

Does the Coronal Plane Alignment of the Ankle Normalize after Total Knee Arthroplasty?

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INTRODUCTION: Total knee arthroplasty (TKA) with mechanical alignment (MA), performed for end-stage knee osteoarthritis (OA), can correct the varus/valgus knee deformities to a standardized alignment. Changes in lower extremity alignment after TKA have been reported to influence the onset and progression of adjacent joint pain and OA. However, the effect of TKA on ankle alignment remains unclear.

The purpose of this study was to determine (1) the incidence and characteristics of ankle OA in patients undergoing TKA, (2) whether improvements in lower extremity alignment after TKA can normalize ankle alignment, and (3) the factors that contribute to abnormal ankle alignment after TKA.

METHODS: Between 2015 and 2021, 396 cases (396 knees) underwent initial unilateral TKA at our hospital. Exclusion criteria included post-total hip arthroplasty (23 patients), rheumatoid arthritis (13 patients), post-knee trauma (6 patients), post-knee fusion (1 patient) or ankylosis (1 patient), implant failure (1 patient), insufficient follow-up (20 patients). A total of 331 cases (331 knees, 84%) were available for analysis. There were 81 males and 250 females, with a median age of 75 years (36-91 years). The control group consisted of 40 healthy subjects (80 knees) with no foot or ankle complaints. The cohort included 20 males and 20 females with a median age of 23 years (22-28 years).

Standing radiographs of the entire lower extremity were used to measure the tibial anterior surface angle (TAS), tibial medial malleolus angle (TMM) and tibial bimalleolus angle (TBM) as indicators of ankle bone morphology. Hip-knee-ankle angle (HKA), tibiotalar tilt angle (TTA), tibial plafond inclination angle (TPIA), and talar inclination angle (TIA) were measured as indicators of alignment (Fig. 1). Radiographs were taken preoperatively and 2 months postoperatively. Normal ranges for these indices were defined as the 2.5-97.5 percentile of the control group measurements. Changes in the percentage of patients with normal values before and after TKA were analyzed. In addition, factors influencing abnormal ankle alignment after TKA were examined using multivariate analysis.

RESULTS: Ankle OA, defined as Takakura-Tanaka classification stage 2 or higher, was observed in 59 patients (18%). The ankle OA group had a higher proportion of females (86% vs. 73%, $p = 0.024$), increased TAS varus (87° vs. 90° , $p=0.005$), and TMM (24° vs. 21° , $p < 0.001$). Normal ranges for alignment were defined as $-6.9^\circ \leq \text{HKA} \leq 4.8^\circ$, $-2.6^\circ \leq \text{TTA} \leq 2.4^\circ$, $83^\circ \leq \text{TPIA} \leq 96^\circ$, and $83^\circ \leq \text{TIA} \leq 96^\circ$. The percentage of normal HKA increased from 16% to 85% preoperatively, and the percentage of normal ankle alignment increased from 87%, 26%, and 24% for TTA, TPIA, and TIA preoperatively to 88%, 67%, and 64% postoperatively, respectively (Table1). Patients with ankle OA had a lower percentage of normalized postoperative TTA compared to patients without OA (64% vs. 93%, $p < 0.001$). Patients with preoperative medial knee OA were less likely to have normalized postoperative TIA (80% vs. 85%, $p < 0.001$), women were less likely to have normalized postoperative TPIA (62% vs. 79%, $p = 0.001$) and TIA (58% vs. 81%, $p < 0.001$).

DISCUSSION AND CONCLUSION: Postoperative ankle alignment tended to normalize as lower extremity alignment improved with TKA, highlighting an unrecognized benefit of TKA with mechanical alignment: the potential for improved ankle alignment. Correction of varus/valgus knee deformity significantly affects the biomechanical alignment of the entire lower extremity, including the ankle. However, our results indicate that this normalization process is not uniform across patient groups. Specifically, TTA normalization is less likely in patients with preoperative ankle OA, TIA normalization is less likely in patients with preoperative medial knee OA. In addition, both TPIA and TIA were less likely to normalize in women.

The normalization of ankle alignment in the majority of patients after TKA underscores the importance of addressing knee deformity as part of a comprehensive approach to lower extremity OA management. Improving knee alignment may reduce the risk of adjacent joint complications and improve overall functional outcomes and quality of life for patients undergoing TKA. Future research should focus on longitudinal studies to track the long-term outcomes of ankle alignment after TKA, particularly in patients with pre-existing ankle and medial knee OA.

Fig.1: Indicators of ankle bone morphology and alignment

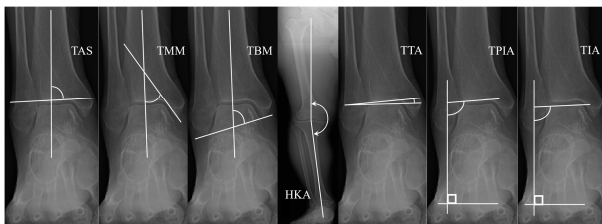


Table1: Changes in ankle alignment ($^\circ$) and percent of normal range (%) due to TKA

Parameters	Comparison of Alignment			Percent of Normal Range		
	Preop.	Postop.	P value	Preop.	Postop.	P value
HKA	-12 $^\circ$	-2.0 $^\circ$	< 0.001	16%	85%	< 0.001
TTA	-0.2 $^\circ$	-0.1 $^\circ$	0.424	87%	88%	0.727
TPIA	99 $^\circ$	94 $^\circ$	< 0.001	26%	67%	< 0.001
TIA	99 $^\circ$	95 $^\circ$	< 0.001	24%	64%	< 0.001

* Data are presented as median.