Mechanical Alignment Total Knee Arthroplasty Restores Ankle Alignment but Not Always Pain-Free: Predictors of Residual Ankle Pain

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INTRODUCTION:

Mechanical alignment total knee arthroplasty (MA-TKA) is a well-established procedure for correcting varus/valgus limb deformities in patients with end-stage knee osteoarthritis (OA). Our previous study (Yamaguchi et al. Knee Surg Relat Res. 2025.) demonstrated that MA-TKA restores ankle alignment parameters, including the tibial plafond and talar inclination. However, the clinical impact of these alignment changes, particularly on postoperative ankle pain, remains unclear.

This study aimed to determine the following: (1) the incidence of ankle OA and the time course of ankle pain following TKA, (2) alignment differences based on the presence or absence of postoperative ankle pain, and (3) risk factors for residual ankle pain after TKA.

METHODS:

Between 2023 and 2024, 154 patients (183 knees) underwent primary MA-TKA at our institution. Exclusion criteria were post-total hip arthroplasty (5 patients), rheumatoid arthritis (19 patients), post-knee osteotomy (6 patients), implant failure (1 patient), and insufficient follow-up (16 patients). A total of 107 cases (134 knees, 73%) were eligible for analysis. There were 14 males and 93 females, with a median age of 74 years (49-92 years). Standing whole-leg radiographs were obtained preoperatively and 2 months postoperatively. Alignment parameters included the hip-knee-ankle angle (HKA), tibiotalar tilt angle (TTA), tibial plafond inclination angle (TPIA), talar inclination angle (TIA), and hindfoot alignment angle (HAA) (Fig. 1). Normal ranges for these parameters were defined as the 2.5^{th} to 97.5^{th} percentile values from a control group consisting of 40 healthy subjects (80 knees; 20 males and 20 females with a median age of 23 years [22-28 years]) with no foot or ankle complaints.

Ankle pain was assessed using a visual analog scale (VAS) at baseline, 6 months, and 12 months postoperatively. Patients were stratified by the presence of postoperative ankle pain (VAS ≥20). The proportion of parameters within the normal range before and after TKA was compared between the two groups. Factors associated with ankle pain after TKA were also investigated.

RESULTS: Ankle OA (Takakura-Tanaka classification stage ≥2) was present in 40 (30 %) patients. The incidence of ankle pain decreased from22% preoperatively to 13% at 6 months ($p = 0.04$), and 9% at 12 months ($p = 0.002$). Normal alignment ranges were established as follows: $-6.9° \leq HKA \leq 4.8°$, $-2.6° \leq TTA \leq 2.4°$, $83° \leq TPIA \leq 96°$, $83° \leq TIA \leq 96°$ and $-6.1° \leq HAA \leq 6.8°$. MA-TKA significantly improved alignment parameters: HKA improved from -10° to -1°, TPIA from 99° to 94°, TIA from 99° to 94°, and HAA from 5.5° to 3.8° (all $p < 0.001$) (Table1). Patients with postoperative ankle pain had a significantly lower rate of preoperative TTA within the normal range than those without ankle pain (at 6 months, 70% vs. 89%, p=0.03; at 12 months, 67% vs. 89%, p=0.02). Furthermore, patients with postoperative ankle pain had a higher prevalence of ankle OA (6 months: 53% vs. 27%, p=0.02; 12 months: 50% vs. 28%, p=0.11) (Table2 and 3).

DISCUSSION AND CONCLUSION:

This study examined the relationship between lower-extremity alignment and ankle pain after MA-TKA. Although MA-TKA is primarily performed to correct varus or valgus knee deformities, it can also improve ankle alignment by restoring the mechanical axis of the lower extremity. Radiographic assessment revealed significant improvements in alignment parameters, including HKA, TPIA, TIA, and HAA. Importantly, the frequency of ankle pain decreased significantly over time, from 22% preoperatively to 13% at 6 months and 9% at 12 months. These results suggest that restoring lower-extremity alignment may reduce mechanical stress on the ankle and contribute to symptom relief.

However, this improvement was not uniform in all patients. Patients with postoperative ankle pain had a significantly higher prevalence of preoperative ankle OA and abnormal TTA. These findings suggest that OA and abnormal TTA may limit the realignment benefit of MA-TKA on the ankle. These findings underscore the importance of considering ankle pathology and alignment during preoperative planning. Early identification of patients at risk for persistent ankle pain may help guide treatment strategies and improve functional outcomes after MA-TKA. Further longitudinal research is necessary to evaluate the longevity of these alignment changes and their effects on joint health.

In conclusion, while MA-TKA improves ankle alignment and reduces pain in most cases, preoperative ankle OA and abnormal TTA are key predictors of residual symptoms. Careful ankle assessment is essential for optimizing outcomes and guiding patient counseling.

FIGURE LEGENDS

Figure 1: Indicators of lower extremity and ankle alignment

Fig. 1

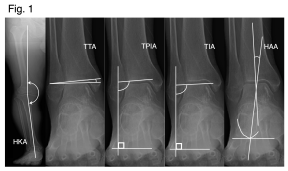

Table 1: Change in alignment parameters after total knee arthroplasty

Parameters* (°)	Preoperative	Postoperative	P value†
Hip-knee-ankle angle	-10 (-37 to 32)	-0.9 (-10 to 9)	< 0.001
Tibiotalar tilt angle	-0.4 (-11 to 12)	-0.3 (-12 to 6)	0.691
Tibial plafond inclination angle	99 (73-116)	94 (83-109)	< 0.001
Talar inclination angle	99 (72-116)	94 (82-110)	< 0.001
Hindfoot alignment angle	5.5 (-14 to 16)	3.8 (-10 to 14)	< 0.001

*Median (range); †Wilcoxon signed-rank test

Table 2: Demographic data of the presence or absence of ankle pain at 6 months after surgery. The alignment parameters were preoperative and within the normal range.

Parameters	Ankle pain (+) (n = 17 patients)	Ankle pain (-) (n = 117 patients)	P value
Hip-knee-ankle angle†	23	23	0.967
Tibiotalar tilt angle†	70	89	0.026
Tibial plafond inclination angle†	35	21	0.222
Talar inclination angle†	29	24	0.630
Hindfoot alignment angle†	41	60	0.128
Age† (years)	76	75	0.995
Sex† (Female)	88	88	0.981
Body mass index† (kg/m²)	24	26	0.222
Ankle OA‡	53	27	0.026

*Median (range); †Number (%), Chi-square test

Table 3: Demographic data of the presence or absence of ankle pain at 12 months after surgery. The alignment parameters were preoperative and within the normal range.

Parameters	Ankle pain (+) (n = 12 patients)	Ankle pain (-) (n = 122 patients)	P value
Hip-knee-ankle angle†	25	23	0.872
Tibiotalar tilt angle†	67	89	0.024
Tibial plafond inclination angle†	25	23	0.873
Talar inclination angle†	33	24	0.463
Hindfoot alignment angle†	58	58	0.993
Age† (years)	75	76	0.236
Sex† (Female)	92	88	0.686
Body mass index† (kg/m²)	28	26	0.910
Ankle OA‡	50	28	0.110

*Median (range); †Number (%), Chi-square test