P, Massé V, Lavigne M, Vendittoli P-A. A randomised trial of all-polyethylene and metal-backed tibial components in unicompartmental arthroplasty of the knee.
18. Andriollo L, Montagna A, Mazzella GG, Sangaletti R, Benazzo F, Rossi SMP. Navigated versus conventional medial unicompartmental knee arthroplasty: minimum 18 years clinical outcomes and survivorship of the original Cartier design. Knee. 2024;49:183–91.
19. Costa GG, Lo Presti M, Grassi A, Agrò G, Cialdella S, Mosca M, et al. Metal-backed Tibial Components do not reduce risk of early aseptic loosening in Unicompartmental knee arthroplasty: a systematic review and Meta-analysis. J Knee Surg. 2020;33:180–9.
20. Lee M, Cheng D, Chen J, Liow L, Lo NN, Yeo SJ. No difference in functional outcomes, quality of life and survivorship between metal-backed and all-polyethylene tibial components in unicompartmental knee arthroplasty: a 10-year follow-up study. Knee Surgery, Sports Traumatology, Arthroscopy. 2021;29:3368–74.
21. Elmhiregh A, Abuodeh Y, Alzobi O, Zikria B, Alkhayarin M, Morrey BF. All-polyethylene versus metal-backed tibial components in total knee arthroplasty: a meta-analysis of randomized controlled trials. Eur J Orthop Surg Traumatol. 2023;33:3611–22.
22. Toman J, Iorio R, Healy WL. All-polyethylene and metal-backed tibial components are equivalent with BMI of less than 37.5. Clin Orthop Relat Res. Springer Science and Business Media, LLC; 2012. pp. 108–16.
23. Piovan G, De Berardinis L, Screpis D, Senarighi M, Povegliano L, Natali S et al. Metal-backed or all-poly tibial components: which are better for medial unicompartmental knee arthroplasty? A propensity-score-matching retrospective study at the 5-year follow-up. J Orthop Traumatol. 2024;25.
24. Kohn MD, Sassoon AA, Fernando ND. Classifications in brief: Kellgren-Lawrence classification of Osteoarthritis. Clin Orthop Relat Res. 2016;474:1886–93.
25. Ahlbäck S. Osteoarthrosis of the knee. A radiographic investigation. Acta Radiol Diagn (Stockh). 1968;277:7–72.
26. Rodríguez-Merchán EC, Gómez-Cardero P. Unicompartmental knee arthroplasty: current indications, technical issues and results. EFORT Open Rev. 2018;3:363–73.
27. Cartier P, Sanouiller J-L, Grelsamer RR. Unicompartmental knee arthroplasty surgery 10-Year Minimum follow-up period. J Arthroplasty. 1996.
28. Deschamps G, Chol C. Fixed-bearing unicompartmental knee arthroplasty. Patients' selection and operative technique. Orthopaedics and Traumatology: Surgery and Research; 2011. pp. 648–61.
29. Insall J, Dorr L, Scott R, Scott W. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res. 1989;248:13–4.
30. Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br. 1998;80:63–9.
31. Luger M, Schopper C, Krottenthaler ES, Mahmoud M, Heyse T, Gotterbarm T et al. Not all questions are created equal: the weight of the Oxford knee scores questions in a multicentric validation study. J Orthop Traumatol. 2023;24.
32. Ware JJ, Sherbourne C. The MOS 36-item short-form health survey (SF-36). I. conceptual framework and item selection. Med Care. 1992;30:473–83.

33. Sansone V, Fennema P, Applefield RC, Marchina S, Ronco R, Pascale W et al. Translation, cross-cultural adaptation, and validation of the Italian language Forgotten Joint Score-12 (FJS-12) as an outcome measure for total knee arthroplasty in an Italian population. BMC Musculoskelet Disord. 2020;21.
34. De Berardinis L, Senarighi M, Ciccullo C, Forte F, Spezia M, Gigante AP. Fast-track surgery and telerehabilitation protocol in unicompartmental knee arthroplasty leads to superior outcomes when compared with the standard protocol: a propensity-matched pilot study. Knee Surg Relat Res. 2022;34.
35. Domb BG, Bheem R, Monahan PF, Rosinsky PJ, Maldonado DR, Meghpara MB, et al. Minimum five-year outcomes of hip resurfacing: propensity-score matched against total hip Arthroplasty Control Groups. J Arthroplasty. 2021;36:2012–5.
36. Yoo JD, Huh MH, Shin YS. Risk of revision in UKA versus HTO: a nation-wide propensity score-matched study. Arch Orthop Trauma Surg. 2023;143:3457–69.
37. De Berardinis L, Senarighi M, Farinelli L, Qordja F, Gallo A, Spezia M et al. In primary total hip arthroplasty, the direct anterior approach leads to higher levels of creatine kinase and lower levels of C-reactive protein compared to the posterolateral approach: a propensity score matching analysis of short-term follow-up data. J Orthop Surg Res. 2023;18.
38. Duan X, Zhao Y, Zhang J, Kong N, Cao R, Guan H et al. Learning curve and short-term clinical outcomes of a new seven-axis robot-assisted total knee arthroplasty system: a propensity score-matched retrospective cohort study. J Orthop Surg Res. 2023;18.
39. Xie T, de Vries AJ, van der Veen HC, Brouwer RW. Total knee arthroplasty following lateral closing-wedge high tibial osteotomy versus primary total knee arthroplasty: a propensity score matching study. J Orthop Surg Res. 2024;19.
40. Bahk JH, Jo WL, Kim SC, Kwon SY, Lim YW. Lateral pillar is the key in supporting pre-collapse osteonecrosis of the femoral head: a finite element model analysis of propensity-score matched cohorts. J Orthop Surg Res. 2021;16.
41. Ma M, Song P, Zhang S, Kong X, Chai W. Does robot-assisted surgery reduce leg length discrepancy in total hip replacement? Robot-assisted posterior approach versus direct anterior approach and manual posterior approach: a propensity score-matching study. J Orthop Surg Res. 2023;18.
42. Zhao H, Meng J, Sun T, Wan Z, Qin S, Zhang F et al. Risk factors for deep surgical site infection following surgically treated peri-ankle fractures: a case–control study based on propensity score matching. J Orthop Surg Res. 2022;17.
43. Austin PC. An introduction to propensity score methods for reducing the effects of confounding in observational studies. Multivar Behav Res. 2011;46:399–424.
44. Rosenbaum PR. Optimal matching for Observational studies. Source: Journal of the American Statistical Association; 1989.
45. Austin PC. Some methods of propensity-score matching had superior performance to others: results of an empirical investigation and monte carlo simulations. Biom J. 2009;51:171–84.
46. Kozinn S, Scott R. Unicondylar knee arthroplasty. J Bone Joint Surg Am. 1989;71:145–50.
47. Campi S, Papalia GF, Esposito C, Albo E, Cannata F, Zampogna B et al. Unicompartmental knee replacement in obese patients: A systematic review and meta-analysis. J Clin Med. MDPI; 2021.
48. Vasso M, Antoniadis A, Helmy N. Update on unicompartmental knee arthroplasty: current indications and failure modes. EFORT Open Rev. 2018;3:442–8.
49. Cavaignac E, Lafontan V, Reina N, Pailhé R, Warmy M, Laffosse JM et al. Obesity has no adverse effect on the outcome of unicompartmental knee replacement at a minimum follow-up of seven years. Bone Joint J. 2013;95–1064.
50. Foo WYX, Liow MHL, Chen JY, Tay DKJ, Lo NN, Yeo SJ. All-polyethylene unicompartmental knee arthroplasty is associated with increased risks of poorer knee society knee score and lower satisfaction in obese patients. Arch Orthop Trauma Surg. 2022;142:3977–85.
51. Kim MS, Koh IJ, Choi YJ, Lee JY, In Y. Differences in Patient-Reported Outcomes between Unicompartmental and total knee arthroplasties: a propensity score-matched analysis. J Arthroplasty. 2017;32:1453–9.
52. Zuiderbaan HA, van der List JP, Khamaisy S, Nawabi DH, Thein R, Ishmael C, et al. Unicompartmental knee arthroplasty versus total knee arthroplasty: which type of artificial joint do patients forget? Knee surgery, sports Traumatology. Arthroscopy. 2017;25:681–6.
53. Singh V, Yeroushalmi D, Lygrisse KA, Simcox T, Long WJ, Schwarzkopf R. The influence of obesity on achievement of a 'forgotten joint' following total knee arthroplasty. Arch Orthop Trauma Surg. 2022;142:491–9.
54. Evans AL, Paggiosi MA, Eastell R, Walsh JS. Bone density, microstructure and strength in obese and normal weight men and women in younger and older adulthood. J Bone Miner Res [Internet]. 2015 [cited 2024 Aug 22];30:920–8. https://pubmed.ncbi.nlm.nih.gov/25400253/
55. D'Ambrosi R, Nuara A, Mariani I, Corona K, Mogos S, Catellani F et al. Return to physical activity and change in body mass index after hypoallergenic medial mobile-bearing unicompartmental knee arthroplasty. J Orthop Traumatol. 2021;22.
56. D'Ambrosi R, M Anghilieri F, Corona K, Mariani I, Valli F, Ursino N, et al. Similar rates of return to sports and BMI reduction regardless of age, gender and preoperative BMI as seen in matched cohort of hypoallergenic and standard Cobalt Chromium medial unicompartmental knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2022;30:890–8.
57. Ast MP, Abdel MP, Lee YY, Lyman S, Ruel AV, Westrich GH. Weight changes after total hip or knee arthroplasty: prevalence, predictors, and effects on outcomes. J Bone Joint Surg - Am Volume. 2014;97:911–9.
58. Dai Yke, Lin W, Yang G, min, Lu J feng, Wang F. Joint Awareness after Unicompartmental Knee Arthroplasty Evaluated with the Forgotten Joint Score. Orthop Surg. 2020;12:218–23.

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