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Foot and/or ankle problems following limb alignment changes in uni-compartmental knee arthroplasty

Harun Reşit Güngör[1], Gökhan Bayrak[2], Hakan Zora[3], Raziye Şavkın[4] and Nihal Büker[4]

Abstract

Objective: Foot and/or ankle (F/A) problems may be encountered in medial uni-compartmental knee (UKA) patients postoperatively due to the limb alignment changes and alterations in weight bearing of F/A. This study aimed to evaluate the risk factors and the incidence of foot and ankle (F/A) problems in (UKA) arthroplasty patients. **Methods:** Patients who underwent UKA between 2016 and 2019 in our clinic were evaluated and the presence of F/A problems was recorded. Radiologic evaluations included hip knee ankle angle (HKA), medial proximal tibial angle, posterior tibial slope angle, talar tilt angle, talar inclination, talar dome to mechanical axis (TDMA), and talocrural angle (TCA) measured on preoperative and follow-up long-leg standing radiographs. The range of motion, Q angles, and muscle strengths were measured. Visual analog scale, physical performance limitations, and patient-reported activity limitations were evaluated for all patients. Patients with reported F/A problems were additionally evaluated with Foot Functional Index. **Results:** Forty-four patients (38 female, 6 male; mean age 58.66 ± 8.6 years; mean BMI 31.30 ± 3.81, mean follow-up period 34.22 ± 18.95 months) were included in the study. There were 13 patients (29.5%) with reported F/A problems. Postoperative comparison of patients with and without F/A problems showed statistically significant differences in only WOMAC and SF12 physical health sub-scores ($p = 0.002$, $p = 0.003$, respectively). There was no significant postoperative change in TDMA in patients with F/A problems ($p > 0.05$) in contrast to patients without F/A problems ($p = 0.006$). There was no statistically significant difference in preoperative TCA measurements between groups ($p = 0.79$). Comparison of knee and ankle radiologic measurements between groups demonstrated significant difference only in postoperative HKA measurements (-2.82 ± 2.53 vs. -0.80 ± 3.12, $p = 0.033$). **Conclusion:** F/A problems adversely affecting the functional status were frequent in our cohort of UKA patients. Postoperative residual varus deformity may be a risk factor for this. Therefore, if slight varus alignment is aimed at UKA patients, preoperative F/A status should be evaluated.

Keywords

Unicompartmental knee arthroplasty, foot, ankle, physical functional performance

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Introduction

Osteoarthritis (OA) is one of the most important reasons of morbidity in the elderly population and is frequently encountered in the knee joints.[1] Knee osteoarthritis has been reported to be detected 9 times more frequent in the medial compartment than the lateral compartment. One of the surgical treatment modalities of unicompartmental knee OA is unicondylar knee arthroplasty (UKA).[2] UKA restores knee function and relieves pain in the affected

[1]Orthopedics and Traumatology Department, Pamukkale University Medical Faculty, Denizli, Turkey
[2]Physiotherapy and Rehabilitation Department of Faculty of Health Sciences, Muş Alparslan University, Muş, Turkey
[3]Department of Orthopedics and Traumatology, Artvin State Hospital, Artvin, Turkey
[4]Faculty of Physiotherapy and Rehabilitation, Pamukkale University, Denizli, Turkey

Corresponding author:
Harun Reşit Güngör, Orthopedics and Traumatology Department, Pamukkale University Medical Faculty, Denizli, Turkey.
Email: hrgungor@gmail.com

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compartment. Preservation of patella-femoral and contralateral tibio-femoral compartments along with cruciate ligaments resulting in less invasive surgery, lesser perioperative morbidity, enhanced postoperative functional recovery, and better patient satisfaction are all potential advantages of UKA.[3] In addition, kinematics of the knee joint has been reported to be more natural than total knee arthroplasty (TKA) in UKA.[4]

Appropriate biomechanical alignment of the lower extremity depends on the bones of this extremity along with hip, knee, foot, and ankle joints.[5,6] Foot and/or ankle (F/A) problems are frequently encountered in TKA patients due to preoperative varus or valgus deformity resulting in abnormal loading and compensatory changes in the foot and ankle.[7,8] Restoration of these deformities in these patient groups to neutral may result in deterioration of function in F/A due to previous compensatory changes in these joints.[9,10] Although preoperative varus deformity is not pronounced in UKA patients as much as TKA indicated patients, F/A problems may still be detected in this patient group due to deteriorating alignment of the lower extremity. Problems following TKA related to foot and ankle biomechanics and pain related to these joints have been reported in the literature, however, to the best of our knowledge, the interaction between UKA applied to medial compartmental knee osteoarthritis and foot and/or ankle problems has not been studied in the literature until now.[7–9] Therefore, we aimed to investigate limb alignment changes both for knee and ankle in the postoperative period in patients undergoing UKA and to answer whether foot and/or ankle problems affect the outcome of the surgery and the physical performance of these patients?

Materials and methods

This single-center study was conducted at the Department of Orthopedics and Traumatology in a university hospital. Patients who had undergone UKA for isolated medial compartment OA from 2016 to 2019 were screened from the hospital registry system. Eligible patients were contacted by telephone and invited to participate in the present study. This study was conducted in accordance with the Helsinki Declaration Principles after the approval of Clinical Research and Ethics Committee of the authors' affiliated institution.

Participants

Only one side-operated UKA patients were included in the study. Other inclusion criteria were as follows: medial compartment OA with exposed bone on the femur and the tibia, functionally intact anterior cruciate ligament (also verified by MRI), full-thickness and good-quality lateral cartilage present (verified by MRI), American Society of Anesthesiologists (ASA) score<3, able to perform the required clinical assessment tasks. Exclusion criteria were as follows: revision UKA surgery, had rheumatoid arthritis or other inflammatory disorders, previously had septic arthritis, had previous knee surgery in either lower extremity, had significant damage to the patella–femoral joint, especially on the lateral facet, had concurrent hip or spinal pathology, apparent radiologic narrowing or deuteriation of ankle joint due to secondary reasons (trauma, rheumatologic disease), chronic ankle instability, neurologic compromise, psychiatric problems, regular hypnotic and/or anxiolytic medication usage, dementia.

Fifty patients who had medial UKA were evaluated. Six patients were excluded from the study: lost to follow-up ($n = 2$), not willing to participate in the study ($n = 2$), previous knee surgery in either lower extremity ($n = 1$), revision surgery ($n = 1$). The final study sample consisted of 44 patients, 13 with F/A pain and 31 without F/A pain (Figure 1).

Surgical technique

All the operations were performed by the same surgeon using the same brand and type of prosthesis through 8–12 cm of longitudinal medial parapatellar approach. All the patients received fixed-bearing UKA (Unicompartmental High Flex Knee, Zimmer-Biomet Inc., Warsaw, Indiana 46580, ABD), and high viscosity polymethyl methacrylate (PMMA) bone cement (Oliga- G21 srl-Vias. Pertini, 8-41039 San Possodonio (MO)-Italy). All the operations were performed without using a tourniquet.

Evaluations

Patients were evaluated postoperatively at the latest follow-up. Clinical and demographic variables (age, body mass index, gender, dominant and operated extremity, occupation) of the patients were recorded.

Radiologic measurements

Radiologic evaluations were performed on preoperative and follow-up long leg standing radiographs by using a computer-based DICOM system (Probel©, 2.0.9.0) and by using the same computer terminal with a high-resolution monitor. All the measurements were performed by the same observer (HZ) blind to the group of the patients. Hip knee ankle (HKA) angle, posterior tibial slope (PTS) angle, talar tilt angle (TTA), talar inclination (TI), talar dome to mechanical axis (TDMA) angle, and talocrural angle (TCA) were measured on these radiographs. Medial proximal tibial angle (MPTA) was measured on preoperative radiographs. Since the evaluation of this angle is difficult due to medially seated tibial baseplate and polyethylene insert, MPTA measurements were performed referencing distal femoral component on long-leg standing radiographs. HKA angle represents the angle between the mechanical axes of the femur and the mechanical axis of the tibia. MPTA is the angle between the tibial mechanical axis

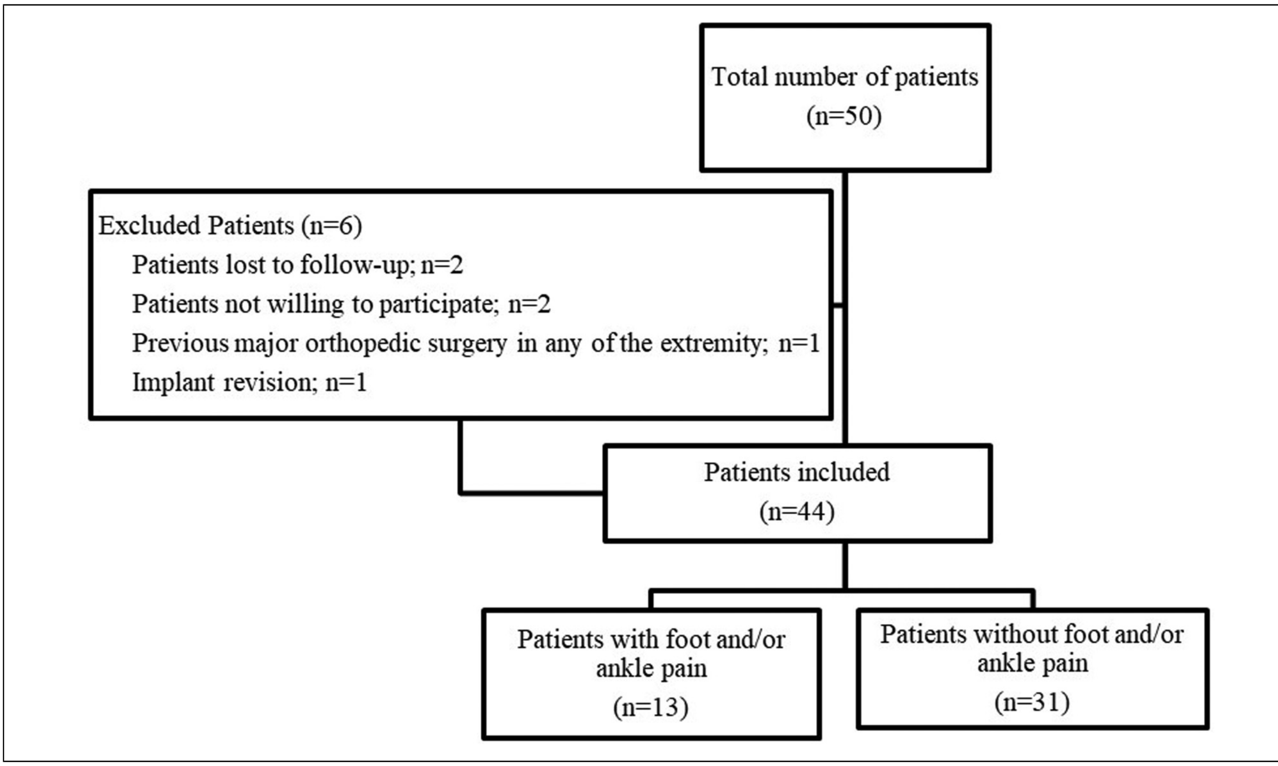

Figure 1. Flow chart of the study.

and the articular surface of the proximal tibia. PTS angle is the posterior inclination of the tibial plateau and is measured on lateral knee radiographs. TTA is the lateral angle between the line parallel to the tibial plafond and the line parallel to the talar dome. TI is the angle between the horizontal line and the tangential line at the talar dome. TDMA angle represents the lateral angle between the mechanical axis and the line parallel to the talar dome. TCA is measured on the medial side between the line connecting the tips of both malleoli and a perpendicular line to the tibial plafond. Since TCA is not expected to change postoperatively, only preoperative measurements were used to compare groups (Figure 2).

Foot and/or ankle evaluations

The patients were questioned whether they had F/A pain and disability. Those patients with reported F/A problems were evaluated with foot function index (FFI). This index consists of 23 items grouped into three subscales: pain (9-item), disability (9-item), and activity limitation (5-item). To obtain the subscale score, item scores of a subscale are summed, and then the item total score is divided by the highest potential score and this value is multiplied by 100 to get a percentage. A total FFI score is derived by calculating the average of the three sub-scale scores.[11]

Secondary outcomes included postoperative perceived knee pain during rest and walking (visual analog scale-VAS), quadriceps muscle strength (Commander Muscle Tester hand-held dynamometer, J Tech, USA), patient-reported activity limitation measurements (the Western Ontario and McMaster Universities Arthritis Index-WOMAC), performance-based activity limitation measurements (Short Physical Performance Battery-SPPB, 30 s-chair stand test, 40-meter fast-paced walk test, and stair-climb test), and quality of life (Short Form-12, SF-12).

Statistical analysis

The data were analyzed using SPSS 24.0 (IBM Corp. Released 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.) package program. Continuous variables were given as mean ± standard deviation, median (minimum and maximum), and categorical variable values are presented as absolute numbers (*n*) and percentages (%). The conformity of continuous variables with normal distribution was evaluated using the Kolmogorov–Smirnov test. Paired Samples t-test for parametric test assumptions and Wilcoxon Paired Signed Test for non-parametric test assumptions were used for intragroup comparisons of patients' preoperative and postoperative radiological evaluations. Independent Samples t-test for parametric test assumptions and Mann–Whitney U Test for non-parametric test assumptions were used for comparison of the groups. The amount of change from preoperative to follow up in knee and ankle radiographic assessments is represented as

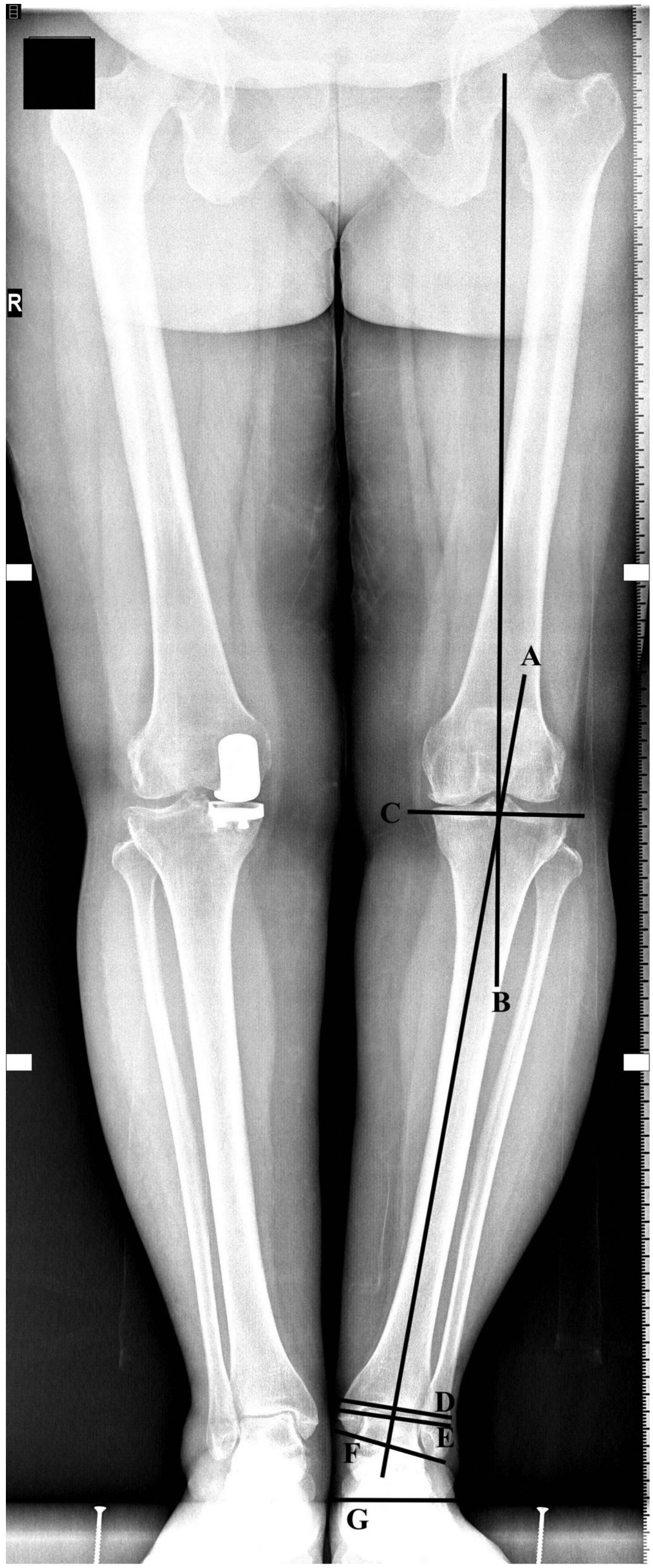

Figure 2. HKA angle represents the angle between the mechanical axes of the femur (A) and the mechanical axis of the tibia (B). MPTA is the angle between the tibial mechanical axis (B) and the articular surface of the proximal tibia (C). TTA is the lateral angle between the line parallel to the tibial plafond (D) and the line parallel to the talar dome (E). TI is the angle between the horizontal line (G) and the tangential line at the talar dome (E). TDMA angle represents the lateral angle between the mechanical axis and the line parallel to the talar dome (E). TCA is measured on the medial side between the line connecting the tips of two malleoli (F) and a perpendicular line to the tibial plafond (D).

Δ. The correlation between radiographic changes in the knee and ankle radiographic assessments and secondary outcomes was examined. Spearman's correlation test was used to establish the correlations between continuous variables that were non-normally distributed, whereas Pearson's correlation test was used to establish the correlations between those with a normal distribution. Statistical significance was set at $p \leq 0.05$.

Results

A total number of 44 patients were included in the study. In patients with F/A problems (mean age, 58.92 ± 7.69 years; 12 females and 1 male), the mean follow-up period was 36.33 ± 15.74 month and patients without F/A problems (mean age, 58.39 ± 9.51 years; 26 females and 5 males), the mean follow-up period was 32.10 ± 22.15 month (Table 1).

Thirteen patients reporting F/A problems were evaluated with FFI. The mean pain score was 49.54 ± 14.90, disability score was 55.00 ± 17.61, activity restriction score was 30.17 ± 18.28 and total score of FFI was 57.40 ± 18.69.

Mean values of HKA measurements showed more residual varus deformity in patients with F/A problems in contrast to patients without F/A problems (-2.82 ± 2.53 degrees vs. -0.80 ± 3.12). Concerning ankle radiologic measurements, there was no significant postoperative change in TDMA in patients with F/A problems ($p = 0.406$) in contrast to patients without F/A problems ($p = 0.006$). There was no statistically significant difference in preoperative TCA measurements between groups ($p = 0.79$). TTA and TI angles showed significant improvements in both groups in postoperative measurements. Comparison of the preoperative and postoperative knee and ankle radiologic measurements between groups demonstrated significant difference only in HKA measurements ($p = 0.03$) (Table 2).

There was a significant difference between patients with F/A problems and without F/A problems in only post-operative WOMAC score ($p = 0.002$) and SF-12 physical health sub-score ($p = 0.003$) (Table 3).

In patients with and without F/A problems, there was no significant relationship between postoperative knee radiologic measurements and pain, quadriceps muscle strength, patient-reported and performance-based activity limitation, and quality of life including FFI ($p > 0.05$). There was also no correlation between FFI and postoperative knee radiographic evaluation in patients with F/A problems ($p > 0.05$) (Table 4).

The relationship of ankle radiologic measurements with FFI evaluations in patients with F/A problems showed significant negative moderate correlations between walking VAS scores and TDMA measurements ($r = -0.58$, $p = 0.04$). In addition, TDMA measurements showed positive moderate correlations with SPPB evaluations ($r = 0.64$, $p = 0.02$) (Table 5).

Discussion

The most important finding of our study is that the presence of F/A problems adversely affecting the functional status was not infrequent in our cohort of UKA patients. The postoperative difference in HKA measurements referring to residual varus deformity may be considered a risk factor for F/A problems. In addition, a statistically insignificant change in TDMA in patients with F/A problems along with a significant change in TTA and TI measurements supports this finding.

Any deformity in either joint of the lower extremity namely the hip, knee, or ankle plays an important role in the overall alignment. Varus or valgus alignment at the knee level results in compensatory changes in the hindfoot

Table 1. Demographic and clinic variables of the patients.

Variables	Patients with F/A problems ($n = 13$) Mean ± SD (min-max)	Patients without F/A problems ($n = 31$) Mean ± SD (min-max)	*p*
Age (year)	58.92 ± 7.69 (48–71)	58.39 ± 9.51 (45–77)	0.846
BMI (kg/m^2)	30.86 ± 3.61 (25.71–37.04)	31.74 ± 4.00 (25.10–39.06)	0.550
Average follow-up of (month)	36.33 ± 15.74 (14–64)	32.10 ± 22.15 (6–64)	0.489
	n (%)	*n* (%)	
Gender			
Female	12 (92.3)	26 (83.9)	**0.000**
Male	1 (7.7)	5 (16.1)	
Dominant extremity			
Right	12 (92.3)	28 (90.3)	**0.000**
Left	1 (7.7)	3 (97.7)	
Operated extremity			
Dominant side	6 (46.2)	17 (54.8)	0.763
Non-dominant side	7 (53.8)	14 (45.2)	
Occupation			
Housewife	9 (69.2)	18 (58.1)	**0.000**
Retired	3 (23.1)	6 (19.4)	
Blue-collar worker	1 (7.7)	7 (22.6)	

F/A: foot/ankle; BMI: body mass index; SD: standard deviation; min: minimum; max: maximum.

Table 2. Comparison of patients in terms of knee and ankle radiologic evaluations.

	Patients with F/A problems ($n = 13$)			Patients without F/A problems ($n = 31$)			Difference between groups	
Radiographic assessment	preop mean ± SD	postop mean ± SD	*p*	preop mean ± SD	postop mean ± SD	*p*	preop *p*	postop *p*
Knee								
HKA	−7.06 ± 2.51	−2.82 ± 2.53	**0.000**	−6.66 ± 2.83	−0.80 ± 3.12	**0.000**	0.64	**0.03**
MPTA	86.65 ± 1.73	88.44 ± 1.027	**0.002**	87.53 ± 2.20	88.29 ± 1.71	0.095	0.17	0.12
PTS	6.88 ± 3.22	3.86 ± 1.72	**0.004**	7.46 ± 1.93	4.65 ± 1.27	**0.000**	0.56	0.15
Ankle								
TTA	1.07 ± 0.90	0.31 ± 0.63	**0.019**	1.81 ± 2.09	0.91 ± 1.63	**0.009**	0.11	0.09
TI	4.44 ± 2.94	1.92 ± 1.68	**0.006**	5.11 ± 2.79	3.25 ± 2.87	**0.005**	0.49	0.06
TDMA	91.18 ± 3.99	90.25 ± 1.83	0.406	92.03 ± 4.18	90.20 ± 3.08	**0.006**	0.53	0.95
TCA	79.90 ± 3.37	80.82 ± 1.90	0.313	80.19 ± 2.89	81.38 ± 2.69	**0.006**	0.79	0.43

F/A: foot/ankle; HKA: hip knee ankle angle; MPTA: medial proximal tibial angle; PTS: posterior tibial slope; TTA: talar tilt angle; TI: talar inclination; TDMA: talar dome to mechanical axis angle; TCA: talocrural angle; SD: standard deviation.

Table 3. Postoperative comparison of patients in terms of pain, quadriceps muscle strength, functionality, and quality of life.

Variables	Patients with F/A problems ($n = 13$) X ± SD	Patients without F/A problems ($n = 31$) X ± SD	*p*
VAS (cm)			
Resting	2.06 ± 3.03	1.87 ± 2.56	0.844
Walking	4.68 ± 3.83	2.35 ± 2.71	0.063
Quadriceps muscle strength (Newton)			
Operated side	167.00 ± 39.36	180.03 ± 69.36	0.436
Healthy side	147.04 ± 63.90	189.69 ± 60.85	0.055
WOMAC (0–100)	41.29 ± 12.10	26.12 ± 17.04	**0.002**
SPPB (0–12)	8.15 ± 3.00	9.00 ± 2.35	0.376
30-s chair-stand test	9.92 ± 2.78	9.27 ± 2.87	0.491
40-meter fast-paced walk test (second)	49.99 ± 20.16	43.68 ± 12.30	0.312
Stair-climb test (sec)	24.37 ± 13.38	21.17 ± 10.50	0.452
SF-12			
Physical health	30.50 ± 9.35	40.78 ± 9.19	**0.003**
Mental health	43.20 ± 15.59	47.61 ± 10.63	0.364

F/A: Foot/Ankle; VAS: visual analogue scale; WOMAC: The Western Ontario and McMaster Universities Arthritis Index; SPPB: Short Physical Performance Battery; SF-12: Short Form-12; cm: centimeter: SD: standard deviation.

to maintain coronal plane alignment of the lower extremity. Norton et al. studied these compensatory changes on long-leg radiographs of 324 patients (401 knees) undergoing TKA.[8] The authors reported that for every degree increase in the valgus position of mechanical axis angle, the hindfoot shifts towards varus by 0.43 degrees, and for every degree increase of varus position in mechanical axis angle, the hindfoot shifts towards valgus by 0.49 degrees. This study indicates that every degree of deformity at the knee level has a compensatory effect at the ankle level. In addition, Xie et al. reported 13 cases of ankle osteoarthritis out of 57 cases with neutral tibial alignment who underwent TKA.[12] Therefore, although the varus deformity in the UKA indicated medial compartment arthrosis patients mostly being less than 10 degrees is not pronounced as it is in TKA indicated varus arthrosis patients, ankle compensatory changes and ankle problems may still be encountered.

Long-standing varus deformity in most of the gonarthrotic patients and adaptive changes in the ankle joints of these patients are known entities reported in the literature. However, although patients with ankle pain before and after TKA are frequently encountered in clinical experience, the true incidence of ankle pain without apparent osteoarthritic changes in ankle joint in TKA patients has not been reported in the literature. Most of the studies related to ankle joint in TKA patients report the incidence of radiologic changes. Lee et al. reported 35.2% (50 cases out of 142) arthritis in the ankle before TKA, and 21.8% (31 cases) newly developed or progressive ankle osteoarthritis after TKA.[13] Tallroth et al. reported that approximately one-third of the patients operated due to knee osteoarthritis had concomitant ankle osteoarthritis.[14] To the best of our knowledge, there are no studies reporting the incidence of ankle pain or ankle degenerative changes in patients undergoing medial UKA. In our study, there were 13 patients (29.5%) with reported F/A problems postoperatively. Radiologic signs of osteoarthritis in the ankle joint were not detected in any of the patients in our cohort. This is probably related to the less pronounced degree of varus deformity in our patients and also in all other medial uni-compartmental osteoarthritic patients. In addition, this varus deformity is not expected to be a long-standing varus deformity as it is in TKA indicated osteoarthritis patients.

Adoptive changes in ankle joint following correction of varus or valgus deformity at knee joint following TKA may aggravate preoperatively existing ankle problems or may cause postoperative ankle pain and progression of osteoarthrosis at the ankle joint. Gursu et al. studied 80 knees with varus deformity over 10 degrees who underwent TKA.[15]

Table 4. Relationship between postoperative knee radiographic assessment and pain, functionality, quality of life and foot function in patients with and without F/A problems.

	Patients with F/A problems ($n = 13$)		Patients without F/A problems ($n = 23$)	
Variables	ΔHKA r (p)	ΔPTS r (p)	ΔHKA r (p)	ΔPTS r (p)
VAS (cm)				
Resting	−0.04 (0.89)	−0.25 (0.41)	0.30 (0.10)	0.07 (0.70)
Walking	−0.03 (0.91)	0.14 (0.65)	0.29 (0.11)	−0.22 (0.23)
WOMAC (0–100)	0.27 (0.38)	−0.03 (0.92)	0.29 (0.11)	−0.25 (0.18)
SPPB (0–12)	−0.36 (0.23)	0.04 (0.89)	0.10 (0.58)	0.01 (0.96)
30-s chair-stand test	−0.01 (0.99)	0.17 (0.57)	−0.06 (0.73)	0.02 (0.89)
40-meter fast-paced walk test (sec)	0.07 (0.81)	−0.34 (0.26)	0.22 (0.25)	0.02 (0.90)
Stair-climb test (sec)	0.36 (0.23)	−0.30 (0.32)	0.10 (0.59)	−0.06 (0.74)
SF-12				
Physical health	−0.32 (0.29)	0.27 (0.37)	−0.24 (0.18)	0.09 (0.61)
Mental health	−0.23 (0.45)	−0.20 (0.51)	0.32 (0.08)	−0.01 (0.95)
Foot functional index				
Pain	−0.22 (0.48)	0.12 (0.69)	-	-
Disability	0.01 (0.97)	−0.02 (0.96)	-	-
Activity restriction	0.29 (0.35)	0.19 (0.56)	-	-
Total score	0.28 (0.37)	0.17 (0.60)	-	-

F/A: foot/ankle; Δ: difference between follow-up and preoperative; HKA: hip knee ankle angle; MPTA: medial proximal tibial angle; PTS: posterior tibial slope: VAS: visual analog scale; SPPB: short physical performance battery; WOMAC: the Western Ontario and McMaster Universities Arthritis Index; SF-12: short form-12; cm: centimeter; SD: standard deviation.

Table 5. Relationship between postoperative ankle radiographic assessment and pain, functionality, quality of life and foot function in patients with F/A problems.

	Patients with F/A problems ($n = 13$)		
Variables	ΔTTA r (p)	ΔTI r (p)	ΔTDMA r (p)
VAS (cm)			
Resting	0.13 (0.67)	−0.13 (0.67)	−0.27 (0.37)
Walking	0.16 (0.61)	−0.45 (0.13)	**−0.58 (0.04)**
Foot functional index			
Pain	0.49 (0.09)	0.27 (0.37)	0.23 (0.44)
Disability	−0.02 (0.94)	0.22 (0.48)	−0.10 (0.75)
Activity restriction	−0.09 (0.79)	0.03 (0.93)	0.06 (0.85)
Total score	−0.06 (0.86)	0.20 (0.54)	0.18 (0.58)
WOMAC (0–100)	−0.41 (0.16)	−0.18 (0.56)	−0.09 (0.77)
Short physical performance battery (0–12)	0.30 (0.32)	0.22 (0.47)	**0.64 (0.02)**
30-s chair-stand test	0.30 (0.31)	−0.08 (0.80)	0.50 (0.08)
40-meter fast-paced walk test (sec)	−0.15 (0.64)	0.16 (0.60)	−0.37 (0.22)
Stair-climb test (second)	−0.20 (0.51)	−0.13 (0.67)	−0.35 (0.24)
SF-12			
Physical health	0.46 (0.12)	0.32 (0.29)	−0.1 (0.97)
Mental health	−0.07 (0.83)	−0.09 (0.77)	0.19 (0.53)

F/A: foot/ankle; Δ: difference between follow-up and preoperative; TTA: talar tilt angle; TI: talar inclination; TDMA: talar dome to mechanical axis angle; VAS: visual analog scale; WOMAC: The Western Ontario and McMaster Universities Arthritis Index; SPPB: short physical performance battery: SF-12: short form-12; cm: centimeter; SD: standard deviation.

They reported that acute correction of the long-standing varus deformity to neutral or slight valgus in the knee could deteriorate the ankle due to previous adaptive changes. Therefore, the authors suggested minimal varus or at most neutral orientation in the knee for optimal position of the leg in order not to cause overcorrection, malalignment, and functional complaints in the ankle. However, they did not evaluate the clinical complaints of patients along with radiological measurements. On the other hand, Kim et al. evaluated radiologic factors related to ankle pain in 65 ankles of 55 patients before and after TKA and followed for an average period of 31.3 months.[16] The authors reported that patients with postoperative ankle pain or who experienced aggravation of preoperatively existing ankle pain after TKA had significantly higher degrees of residual varus. These results are parallel to the findings in our study. Postoperative HKA measurements showed statistically more residual varus deformity in patients with F/A problems in contrast to patients without F/A problems (mean values -2.82 ± 2.53 degrees, -0.80 ± 3.12, respectively; $p = 0.03$). In addition, statistically insignificant change of TDMA in patients with F/A problems in contrast to statistically significant change in patients without F/A problems support this finding (Table 4).

Several alignment techniques have been postulated in the literature for UKA. Mechanical alignment, adjusted mechanical alignment leaving up to 3 degrees of residual varus deformity, patient-specific kinematic alignment, and restricted kinematic alignment with computational assisted surgery restricting constitutional varus deformity to ≤3 degrees are those suggested techniques for the alignment of the lower extremity in UKA procedure.[17] Valgus orientation of knee in medial UKA is not acceptable since this position accelerates lateral compartment arthrosis. While the mechanical alignment technique offers neutral orientation at the knee level for a favorable clinical outcome, other techniques offer somewhat residual varus. In our study, residual varus deformity at the knee is a risk factor for a possible ankle function limitation. Therefore, careful preoperative evaluations of the hindfoot should be performed if residual varus alignment is aimed at the knee with any of the alignment techniques.

One of the limitations of our study is that we did not evaluate patients preoperatively. Therefore, we could not answer whether the F/A pain was present preoperatively, whether the preoperative ankle pain was aggravated or alleviated in these patients, and whether ankle pain was new postoperatively. Another limitation is that we did not evaluate subtalar joint radiographically since we only used long leg-standing radiographs for radiologic evaluations. Compensatory changes not only ankle- and subtalar joints but also at the foot level have been reported in the literature following the correction of varus deformity.[13,14,18] Therefore, careful examination of the patients planned for the correction of varus deformity at the knee level should carefully be performed for possible ankle and subtalar joins, and foot problems.

The presence of F/A problems adversely affecting the functional status was frequent in our cohort of UKA patients. Relatively more postoperative residual varus deformity may be considered as a risk factor rendering patients susceptible to functional limitations due to F/A problems. Therefore, if slight varus alignment is aimed at UKA patients, comprehensive evaluations before surgery should include the patients' detailed F/A status to decide about the possible F/A problems and to inform and discuss the outcome with the patients.

Highlights

- Our study is the first to report the incidence of pain and functional limitations in the ankle joint in medial compartment UKA patients postoperatively.
- The presence of F/A problems adversely affecting the functional status was frequent in our cohort of UKA patients.
- Relatively more postoperative residual varus deformity may be considered as a risk factor rendering patients susceptible to functional limitations due to F/A problems.
- If slight varus alignment is aimed at UKA patients, comprehensive evaluations before surgery should include patients' detailed F/A status to decide about the possible F/A problems, and to inform and discuss the outcomes with the patients.

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ORCID iDs

Harun Reşit Güngör https://orcid.org/0000-0002-0721-0890
Gökhan Bayrak https://orcid.org/0000-0001-9224-996X

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