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FOOT

COMPARISON OF CHANGES IN THE ANKLE AFTER UNICONDYLAR KNEE ARTHROPLASTY AND HIGH TIBIAL OSTEOTOMY

COMPARAÇÃO CLÍNICA E RADIOLÓGICA DAS ALTERAÇÕES NO TORNOZELO APÓS ARTROPLASTIA UNICONDILAR DO JOELHO E OSTEOTOMIA TIBIAL ALTA

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ABSTRACT

Objectives: We aimed to compare the changes in the coronal alignment of the ankle joints and their clinical effects after high tibial osteotomy (HTO) and unicondylar knee arthroplasty (UKA). Methods: 50 HTO and 54 UKA patients who were operated on for medial knee osteoarthritis between 2013 and 2018 were retrospectively evaluated. The hip-knee-ankle angle (HKA), the medial proximal tibial angle (MPTA), the tibial plafond inclination (TPI) and the talar inclination (TI) angles were measured before and after operation. Visual analog scale (VAS), short form 36 (SF-36), and ankle-hindfoot scale (AHS) scores of both groups were evaluated and recorded. Results: Angular changes in the HKA, MPTA, TPI and TI values showed significantly greater values in the HTO group ($p<0.001$). When asymptomatic and symptomatic cases were compared, it was found that changes in the HKA, TPI and TI values were significantly greater in symptomatic cases in the HTO group ($p<0.05$). A significant decline was observed in the VAS, SF-36 and AHS scores in the HTO group in the postoperative period ($p<0.05$). In intergroup evaluations, a significant decline was detected in pain and functional scores of the HTO group when compared to the UKA group ($p<0.05$). Conclusion: Unicondylar knee arthroplasty can be a good alternative to HTO in selected cases for postoperative ankle complaints. ***Level of Evidence III; Therapeutic Studies Investigating the Results of Treatment.***

Keywords: Ankle. Osteotomy. Arthroplasty, Replacement, Knee.

RESUMO

Objetivos: Nosso objetivo foi comparar as alterações no alinhamento coronal das articulações do tornozelo e seus efeitos clínicos após osteotomia tibial alta (OTA) e artroplastia unicondilar do joelho (AUJ). Métodos: 50 pacientes de HTO e 54 de AUJ operados de osteoartrite medial do joelho entre 2013 e 2018 foram avaliados retrospectivamente. O ângulo quadril-joelho-tornozelo (QJT), o ângulo tibial proximal medial (ATPM), a inclinação do platô tibial (IPT) e os ângulos de inclinação talar (IT) foram medidos no pré- e pós-operatório. A escala visual analógica (VAS), forma curta 36 (SF-36), e a escala tornozelo-retropé (ETR) de ambos os grupos foram avaliadas e registradas. Resultados: Alterações angulares nos valores de QJT, ATPM, IPT e IT mostraram valores significativamente maiores no grupo OTA ($p<0,001$). Quando os casos assintomáticos e sintomáticos foram comparados, verificou-se que as alterações nos valores de QJT, IPT e IT foram significativamente maiores nos casos sintomáticos no grupo OTA ($p<0,05$). Observou-se declínio significativo nos escores VAS, SF-36 e ETR no grupo HTO no pós-operatório ($p<0,05$). Nas avaliações intergrupos, foi detectado declínio significativo na dor e nos escores funcionais do grupo OTA quando comparado ao grupo AUJ ($p<0,05$). Conclusão: Em casos de queixas pós-operatórias quanto ao tornozelo, a artroplastia unicondilar do joelho pode ser uma boa alternativa para OTA. ***Nível de evidência III; Estudos Terapêuticos Investigando Resultados de Tratamento.***

Descritores: *Tornozelo. Osteotomia. Artroplastia do Joelho.*

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INTRODUCTION

Carrying 75% of the body weight by the medial compartment of the knee causes arthrosis in this region in the early period.[1,2] In such cases, medial opening-wedge high tibial osteotomy (HTO) and unicondylar knee arthroplasty (UKA) provide relief in pain and improvement in knee functions.[3,4] Biomechanically, the weight-bearing axis is shifted from the medial to the lateral aspect of the joint in HTO, therefore 1.7-1.9 degrees of valgus is recommended for optimum load distribution postoperatively.[5] On the other hand, in UKA, the ligament tension is replaced, and the knee and leg alignment is returned to the pre-disease state where a slightly varus position is often recommended.[6,7] Both surgical procedures are known to alter the postoperative coronal alignment, while the anatomical orientation of the ankle and foot is secondarily affected.[8,9]
Our aim in this study was to compare the changes in the coronal alignment of the ankle joints and their clinical effects after HTO and UKA.

Patients and Methods

The study was approved by the institutional Ethics Committee (2020.137.05.38). Verbal consent was obtained from all patients for this study. One hundred and four patients (50 HTO, 54 UKA) who were operated on for medial knee osteoarthritis between 2013 and 2018 were retrospectively evaluated. All operations were performed by the same surgical team.
High tibial osteotomy was performed as biplanar osteotomy starting from the proximal of the tibial tuberosity. A plate-screw system (OWO Plate; TST Ltd., Istanbul, Turkey) was used for fixation, while no bone substitute was used during surgery. Unicondylar knee arthroplasty was performed using cemented ZUK (Zimmer® Unicompartmental High Flex Knee System; Zimmer Biomet, Warsaw, IN, USA).
Patients who were under 60 years of age and had symptomatic varus-aligned medial arthrosis of the knee were indicated for HTO, while those who had isolated medial arthrosis, coronal plane deformity below 10 degrees and were below 60 years of age were planned to undergo UKA. Patients who had knee flexion below 90 degrees, experienced a lateral bone cortex fracture perioperatively, underwent bilateral surgery, and had lateral or patellofemoral knee joint arthrosis, knee flexion contracture over 10 degrees, ligament instability, rheumatoid arthritis, a trauma or surgery that would disrupt the lower extremity alignment, cases with preoperative arthrosis findings or pain in the ankle, foot deformities, a BMI greater than 35, and those with insufficient registration and/or follow-up information were excluded from the study. A total of 91 cases were included in the study.
Alignment of the lower extremity was evaluated with standardized preoperative and postoperative anteroposterior radiographs (with the patella placed anteriorly and in the middle and the feet standing at attention position). The following parameters were radiologically evaluated. The hip-knee-ankle angle (HKA) was defined as the angle between the mechanical axes of the femur and the tibia. The angle between the mechanical axis of the tibia and the proximal tibial joint line was considered as the medial proximal tibial angle (MPTA), and the angle between the tangent to the tibial plafond and the horizontal line was considered as the tibial plafond inclination (TPI). While talar inclination (TI) was defined as the angle between the tangent to the talar dome and the horizontal line, the angle between the talus and the plafond was accepted as the talar tilt (TT). Varus alignment was accepted as a 'positive' angle value in all measurements. All measurements were performed using the PACS - Picture Archiving and Communication System by two separate orthopedic surgeons, who did not participate in the treatments (Figures 1 and 2).
Preoperative and postoperative visual analog scale (VAS), short form 36 (SF-36) and ankle-hindfoot scale (AHS) scores of both groups were evaluated and recorded.

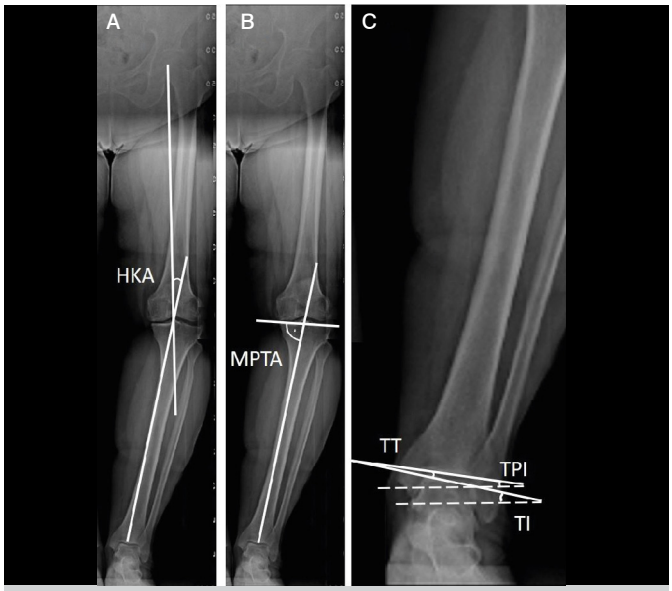

Figure 1. (A) The hip-knee-ankle (HKA) angle, (B) the medial proximal tibial angle (MPTA) and (C) the tibial plafond inclination (TPI), talar inclination (TI), and talar tilt (TT). The dashed line indicates the ground.

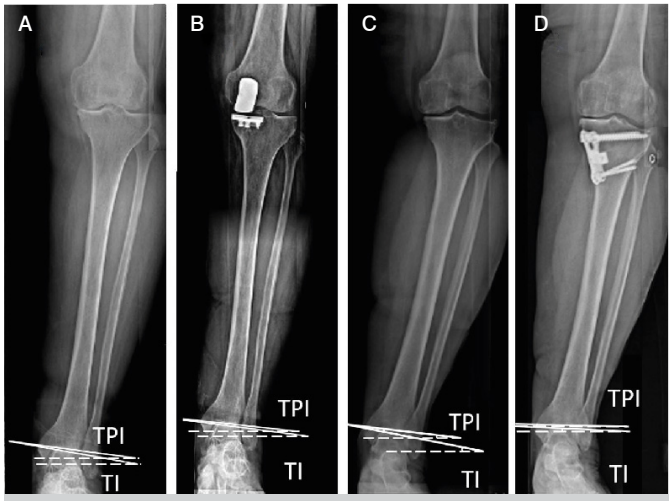

Figure 2. (A-B) Angular change in the ankle between the measurements performed before and after UKA. (C-D) Angular change in the ankle between the measurements performed before and after HTO.

Statistical Methods

Statistical analyses were performed by a biostatistician (member of authorship) using the IBM SPSS Statistics v.17.0 software. The normality of the data was analyzed using the Kolmogorov-Smirnov test. All descriptive statistics were reported as mean ± standard deviation. The Mann-Whitney U test was used to determine the average difference between two unrelated groups. All comparative tests were two-tailed, and a p value of less than 0.05 was considered statistically significant.

RESULTS

The demographic information, follow-up times and BMI values of all patients are provided in (Table 1). Newly-onset and resistant ankle complaints were detected in six HTO patients and two UKA patients. All symptomatic cases were treated conservatively. Preoperative and postoperative radiological measurements in both groups are shown in (Table 2).

The angular changes between the preoperative and postoperative radiological measurements in both groups are shown in (Table 3). Angular changes in the HKA, MPTA, TPI, and TI showed significantly greater values in the HTO group ($p<0.001$).

Angular changes in both groups were compared in asymptomatic and symptomatic cases in (Table 4). Changes in the HKA, TPI and TI values were found to be significantly greater in symptomatic cases in the HTO group ($p<0.05$).

The clinical results for the ankle are presented in (Table 5). A significant decline was observed in the VAS, SF-36 and AHS scores in the HTO group in the postoperative period ($p<0.05$). In the intergroup evaluations, a significant decline was detected in pain and functional scores of the HTO group when compared to the UKA group ($p<0.05$).

The intraclass correlation coefficient (ICC) for HKA and MPTA was 0.702-0.652 for interobserver and 0.784-0.683 for intraobserver reliability. The ICCs for TPI and TT were 0.802-0.788 and 0.683-0.634, respectively, for intraobserver reliability.

Table 1. Demographic information, follow-up and BMI data of the patients.

	HTO	UKA	Total	p
	Mean SD	Mean SD	Mean SD	
Age (yrs.)	46.32 8.84	54.58 6.36	50.86 8.59	<0.001*
Gender (n, %)				0.969†
Male	4 (9.8)	5 (10.0)	9 (9. 9)	0.969†
Female	37 (90.2)	45 (90.0)	82 (90.1)	
Follow-up period (mos.)	29.05 6.26	26.68 3.56	27.75 5.07	0.460*
BMI (kg/m^2)	32.41 1.12	32.56 1.16	32.49 1.14	0.379*

BMI: body mass index, HTO: high tibial osteotomy, UKA: unicondylar knee arthroplasty, SD: standard deviation.*Mann-Whitney U test, †Chi-squared testSignificant p values are written in bold.

Table 2. Comparison of the preoperative and postoperative radiological measurements.

HTO	Preoperative		Postoperative		Angular change	
	Mean	SD	Mean	SD	Mean	SD
HKA (°)	14.05	2.42	-0.44	1.79	14.49	2.63
MPTA (°)	83.68	2.53	89.33	2.02	5.65	1.86
TPI (°)	12.12	3.10	-1.39	4.14	13.51	2.64
TI (°)	11.91	3.05	-1.32	4.09	13.23	2.66
TT (°)	0.20	0.25	0.15	0.26	0.05	0.23
UKA	**Preoperative**		**Postoperative**		**Angular change**	
	Mean	SD	Mean	SD	Mean	SD
HKA (°)	8.37	2.27	2.28	2.16	6.09	1.61
MPTA (°)	86.55	2.41	87.26	2.49	0.71	0.53
TPI (°)	7.48	3.18	1.53	2.41	5.95	1.70
TI (°)	7.40	3.17	1.63	2.42	5.77	1.66
TT (°)	0.11	0.09	0.15	0.12	0.04	0.11

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt, UKA: unicondylar knee arthroplasty.

Table 3. Intergroup comparison of the changes in radiological parameters.

Postoperative-Preoperative	HTO		UKA		p*
	Mean	SD	Mean	SD	
HKA (°)	14.49	2.63	6.09	1.61	<0.001
MPTA (°)	5.65	1.86	0.71	0.53	<0.001
TPI (°)	13.51	2.64	5.95	1.70	<0.001
TI (°)	13.23	2.66	5.77	1.66	<0.001
TT (°)	0.05	0.23	0.04	0.11	0.214

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt. *Mann-Whitney U test. Significant p values are written in bold.

Table 4. Comparison of the angular changes in asymptomatic and symptomatic patients.

HTO Postoperative-Preoperative	Asymptomatic (n=35)		Symptomatic (n=6)		p*
	Mean	SD	Mean	SD	
HKA (°)	13.95	2.38	17.65	1.71	0.001
MPTA (°)	5.65	1.64	5.60	3.06	0.941
TPI (°)	12.91	2.28	17.00	1.79	<0.001
TI (°)	12.63	2.26	16.68	2.26	0.001
TT (°)	0.13	0.14	0.43	0.44	0.057
UKA Postoperative-Preoperative	**Asymptomatic (n=35)**		**Symptomatic (n=6)**		**p***
	Mean	SD	Mean	SD	
HKA (°)	6.08	1.63	6.35	1.63	0.655
MPTA (°)	0.83	0.54	0.70	0.42	0.920
TPI (°)	5.92	1.71	6.50	2.12	0.441
TI (°)	5.74	1.66	6.40	1.98	0.442
TT (°)	0.10	0.11	0.10	0.14	0.937

HKA: hip-knee-ankle angle, HTO: high tibial osteotomy, MPTA: medial proximal tibial angle, SD: standard deviation, TI: talar inclination, TPI: tibial plafond inclination, TT: talar tilt, UKA: unicondylar knee arthroplasty. *Mann-Whitney U test. Significant p values are written in bold.

Table 5. Comparison of the preoperative and postoperative clinical scores.

	HTO	UKA	p*
	Mean SD	Mean SD	
Preoperative ankle VAS score	1.32 0.47	2.04 0.80	0.025
Postoperative ankle VAS score	2.54 2.04	2.20 1.46	
p†	0.002	0.914	
Preoperative SF-36 score	89.02 8.68	88.36 6.14	0.002
Postoperative SF-36 score	80.61 17.11	86.94 9.14	
p†	<0.001	0.108	
Preoperative AHS score	93.98 7.07	92.62 7.03	0.042
Postoperative AHS score	87.39 16.42	89.94 12.04	
p†	<0.001	0.324	

AHS: ankle-hindfoot scale, HTO: high tibial osteotomy, SD: standard deviation, SF-36: short form 36, UKA: unicondylar knee arthroplasty, VAS: visual analog scale. *Repeated measures ANOVA, †Wilcoxon test. Significant p values are written in bold.

DISCUSSION

The most important finding of our study is that HTO affects the ankle orientation more than UKA and causes more clinical symptoms. To our knowledge, changes in ankle orientation after HTO and UKA and the clinical implications of this condition have not been compared to date in the literature.

It is known that compensatory alignment changes develop in the ankle secondary to knee deformities.[10] However, this physiological adaptation deteriorates after corrective surgical procedures and causes complaints in the ankle.[11] Lee and Jeong reported ankle complaints in 21.8% of their cases after total knee arthroplasty (TKA).[9] Similarly, Shah et al. recounted that 20% of their cases were symptomatic with a marked change in ankle TPI after HTO.[8] In accordance with the literature, the change in the TPI was greater in symptomatic patients in the HTO group in our study (17.00°±1.79° vs. 12.91°±2.28°, $p<0.001$). Shah et al. also reported significantly greater angular changes in the symptomatic group (12.8°±4.9° vs. 8.1°±4.8°, $p=0.03$).[8] Although the change in the TPI in symptomatic patients in the UKA group was greater, it was not significant. Our findings in the HTO group points out to the correlation between postoperative ankle complaints and TPI.

Although it was not significant, ankle complaints were observed more in patients who underwent HTO. Regarding the pain and functional scores, the ankle scores in the HTO group declined after surgery when compared to the preoperative scores, whereas no significant change was observed in the UKA group. In comparison

between the HTO and UKA groups, significantly worse pain and functional scores were observed in the HTO group.

The main reason why HTO has a greater effect on ankle orientation angles is the more significant overcorrection effect of HTO on alignment versus UKA.[12,13] Lee et al. observed a change of 10.8 degrees in the HKA after HTO, while Asada et al. detected a change of 3.9 degrees in their study.[14,15] In another biomechanical study performed on a static model, minimal pressure changes were observed in the ankle after a 5-degree correction with HTO, while an apparent lateralization in the center of pressure was detected after a 10-degree correction.[11] The second reason regarding the effect of HTO on ankle orientation is the fact that the correction zone in HTO is closer to the ankle than in the UKA. This situation is supported by the findings from the literature that confirm that the most obvious effect on ankle pressures is observed after supramalleolar osteotomy, and the least effect after distal femoral osteotomy.[11] We, as well, obtained supportive findings in our study, showing that the HKA, MPT, TPI and TI angles were more affected by HTO. In conclusion, lower extremity alignment and thus ankle orientation is less affected after UKA than HTO.

The extent of the preoperative coronal deformity increases the risk of ankle complaints postoperatively. Lee and Jeong reported that ankle arthritis was more frequently encountered after TKA in knees with greater varus deformities.[9] Similarly, moderate or severe changes in proximal tibial alignment after HTO can significantly reduce the tibiotalar contact area, and therefore, cause an increase in intraarticular pressure in the ankle.[16]

In our study, we noticed that in the HTO group the change in the TPI was above 15 degrees in symptomatic cases and below 15 degrees in asymptomatic cases. Supportive of this finding of ours, it has been reported that posttraumatic coronal plane deformities up to 15 degrees in the proximal and middle regions of the tibia can be compensated by the subtalar joint clinically, radiologically and regarding the width of the weigh-bearing area on the ankle.[17-19] Our study had some limitations. Patients who underwent UKA were older, which can explain the preference of UKA over HTO in older cases with advanced joint degeneration. The relationship between the varus-valgus alignments of the ankle and the clinical outcomes was not evaluated since all our patients' ankles were in the varus position preoperatively. Despite the evaluation of the ankle joint regarding patient complaints, subtalar joint mobility could also be evaluated in order to eliminate possible bias. Our study demonstrates how the alignment of the ankle joints is affected after HTO and UKA, two frequently performed surgical procedures in medial arthrosis of the knee, and the clinical outcomes of this condition.

CONCLUSION

When planning an osteotomy or arthroplasty in the proximity of the knee joint, the orientation of the ankle joint, the presence of arthritis findings and the mobility of the subtalar joint should be evaluated before surgery in order to obviate possible postoperative ankle complaints. In preoperative planning, it should be noted that corrections up to 15 degrees can be tolerated by the ankle, whereas corrections with greater angles may aggregate the complaints. In conclusion, correct planning of the degree of overcorrection in HTOs is extremely important in terms of preventing future ankle complaints. It should be also kept in mind that UKA can be a good alternative to HTO in selected cases for postoperative ankle complaints.

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