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Magnitude of Change in Leg Length and Clinical Impact Following Medial Unicompartmental Knee Arthroplasty

Tarik Bayoumi, MD [a, b, *], Gaby V. ten Noever de Brauw, BSc [a, b], Lindsey V. Ruderman, BA [a], Jelle P. van der List, MD, PhD [b, c], Gino M.M.J. Kerkhoffs, MD, PhD [b, c], Hendrik A. Zuiderbaan, MD, PhD [d], Andrew D. Pearle, MD [a]

[a] Department of Orthopaedic Surgery, Hospital for Special Surgery, Computer Assisted Surgery Center & Sports Medicine, Weill Medical College of Cornell University, New York, New York
[b] Department of Orthopaedic Surgery, Amsterdam UMC Location University of Amsterdam, Amsterdam, The Netherlands
[c] Amsterdam Movement Sciences, Sports, Ageing & Vitality, Amsterdam, The Netherlands
[d] Department of Orthopaedic Surgery, Medische Kliniek Velsen, Velsen, The Netherlands

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ABSTRACT

Background: Change in leg length and leg-length discrepancy (LLD) are common concerns among patients undergoing medial unicompartmental knee arthroplasty (UKA). This study aimed to quantify the magnitude of leg-length change, prevalence of postoperative LLD, and their clinical implications following medial UKA.

Methods: Leg length and mechanical hip-knee-ankle angle (mHKA) were retrospectively measured in 332 patients following unilateral robotic-arm assisted medial UKA for medial compartment osteoarthritis, using calibrated long-leg radiographs. The Knee Injury and Osteoarthritis Otcome Score for Joint Replacement and patient satisfaction were analyzed to assess impact of leg-length change and LLD on outcomes.

Results: Following medial UKA, median leg-length change was 2.0 mm (interquartile range, −1.0 to 5.0 mm; $P < .001$) with a mean correction in mHKA of 4.4° ± 2.7 ($P < .001$). A total of 158 patients (48%) had a leg-length increase by 0 to 5 mm, 64 (19%) by 6 to 10 mm, and 11 (3%) by >10 mm. Leg-length change was positively correlated with mHKA correction ($R = 0.44$, $P < .001$). Postoperatively, moderate (5 to 10 mm) and substantial LLD (≥10 mm) were present in 49% and 17% of patients, respectively. Four-year Knee Injury and Osteoarthritis Outcome Score for Joint Replacement were comparable between patients with and without substantial postoperative LLD ($P = .976$). Proportions of satisfied patients were similar between groups ($P = .687$).

Conclusion: Following medial UKA, the majority of patients had a moderate increase in leg length, the magnitude of which was positively correlated to the correction in mechanical alignment. Postoperative substantial LLD was not uncommon (17% prevalence); however, it had no significant impact on patient-reported outcomes or satisfaction at 4 years follow-up.

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* Address correspondence to: Tarik Bayoumi, MD, Research Fellow Computer Assisted Surgery & Sports Medicine, Hospital for Special Surgery, 535 70th Street, New York, NY 10021.

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Unicompartmental knee arthroplasty (UKA) is a well-established surgical treatment for medial compartment osteoaruthritis (OA) of the knee, with the potential for high patient satisfaction, a fast recovery and improved functional outcomes [1–3]. However, change in leg length as well as leg-length discrepancy (LLD) are common concerns among patients undergoing medial UKA.

Medial UKA aims to resurface the affected compartment and to recreate native alignment and knee kinematics, guided by restoration of ligament balance [4,5]. The change in coronal alignment

that often occurs secondary to the intra-articular correction may also lead to a concomitant change in leg length. Nevertheless, in contrast to total hip- and knee arthroplasty [6–8], the magnitude of change in leg length following medial UKA, as well as its influence on postoperative outcomes remains largely undefined as only limited literature is available on this topic [9]. Given the increased interest in UKA as treatment for medial compartment OA [10,11] and the importance of expectation management during surgical counseling, it would be of interest to characterize leg-length changes following medial UKA.

This study aimed to quantify the magnitude of change in leg length, prevalence of postoperative LLD, and their clinical implications following medial UKA in an arthritic cohort. We hypothesized that medial UKA would lead to a subtle increase in leg length, without a significant impact on patient-reported outcomes.

Methods

Patients and Study Design

Following Institutional Review Board approval (Number 2022-0509), the arthroplasty registry of the senior author (ADP) was screened for patients who received medial UKA between November 1, 2008, and August 1, 2016. Patients were eligible for inclusion if they received primary unilateral robotic-arm assisted medial UKA for medial compartment OA, and completed patient reported outcomes at ≥2 years follow-up. Patients were excluded if they had incomplete, or uncalibrated radiographic records (preoperative and postoperative weight bearing anteroposterior and long-leg radiographs), had a history of tibial or femoral fractures on either side, had a history of hip- or knee arthroplasty on either side, or received simultaneous bilateral knee arthroplasty.

The surgical inclusion criteria for medial UKA were advanced medial compartment OA (Kellgren-Lawrence grade 3 to 4 [12] on anteroposterior weightbearing radiographs), a passively correctable varus deformity, and a fixed flexion deformity of <10°. Clinical or radiographic signs of lateral compartment OA, lateral patellar facet degeneration, prior medial collateral ligament (MCL) surgery, anterior cruciate ligament deficiency with clinical instability, or signs of inflammatory arthritis were contraindications for medial UKA.

We identified 332 patients (332 knees) who met the study inclusion criteria (Figure 1). The mean age at time of surgery was 63 years (range, 41 to 87), mean body mass index was 29 (range, 18 to 46), and 182 patients (55%) were men.

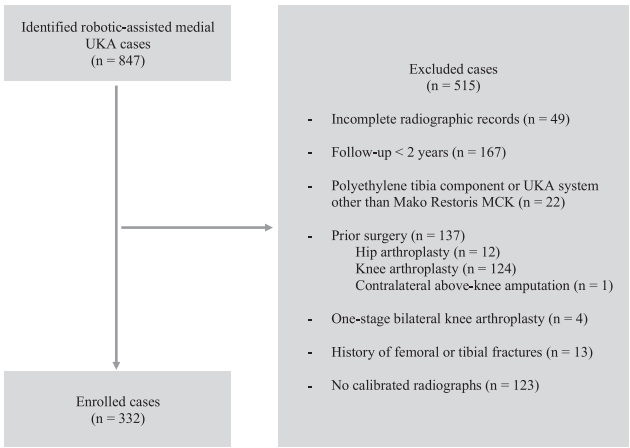

Fig. 1. Flowchart of patient inclusion. UKA, unicompartmental knee arthroplasty.

Implant and Surgical Technique

All procedures were performed by a single surgeon (ADP). A robotic-arm assisted system (Mako Surgical Corp. (Stryker), Fort Lauderdale, FL) was used for implant planning and bone preparation. All patients received a cemented prosthesis with a fixed-bearing tibial only implant (Restoris MCK System, Mako Surgical Corp. (Stryker)). The surgical goal was to restore prearthritic alignment, guided by retensioning of the MCL [4,13,14]. Ligament balance was considered optimal if a stability test under valgus stress, with the polyethylene insert in place, demonstrated a 1 to 2 mm medial gap.

Radiographic Evaluation

Radiographic measurements were performed using routine preoperative and 6-weeks postoperative weight bearing long-leg radiographs. Patients were instructed to stand with their knees fully extended, their feet as close together as possible, their patellae facing forward, and their bodyweight evenly distributed over both limbs while obtaining these radiographs.

All radiographic measurements were performed independently and blinded to postoperative outcomes by 2 observers (GVB and LVR), using a Picture Archiving and Communication System (PACS, Sectra, Imtec AB, version 16, Linköping, Sweden). Intraclass correlation coefficients (ICC) were calculated to assess interobserver reliability, using a 2-way mixed model with absolute agreement. The ICC was excellent for all measurements (ICC mHKA: 0.95 [95% confidence interval (CI) 0.95 to 0.97]; leg length: 0.99 [95% CI 0.98 to 0.99]).

Leg Lengths

Leg lengths of both limbs were measured on preoperative and postoperative calibrated radiographs from the top of the femoral head to the center of the tibial plafond (Figure 2A) [6]. To ensure accurate scaling of the postoperative radiograph, the preoperative leg length of the nonoperative side was used as an internal control to correct for any magnification changes between preoperative and postoperative radiographs. Moderate LLD was defined as a leg-length difference between both limbs of 5 to 10 mm and substantial LLD as a difference of ≥10 mm [6,15].

Mechanical Axis

Preoperative and postoperative mechanical hip-knee-ankle angle (mHKA) were measured as the angle between the mechanical axis of the femur and the mechanical axis of the tibia (Figure 2B). Varus angles were reported as positive values.

Patient-Reported Outcome Measures

The Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS, JR) [16] was completed at a minimum of 2 years follow-up (range, 2 to 9). Additionally, patient satisfaction with the overall function of the operative knee was rated on a 5-point Likert scale (ie, “very satisfied,” “satisfied,” “neutral,” “dissatisfied,” or “very dissatisfied”).

Data Analyses

Data were tested for normality using Shapiro-Wilk tests. Parametric or non-parametric tests were used when appropriate. Preoperative and postoperative normally distributed continuous variables of the operative knee were compared using paired *t*-tests.

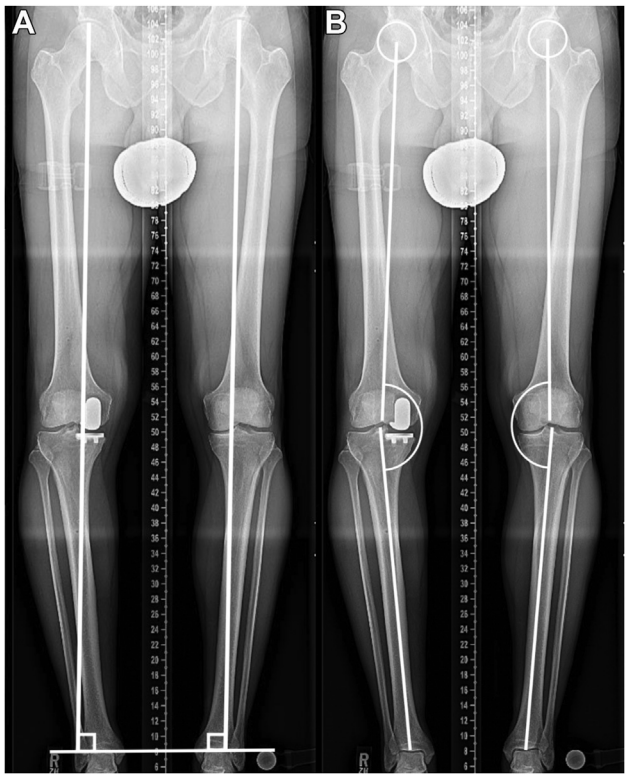

Fig. 2. Postoperative weigth bearing long-leg anteroposterior radiograph following medial unicompartmental knee arthroplasty. A, Leg length was measured from the top of the femoral head to the base of the tibial plafond. B, The mechanical hip-knee-ankle angle (mHKA) measured as the angle between the mechanical axis of the femur and the mechanical axis of the tibia.

Comparison of continuous data between groups was carried out with the independent samples *t*-tests or Mann-Whitney U tests. *Chi*-square tests were used to compare discrete variables. Correlations were examined using Pearson's or Spearman's rank correlations. Radiographic outcomes were compared between preoperative alignment categories (ie, neutral: 0 to 3°; varus: 3 to 10°; and substantial varus: >10°), using 1-way analyses of variance (ANOVA) or Kruskal-Wallis tests. Patient-reported outcomes were compared between patients who did and did not have postoperative LLD. There were 77 patients who received hip- or knee arthroplasty on the contralateral side during the follow-up period (following medial UKA) who were excluded from this analysis, as contralateral joint arthroplasty may have altered the magnitude of LLD as classified directly following the index procedure. Satisfaction scores were dichotomized into 'satisfied' (ie, very satisfied and satisfied), and 'not satisfied' (ie, neutral, dissatisfied, and very dissatisfied). The level of significance was set at 0.05. Analyses were performed in R version 4.1.2. (R Foundation for Statistical Computing, Vienna, Austria).

Results

Leg Length and Leg-Length Discrepancy

Preoperatively, mean leg length of the operative side was significantly shorter than that of the nonoperative side, with a mean difference of −2.5 ± 6.5 mm ($P < .001$; Table 1, Figure 3A). Moderate preoperative LLD was present in 168 patients (51%), and substantial preoperative LLD in 58 patients (18%).

Following medial UKA, leg length of the operative side increased by 0 to 5 mm in 158 patients (48%), by 6 to 10 mm in 64 patients (19%), and by >10 mm in 11 patients (3%) (Figure 4). The median preoperative to postoperative change in leg length was 2.0 mm (interquartile range, −1.0 to 5.0 mm; $P < .001$). Postoperative mean leg length of the operative side was similar to that of the nonoperative side, with a mean difference of −0.4 ± 6.7 mm ($P = .285$; Table 1, Figure 3B).

A total of 162 patients (49%) had moderate postoperative LLD, and 55 patients (17%) had substantial postoperative LLD.

Mechanical Alignment and the Relation to Change in Leg Length

The mean preoperative to postoperative correction in mHKA was 4.4° ± 2.7 ($P < .001$; Figure 5). There was a moderate positive correlation between change in mechanical alignment and magnitude of change in leg length following medial UKA ($R = 0.44$; $P < .001$), indicating that each additional 1° mHKA correction after the first two degrees, would lead to a 0.77 mm increase in leg length, as shown in Figure 6. When comparing preoperative alignment categories, increase in leg length was greatest in patients with substantial preoperative varus (Table 2). Table 3 displays an overview of postoperative alignment and leg-length outcomes that can be expected based on a patient's preoperative difference in leg length and mechanical alignment.

Table 1
Radiographic Outcomes of Included Knees ($n = 332$).

Variable	Preoperatively		*P* Value	Postoperatively	*P* Value
	Operative Side	Nonoperative Side		Operative Side	
	Mean ± SD or n (%)			Mean ± SD or *n* (%)	
Leg length (mm)					
Leg length	827 ± 57.5	830 ± 57.7	<.001[a]	829 ± 57.9	<.001[a,b]
Range	(649 to 990)	(648 to 985)		(643 to 984)	
Difference between both limbs	−2.5 ± 6.5		<.001[a]	−0.4 ± 6.7	.285[c]
Range	(−20 to 16)			(−18 to 22)	
Mechanical axis (°)					
mHKA	7.2° ± 3.6	4.3° ± 3.6		2.8° ± 2.3	
Range	(−2.8 to 17.9)	(−8.2 to 17.8)		(−3.9 to 10.6)	

Radiographic outcomes are presented for all included knees in mean ± standard deviation (SD) and range.
mHKA, mechanical hip-knee-ankle angle.
[a] Indicates statistical significance.
[b] Comparison of preoperative and postoperative leg length of the operative side using paired *t*-test.
[c] Comparison of the postoperative difference in leg length between the operative and nonoperative side using independent samples *t*-test.

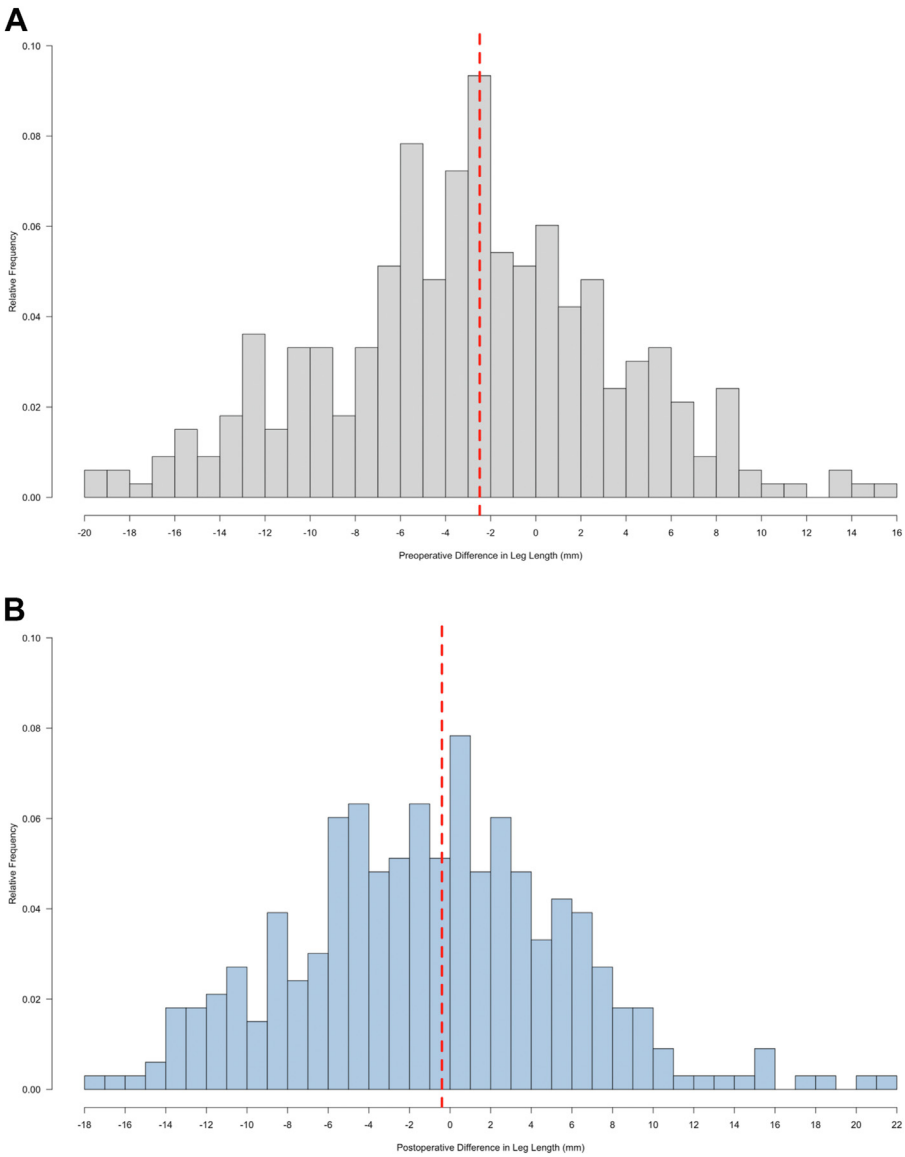

Fig. 3. A, Distribution of preoperative difference in leg length between the operative and nonoperative side. The dashed vertical line indicates the mean of −2.5 mm. B, Postoperative difference in leg length between the operative and nonoperative side following medial unicompartmental knee arthroplasty. The dashed vertical line indicates the mean of −0.4 mm.

Patient-Reported Outcomes

Overall mean KOOS, JR was 84.6 ± 15.9 at average 4.1 years follow-up (range, 2.0 to 9.2). The KOOS, JR outcomes were similar between patients who did and did not have moderate or substantial postoperative LLD (Table 4). Overall change in leg length of the operative limb was not associated with KOOS, JR outcomes (R = 0.02, P = .680). Furthermore, there was no relation between postoperative difference in leg length between limbs and KOOS, JR (R = 0.05, P = .367).

Overall, 90% of patients were satisfied with the overall function of their operative knee, with comparable satisfaction rates between groups (Table 4).

Discussion

The main findings of the present study were that medial UKA as treatment for medial compartment OA led to a moderate increase in leg length in the majority of patients. The magnitude of change in leg length following medial UKA was moderately correlated to the correction in mechanical alignment; therefore, allowing for rough estimation of expected change in leg length, based on the anticipated correction of the coronal deformity. Substantial LLD was not uncommon following medial UKA with a prevalence of 17%; however, both moderate and substantial postoperative LLD were not associated with inferior 4-year patient-reported outcomes, nor was there a relation between the magnitude of postoperative difference in leg length between both limbs and outcomes. These observations suggest that LLD following medial UKA may not necessarily result in inferior outcomes. It is important to note, however, that the etiology of LLD in this study may have been unrelated to the knee.

Medial UKA candidates often express concerns with regard to alteration in leg length following the surgery. The present study demonstrated that patients considering medial UKA for medial compartment OA can anticipate a moderate increase in leg length following this procedure, the magnitude of which largely depends on the correction of the coronal deformity. This is a logical finding that corresponds with the surgical principles of UKA. Medial UKA

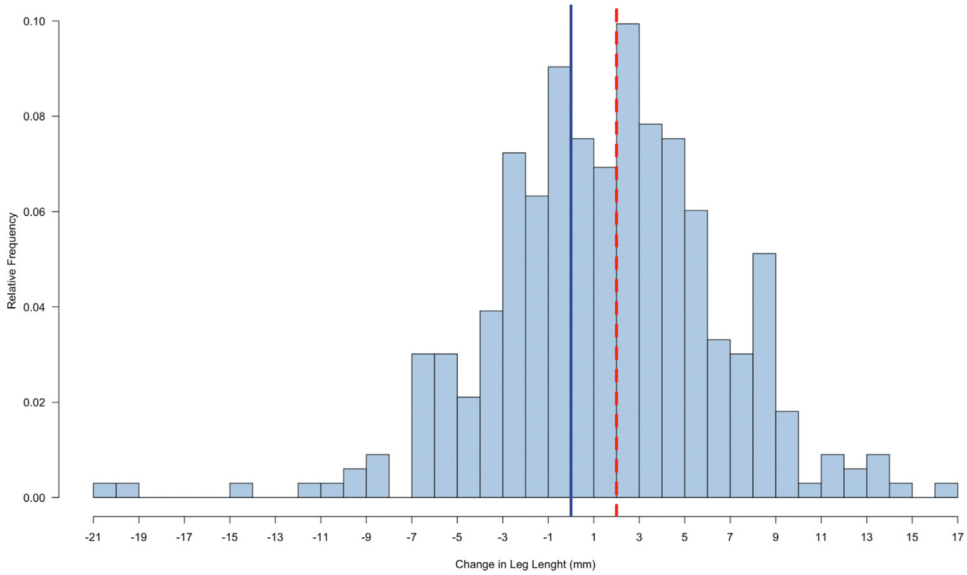

Fig. 4. Distribution of the preoperative to postoperative change in leg length following medial unicompartmental knee arthroplasty. The solid vertical line indicates the border between knees with lengthening (positive values) and knees with shortening (negative values) following the procedure. The dashed vertical line indicates the median of 2.0 mm.

aims to resurface the affected compartment while simultaneously aiming to restore the prearthritic alignment. The correction of the mechanical axis follows secondary to correction of the intra-articular deformity that is achieved through optimization of component size and position, and is commonly guided by restoration of MCL tension. In other words, UKA aims to restore the predisease state of the knee within the constraints of its soft tissue envelope. Therefore, only subtle changes in leg length are generally expected. However, a greater preoperative deformity secondary to medial compartment OA may require a greater intra-articular correction to retension the MCL, which naturally leads to a more substantial concomitant change in leg length (Table 2, Figure 6).

According to our data, each additional 1° mHKA correction after the first two degrees of correction, can lead to a 0.77 mm increase in leg length (Figure 6). However, our study did not assess the influence of correction in the sagittal plane, which has been shown to positively correlate with leg-length change following TKA [7]. Given that sagittal plane corrections are likely to factor into to the overall leg-length change following medial UKA, it is important to consider that estimation of leg-length change based on mHKA correction alone may underestimate the final outcome. Taking this limitation into account, estimating leg-length change through anticipated mHKA correction may still provide an easy and practical method to facilitate patient counseling in daily clinical practice.

To the author's knowledge, only 1 previous study has reported on change in leg length following medial UKA. A study by Zhao et al. [9] of 114 patients observed an average increase in leg length of 9.4 mm and postoperative substantial LLD ($\geq$10 mm) in 22% of patients following medial UKA. The prevalence of postoperative substantial LLD in our study was comparable at 17%. Although average coronal alignment correction was similar to the study by Zhao et al. [9], the overall leg-length increase following medial UKA in the present

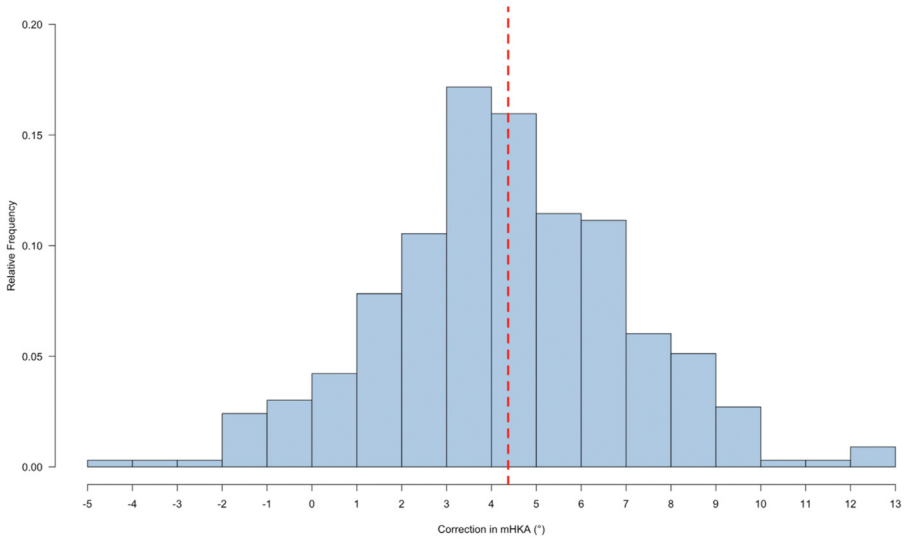

Fig. 5. Distribution of the preoperative to postoperative correction in mechanical alignment (mHKA, mechanical hip-knee-ankle angle) following medial unicompartmental knee arthroplasty. The dashed vertical line indicates the mean of 4.4°.

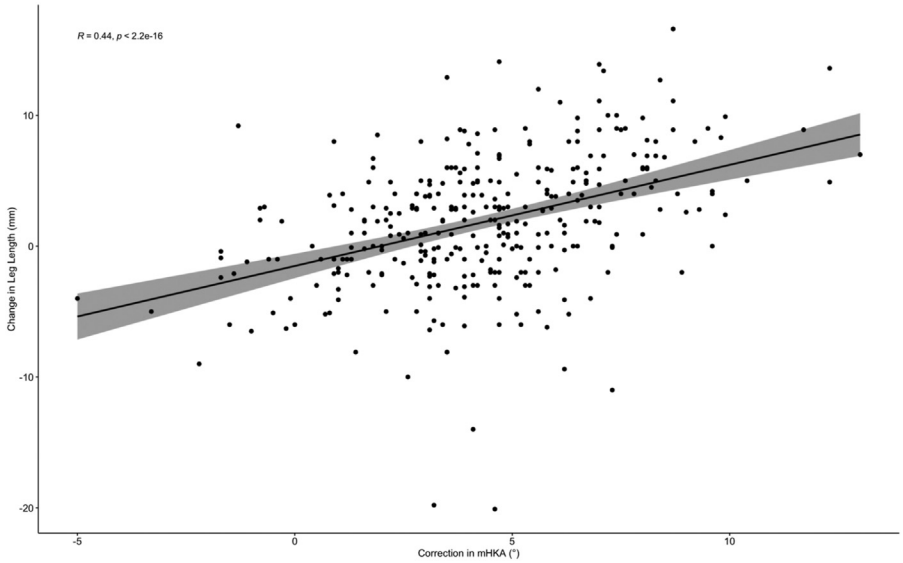

Fig. 6. Relation between the correction in mechanical alignment (mHKA, mechanical hip-knee-ankle angle) and the magnitude of change in leg length following medial unicompartmental knee arthroplasty ($R = 0.44$; $P < .001$).

study appeared to be less substantial. However, direct comparison of the current findings was limited due to the lack of distributional data in their study [9]. Additionally, the study by Zhao et al. [9], did not specify whether calibrated radiographs were used to measure leg length, or whether any corrections were made to adjust for potential magnification changes between preoperative and postoperative radiographs. These methodological differences could have influenced leg-length measurements in their series [9] and may have led to discrepancy in reported change in leg length following medial UKA compared to the current study. Other factors such as method of leg-length measurement, surgical technique, and presence and magnitude of any flexion deformities, may have further contributed to this discrepancy.

The present study found that while mean preoperative leg-length difference was reduced from −2.5 mm to a non-significant mean difference of −0.4 mm following medial UKA, the prevalence of moderate and substantial LLD remained consistent preoperative to postoperatively. Although the exact etiology of LLD in our cohort remained unclear, it is conceivable that postoperative LLD was related to osteoarthritic changes in the contralateral knee, with the operative side being lengthened while the contralateral knee retained OA-related deformities. Nevertheless, the definition of LLD has not been well-established in the literature and it is not known what degree of LLD could lead to musculoskeletal symptoms [17]. For this study, a 10 mm cut-off was chosen, as LLD of ≥10 mm has been associated with inferior outcomes following hip arthroplasty [8]. Given the fundamental differences between hip arthroplasty and UKA, a range of 5 to 10 mm (moderate LLD) was also included in the present study. Moderate LLD was common prior to and following medial UKA, however, did not have a significant impact on mid-term KOOS, JR outcomes, or patient satisfaction when compared to patients who did not have LLD. Similarly, LLD with the cut-off set at 10 mm was not associated with inferior outcomes. Although no correlation was observed between postoperative LLD and patient-reported outcomes, it remains unclear what degree of LLD can be tolerated following medial UKA.

There are several potential limitations to this study that should be taken into consideration. The retrospective study design was

Table 2
Radiographic Outcomes by Preoperative Alignment Group ($n = 329$).

Variable	Neutral 0 to 3°	Varus 3 to 10°	Substantial Varus >10°	*P* Value
	Mean ± SD or *n* (%)			
No. knees[b]	52	218	59	
Leg length (mm)				
Preoperative leg length	820 ± 65	827 ± 58	834 ± 51	.446
Postoperative leg length	820 ± 65	829 ± 58	839 ± 50	.215
Preoperative difference between both limbs	−1.0 ± 6.4	−2.3 ± 6.1	−4.1 ± 7.3	.02[a]
Postoperative difference between both limbs	−1.4 ± 6.9	−0.4 ± 6.4	0.9 ± 7.5	.243
Preoperative to postoperative change in leg length	−0.3 ± 3.3	1.6 ± 4.9	5.0 ± 5.5	<.001[a]
Postoperative LLD (5 to 10 mm)	26 (50%)	100 (46%)	33 (56%)	.337
Postoperative LLD (≥10 mm)	10 (19%)	29 (13%)	13 (20%)	.201
Lower limb alignment (°)				
Preoperative mHKA	2.2° ± 1.0	7.1° ± 1.8	12.6° ± 1.6	<.001[a]
Postoperative mHKA	0.7° ± 1.4	2.8° ± 2.0	5.0° ± 2.2	<.001[a]
Preoperative to postoperative correction in mHKA	1.5° ± 1.8	4.2° ± 2.0	7.6° ± 2.1	<.001[a]

Radiographic outcomes are presented in mean ± standard deviation (SD) or in numbers and frequencies (%).
LLD, leg-length discrepancy; mHKA, mechanical hip-knee-ankle angle.
[a] Indicates statistical significance.
[b] A total of 3 patients had a preoperative valgus deformity and were therefore not included in this analysis.

Table 3
Excepted Change in Leg Length and Difference in Leg Length Following Medial UKA Based on Preoperative Radiographic Categories.

Radiographic Categories	No. Knees	Preoperative		Postoperative		Preoperative to Postoperative
		mHKA (°)	LL Difference (mm)	mHKA (°)	LL Difference (mm)	Change in LL (mm)
		Mean ± SD (Range)		Mean ± SD (Range)		Mean ± SD (Range)
Preoperative LL difference						
>10 mm	45	7.9° ± 4.2 (−1.4 to 17.9)	−10.0 ± 9.7 (−20.0 to 16.0)	3.0° ± 2.6 (−3.9 to 8.0)	−5.8 ± 8.5 (−17.9 to 22.4)	4.0 ± 5.3 (−19.8 to 16.6)
9 to 10 mm	32	8.4° ± 3.7 (1.3 to 16.2)	−3.6 ± 8.8 (−10.0 to 10.0)	3.4° ± 2.3 (−0.9 to 7.8)	−1.5 ± 9.4 (−16.1 to 21.0)	2.0 ± 6.5 (−20.1 to 13.4)
7 to 8 mm	27	8.3° ± 3.1 (4.6 to 15.8)	−1.9 ± 7.2 (−8.0 to 8.0)	3.2° ± 2.4 (−1.1 to 8.9)	0.6 ± 6.6 (−11.0 to 19.0)	2.3 ± 4.9 (−10.0 to 11.1)
5 to 6 mm	64	6.6° ± 3.4 (−2.8 to 13.8)	−1.8 ± 5.2 (−6.0 to 6.0)	2.5° ± 2.0 (−1.4 to 7.8)	0.3 ± 5.8 (−14.2 to 11.0)	2.0 ± 5.0 (−9.4 to 13.9)
3 to 4 mm	65	6.8° ± 3.7 (0.1 to 16.9)	−0.8 ± 3.3 (−4.0 to 4.0)	2.8° ± 2.2 (0.9 to 8.6)	0.5 ± 5.6 (−13.0 to 16.0)	1.1 ± 4.8 (−9.0 to 12.0)
0 to 2 mm	99	6.9° ± 3.3 (0.0 to 15.1)	−0.3 ± 1.4 (−2.0 to 2.0)	2.7° ± 2.5 (−1.8 to 16.0)	1.1 ± 4.6 (−13.0 to 16.0)	1.2 ± 4.3 (−14.0 to 14.1)
Preoperative alignment						
>12°	33	13.7° ± 1.4 (12.1 to 17.9)	−4.7 ± 7.4 (−17.0 to 9.0)	5.6° ± 2.4 (−0.7 to 8.9)	1.4 ± 7.6 (−12.8 to 19.0)	5.7 ± 6.1 (−20.1 to 13.9)
9 to 12°	69	10.3° ± 0.9 (9.1 to 12.0)	−3.7 ± 5.7 (−20.0 to 14.0)	4.2° ± 1.8 (0.0 to 10.6)	−0.3 ± 7.0 (−15.0 to 22.4)	3.2 ± 5.0 (−9.4 to 16.6)
6 to 9°	103	7.4° ± 0.9 (6.1 to 9.0)	−2.4 ± 6.2 (−18.0 to 14.0)	2.7° ± 2.0 (−2.5 to 7.8)	0.0 ± 6.5 (−17.9 to 16.3)	2.5 ± 4.8 (−19.8 to 14.1)
3 to 6°	86	4.7° ± 0.9 (3.1 to 6.0)	−1.2 ± 5.8 (−15.0 to 16.0)	1.8° ± 1.7 (−1.4 to 6.9)	−1.3 ± 6.1 (−13.0 to 13.8)	−0.3 ± 4.2 (−14.0 to 8.5)
0 to 3°	36	1.9° ± 0.8 (0.1 to 3.0)	−1.4 ± 6.7 (−15.0 to 15.0)	0.8° ± 1.3 (−1.8 to 3.3)	−1.2 ± 6.8 (−13.9 to 18.6)	0.1 ± 3.0 (−6.0 to 5.6)
−3 to 0°	5	−1.1° ± 1.1 (−2.8 to 0.0)	−3.6 ± 6.7 (−12.0 to 6.0)	−0.2° ± 3.0 (−3.9 to 4.1)	−5.0 ± 8.7 (−13.2 to 7.3)	−1.7 ± 5.0 (−5.1 to 6.7)

Expected preoperative to postoperative change in leg length of the operative limb and postoperative difference in leg length between both limbs following medial unicompartmental knee arthroplasty (UKA), based on the preoperative difference in leg length and preoperative coronal deformity. Radiographic outcomes are presented in mean ± standard deviation (SD) and range.
LL difference, leg-length difference between the operative and nonoperative limb; mHKA, mechanical hip-knee-ankle angle.

Table 4
Comparison of Mid-Term Patient-Reported Outcomes for Postoperative Radiographic LLD.

Variable	Moderate LLD (5 to 10 mm)			Substantial LLD (≥10 mm)		
	No LLD	LLD	*P* Value	No LLD	LLD	*P* Value
Demographics						
No knees[a]	135	120		211	44	
Age (y) mean ± SD	62.6 ± 9.3	63.8 ± 9.4	.286	62.9 ± 9.3	64.2 ± 9.5	.393
BMI (kg/m^2), mean ± SD	28.8 ± 5.0	29.3 ± 4.9	.290	29.0 ± 4.9	29.3 ± 5.2	.522
Gender, male, n (%)	81 (60%)	61 (53%)	.228	120 (57%)	24 (55%)	.777
KOOS, JR						
No. knees	135	120		211	44	
Mean ± SD	84.0 ± 17.1	83.0 ± 15.5	.397	83.6 ± 16.3	83.4 ± 16.9	.976
Range	(0.0 to 100.0)	(36.9 to 100.0)		(0.0 to 100.0)	(47.4 to 100.0)	
Patient satisfaction						
No. knees	129	115		204	40	
Satisfied, n (%)	112 (87%)	103 (90%)	.509	179 (88%)	36 (90%)	.687
Not satisfied, n (%)	17 (13%)	12 (11%)		25 (12%)	4 (10%)	

Outcomes are presented in mean ± standard deviation (SD) or in numbers and frequencies.
Satisfied indicates being "very satisfied" or "satisfied" with the operative knee; not satisfied indicates being "neutral", "dissatisfied" or "very dissatisfied" with the operative knee.
BMI, Body Mass Index; KOOS, JR, Knee Injury and Osteoarthritis Outcome Score for Joint Replacement; LLD, leg-length discrepancy.
[a] A total of 77 patients underwent contralateral knee or hip arthroplasty within the study follow-up period and were excluded from this analysis.

prone to selection bias and due to this design, direct causality between LLD status and postoperative outcomes could not be established. To minimize confounding variables in these analyses, we excluded patients who underwent joint arthroplasty within the study follow-up, which could have altered the graded magnitude of LLD directly following the index procedure. Also, the status of the contralateral knee was not considered and the presence of any osteoarthritic changes in the contralateral knee may have influenced LLD analyses. However, limiting the study sample to patients who have an unaffected contralateral knee could have led to a less representative cohort of medial UKA patients [18]. In addition, full-length lateral views were not routinely obtained at our institution, and therefore the presence of any flexion deformities could not be assessed. Patients who had a fixed flexion deformity of $\geq 10^{\circ}$ were not considered candidates for UKA, and therefore no large flexion deformities were present in this cohort. However, the presence of mild preoperative flexion deformities could not be ruled out. Hence, some of the outliers shown in Figure 4 may be explained by correction of a large varus deformity in addition to correction of a mild sagittal deformity ($<10^{\circ}$). Additionally, some patients had relative shortening of leg length following the procedure which may be due to inability to achieve full extension in the early postoperative period. Both these factors may have influenced our observations. Furthermore, all procedures were performed by a single surgeon using a robotic-arm assisted technique, which may limit generalizability of the observed results. Nevertheless, the present study provides insight into change in leg length and impact on patient-reported outcomes following medial UKA in a large cohort of 332 patients. Future research should consider change in the sagittal plane in relation to leg length, as well as the status of the contralateral knee in order to provide a more accurate estimation of the expected change in leg length and magnitude of leg-length differences following medial UKA.

Conclusion

The findings of this study suggest that patients who have medial compartment OA can anticipate a moderate increase in leg length following medial UKA, the magnitude of which is positively correlated to the correction in mechanical alignment. Postoperative substantial LLD was not uncommon in our study (17% prevalence); however, it had no significant impact on patient-reported outcomes or satisfaction at 4 years follow-up.

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