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CHANGES IN HINDFOOT ALIGNMENT AFTER TOTAL KNEE ARTHROPLASTY IN KNEE OSTEOARTHRITIC PATIENTS WITH VARUS DEFORMITY-A PROSPECTIVE COMPARATIVE STUDY

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ABSTRACT

Background: Varus deformity of the knee in osteoarthritis (OA) profoundly alters lower limb biomechanics, propagating compensatory deformities to the hindfoot. Total knee arthroplasty (TKA) corrects coronal malalignment, but its downstream effect on hindfoot alignment remains incompletely characterized. Understanding these changes is essential for comprehensive perioperative planning.

Objectives: To evaluate serial changes in hindfoot alignment following TKA and to determine correlations between the severity of pre-operative varus deformity and magnitude of hindfoot correction.

Methods: A prospective comparative cohort study was conducted on 50 patients who underwent primary TKA for knee OA with varus deformity between June 2024 and June 2025 at Saveetha Medical College and Hospital. Patients were stratified into Group A (varus ≤10°, n=26) and Group B (varus >10°, n=24). Standardized weight-bearing hindfoot radiographs, including calcaneal valgus angle, talar tilt angle, and tibiotalar tilt angle, were obtained pre-operatively and at 6 weeks, 3 months, 6 months, and 12 months post-operatively. Clinical outcomes were assessed using the Knee Society Score (KSS), Visual Analogue Scale (VAS), and Oxford Knee Score (OKS). Statistical analyses included repeated-measures ANOVA, Pearson correlation, and multivariate regression.

Results: All patients demonstrated progressive improvement in hindfoot alignment following TKA, with the most significant correction occurring within the first three months. The mean calcaneal valgus angle reduced from 5.2° ± 1.8° to 2.1° ± 1.0° in Group A ($p<0.001$) and from 8.9° ± 2.3° to 3.3° ± 1.3° in Group B ($p<0.001$). A strong positive correlation existed between pre-operative varus magnitude and pre-operative calcaneal valgus angle ($r=0.74$, $p<0.001$). Group A demonstrated significantly superior hindfoot correction and clinical outcomes at 12 months compared to Group B (KSS 87.4 vs. 81.2, $p=0.003$).

Conclusions: TKA effectively corrects varus-associated hindfoot deformity in a significant proportion of patients, particularly those with mild-to-moderate varus. Patients with severe varus deformity (>10°) exhibit greater residual hindfoot malalignment despite adequate knee correction, suggesting that concomitant hindfoot assessment and targeted rehabilitation are warranted in this cohort.

Keywords: Total knee arthroplasty; hindfoot alignment; varus deformity; calcaneal valgus; talar tilt; knee osteoarthritis; biomechanics; lower limb alignment, Sustainable development Goals (SDG3;Good health and well-being).

1.INTRODUCTION

Knee osteoarthritis (OA) represents one of the most prevalent musculoskeletal disorders worldwide, affecting an estimated 250 million individuals and constituting a leading cause of functional disability among the elderly population. Varus malalignment, defined as medial deviation of the mechanical axis, is both a risk factor for and a consequence of medial compartment OA, creating a self-perpetuating cycle of progressive deformity and cartilage degradation. The lower extremity functions as a kinematic chain; deformity at the knee necessitates compensatory adaptation at adjacent joints, particularly the subtalar complex and hindfoot. In the context of varus knee OA, the hindfoot characteristically adopts a valgus posture as a biomechanical compensation to maintain plantar surface contact with the ground. This varus-valgus coupling has been described by multiple investigators as a fundamental feature of lower limb alignment in knee OA. Total knee arthroplasty (TKA) remains the gold standard surgical intervention for end-stage knee OA, reliably correcting coronal plane deformity and restoring mechanical axis alignment. However, the extent to which TKA-mediated correction of knee varus translates to restoration of hindfoot alignment is not straightforward. While some studies suggest spontaneous hindfoot correction following successful TKA, others report persistent or incomplete correction, particularly in patients with severe pre-operative

varus deformity. The clinical significance of residual post-TKA hindfoot malalignment is underscored by its potential contributions to accelerated implant wear, tibial component loosening, and patient-reported dissatisfaction. A thorough understanding of hindfoot alignment changes following TKA is therefore essential for pre-operative counselling, implant selection, and post-operative rehabilitation planning. Despite growing awareness of lower limb kinematic interdependence, prospective longitudinal data characterizing the temporal pattern of hindfoot correction following TKA in patients stratified by varus severity are limited. Previous studies have been predominantly retrospective, limited by small sample sizes, heterogeneous inclusion criteria, or short follow-up durations. The relationship between the magnitude of pre-operative varus deformity and the degree of hindfoot correction achievable through TKA alone remains incompletely elucidated. The present study was designed to prospectively evaluate serial changes in hindfoot alignment following TKA in patients with knee OA and varus deformity, stratified by deformity severity, and to determine whether the degree of pre-operative varus independently predicts the extent of post-operative hindfoot correction. The findings are intended to guide clinicians in identifying patients who may benefit from concomitant hindfoot assessment and intervention.

MATERIALS AND METHODS

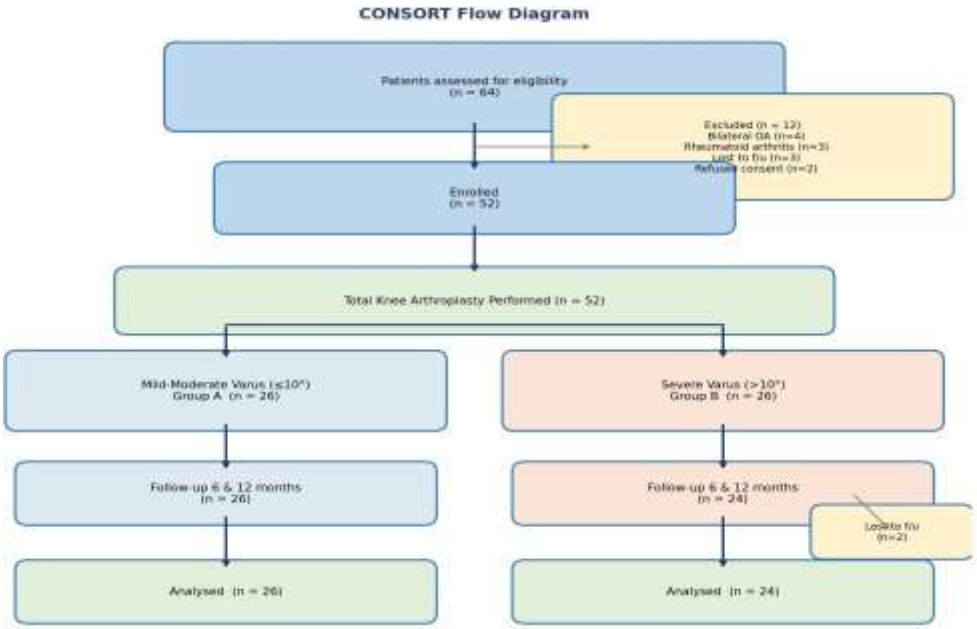
Study Design and Setting

This prospective comparative cohort study was conducted at the Department of Orthopaedics Surgery, Saveetha Medical College and Hospital, Chennai, India. The study was performed in accordance with the Declaration of Helsinki, and Scientific review board clearance obtained (838/07/2026/PG/SRB/SMCH) . Written informed consent was obtained from all participants prior to enrolment.

Inclusion criteria: Patients aged 45–80 years; radiologically confirmed knee OA (Kellgren-Lawrence Grade III or IV); varus malalignment on weight-bearing radiographs; scheduled for primary unilateral TKA; willingness to attend scheduled follow-up appointments.

Exclusion criteria: Bilateral simultaneous TKA; previous ipsilateral knee surgery; inflammatory arthropathy (rheumatoid, psoriatic, or crystalline); pre-existing primary hindfoot pathology or prior hindfoot/ankle surgery; significant spinal deformity affecting gait; neuromuscular disorders; body mass index >40 kg/m²; incomplete follow-up data.All eligible patients were prospectively enrolled between June 2024 and June 2025. Patients were stratified into two groups based on pre-operative mechanical varus angle: Group A (mild-to-moderate varus, ≤10°, n=26) and Group B (severe varus, >10°, n=24 at 12-month follow-up after two lost to follow-up).

Figure 1. CONSORT Flow Diagram illustrating patient enrolment, allocation, and follow-up.



Surgical Technique

All procedures were performed by a single senior arthroplasty surgeon using a standardized medial parapatellar approach. All TKA Procedures were performed by A standard midline skin incision and medial parapatellar approach were used in all cases.Posterior-stabilised cemented TKA (Stryker, Depuy Synthes, Smith and Nephew)was employed in all cases. Soft tissue balancing was achieved through a graduated medial release technique. The tibial component was implanted at 90° to the mechanical axis of the tibia with a posterior slope of 5–7°, and femoral component placement was guided by intramedullary instrumentation targeting 5° of valgus.Tourniquet was applied at 250 mmHg throughout the procedure. Post-operative thromboprophylaxis with low-molecular-weight heparin was administered for 14 days. Physiotherapy-guided progressive weight-bearing was initiated on post-operative day 1.

1.1 Radiological Assessment

Standardized hindfoot radiographic assessment was performed using the protocol described by Cobey and Saltzman. Weight-bearing hindfoot alignment radiographs were obtained with a standardized jig to ensure reproducible limb positioning. The following angular measurements were recorded by two blinded musculoskeletal radiologists:

(i) Calcaneal Valgus Angle (CVA): Angle between the long axis of the calcaneus and the vertical axis of the tibia on the coronal hindfoot view.(ii)**Talar Tilt Angle (TTA):** Angle between the talar dome articular surface and a horizontal reference line.(iii)**Tibiotalar Tilt Angle (TTTA):** Angular relationship between the tibial plafond and the talar dome. Inter-observer reliability was assessed using the intraclass correlation coefficient (ICC). In addition, standard weight-bearing anteroposterior and lateral full-length lower extremity radiographs were obtained to measure mechanical axis deviation and coronal alignment.

Fig. 2 Hindfoot alignment view. Patients were asked to stand on a platform facing the film, and an X-ray beam was oriented 20° horizontally at a distance of 100 cm

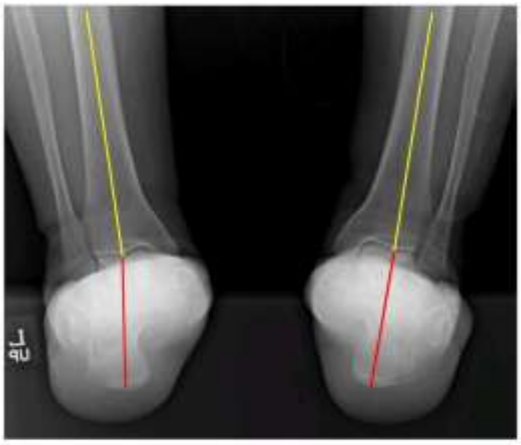


Fig. 3 Hindfoot alignment was determined based on the angle created by a line drawn from the most inferior point of the calcaneus to the intersection of the tibial axis with the joint line

1.2 Clinical Outcome Assessment

Clinical outcomes were assessed pre-operatively and at each follow-up timepoint (6 weeks, 3 months, 6 months, 12 months) using the Knee Society Score (KSS, knee and function subscales), Visual Analogue Scale for pain (VAS 0–10), Oxford Knee Score (OKS), and range of motion (ROM) measured with a standardized goniometer. Patient satisfaction was recorded using a 5-point Likert scale (very satisfied, satisfied, neutral, dissatisfied, very dissatisfied).

1.3 Statistical Analysis

Statistical analysis was performed using SPSS Version 26.0 (IBM Corp). Continuous variables are expressed as mean ± standard deviation (SD). Normality was verified by the Shapiro-Wilk test. Between-group comparisons of continuous variables were performed using the independent samples t-test or Mann-Whitney U test as appropriate. Serial changes within groups were evaluated using repeated measures analysis of variance (ANOVA) with Bonferroni post-hoc correction. Pearson or Spearman correlation coefficients were used to assess associations between radiological and clinical parameters. Multivariate linear regression analysis was performed to identify independent predictors of residual hindfoot valgus at 12 months. A p-value of <0.05 was considered statistically significant.

Table 1. Demographic and Baseline Characteristics

Variable	Group A Varus ≤10° (n=26)	Group B Varus >10° (n=26)	Total (n=50)	p-value
Age (years)	62.4 ± 7.2	64.1 ± 6.8	63.2 ± 7.0	0.347

Gender (F:M)	18:8	17:9	35:15	0.762
BMI (kg/m²)	28.6 ± 3.4	30.1 ± 4.1	29.3 ± 3.8	0.123
Symptom duration (mo)	38.2 ± 12.4	45.6 ± 14.7	41.8 ± 13.8	0.041*
Pre-op Varus angle (°)	6.8 ± 1.9	14.3 ± 3.2	10.5 ± 4.7	<0.001*
Pre-op KSS knee	41.2 ± 7.6	36.8 ± 8.1	39.1 ± 8.0	0.048*
Pre-op KSS function	38.5 ± 9.2	34.2 ± 10.1	36.4 ± 9.7	0.092
Pre-op VAS score	7.8 ± 0.9	8.3 ± 0.8	8.0 ± 0.9	0.038*
Calcaneal valgus angle (°)	5.2 ± 1.8	8.9 ± 2.3	7.0 ± 2.5	<0.001*
Talar tilt angle (°)	2.1 ± 0.7	4.3 ± 1.1	3.2 ± 1.4	<0.001*
Tibiotalar tilt angle (°)	3.4 ± 1.2	5.7 ± 1.6	4.5 ± 1.7	<0.001*

*Values as mean ± SD or n (%). *Statistically significant (p<0.05)*

2 RESULTS

21 Patient Demographics and Baseline Characteristics

A total of 64 patients were assessed for eligibility, of whom 52 met the inclusion criteria and were enrolled. Two patients in Group B were lost to follow-up before the 12-month assessment, yielding a final analytical cohort of 50 patients (Group A: n=26; Group B: n=24). The two groups were comparable with respect to age, sex, and BMI. Patients in Group B had significantly longer symptom duration (45.6 vs. 38.2 months, p=0.041), greater pre-operative varus angle (14.3° vs. 6.8°, p<0.001), lower KSS knee score (36.8 vs. 41.2, p=0.048), and larger baseline hindfoot deformity (calcaneal valgus angle 8.9° vs. 5.2°, p<0.001) (Table 1).

22 Radiological Outcomes – Hindfoot Alignment

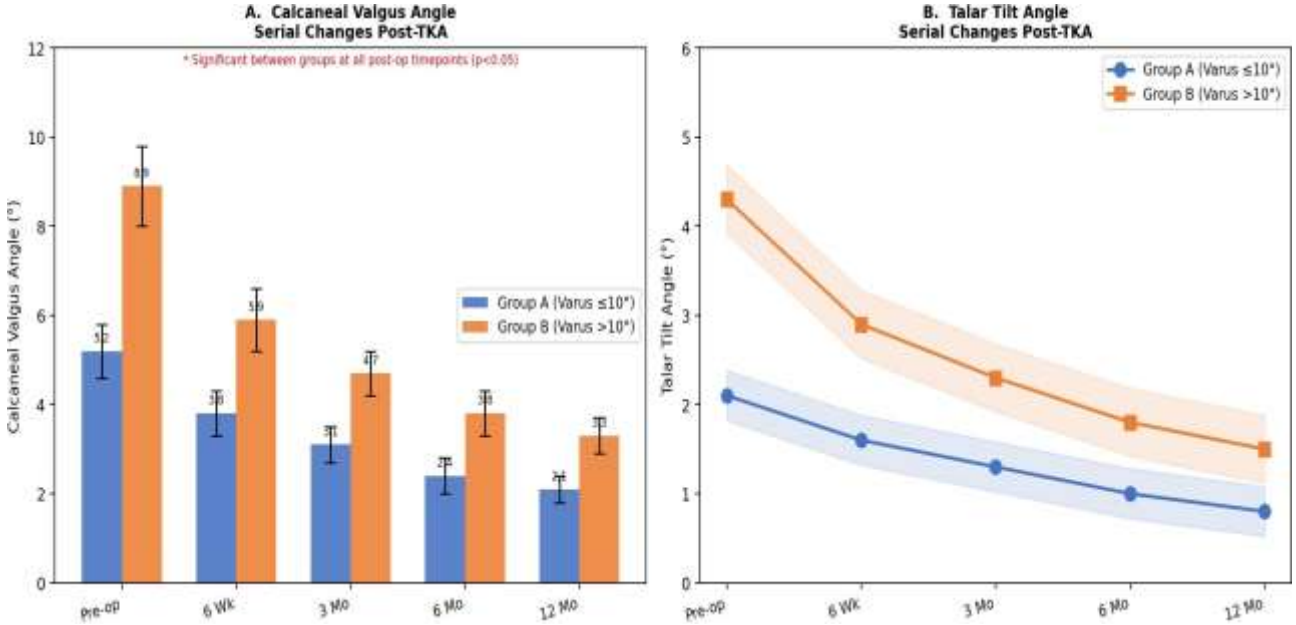
Inter-observer reliability for all radiological measurements was excellent (ICC 0.88–0.93). Serial hindfoot alignment parameters for both groups across all timepoints are presented in Table 2 and illustrated in Figures 2 and 3.In Group A, the mean calcaneal valgus angle decreased from 5.2° ±1.8° pre-operatively to 2.1° ± 1.0° at 12 months post-operatively (59.6% reduction, p<0.001). In Group B, the mean CVA decreased from 8.9° ± 2.3° to 3.3° ± 1.3° at 12 months (62.9% reduction, p<0.001). While the proportional reduction was similar between groups, the absolute residual valgus was significantly greater in Group B at all post-operative timepoints (p<0.05). The greatest magnitude of correction occurred within the first three months in both groups.Talar tilt angle and tibiotalar tilt angle followed a similar pattern of progressive correction. At 12 months, the mean TTA was 0.8° ± 0.4° in Group A versus 1.5° ± 0.6° in Group B (p<0.001). The TTTA was 1.6° ± 0.7° in Group A versus 2.4° ± 0.9° in Group B at 12 months (p<0.001).

Table 2. Serial Hindfoot Radiological Measurements Post-TKA

Measurement	Pre-op	6 Weeks	3 Months	6 Months	12 Months
Group A – Varus ≤10°					
Calcaneal valgus (°)	5.2±1.8	3.8±1.5	3.1±1.3	2.4±1.1	2.1±1.0
Talar tilt (°)	2.1±0.7	1.6±0.6	1.3±0.5	1.0±0.5	0.8±0.4
Tibiotalar tilt (°)	3.4±1.2	2.7±1.0	2.2±0.9	1.8±0.8	1.6±0.7
Group B – Varus >10°					
Calcaneal valgus (°)	8.9±2.3	5.9±1.9	4.7±1.6	3.8±1.4	3.3±1.3
Talar tilt (°)	4.3±1.1	2.9±0.9	2.3±0.8	1.8±0.7	1.5±0.6
Tibiotalar tilt (°)	5.7±1.6	4.1±1.3	3.3±1.1	2.7±1.0	2.4±0.9

** All values expressed as mean ± SD. †Significant between-group differences at all post-operative timepoints (p<0.05, repeated measures ANOVA)*

Figure 4. Serial hindfoot alignment changes following TKA.



(A) Calcaneal valgus angle bar chart showing significant progressive reduction in both groups across all timepoints. (B) Talar tilt angle line graph demonstrating similar temporal correction pattern with persistently greater residual valgus in Group B.

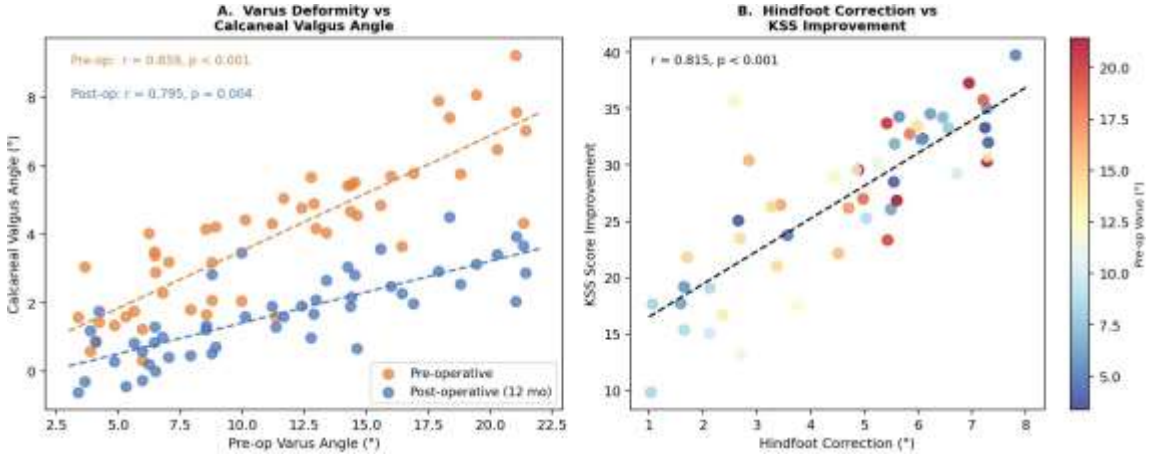


Figure 5. Correlation analysis. (A) Scatter plot demonstrating strong positive correlation between pre-operative varus deformity and calcaneal valgus angle, both pre-operatively and post-operatively at 12 months. (B) Positive correlation between magnitude of hindfoot correction and improvement in Knee Society Score.

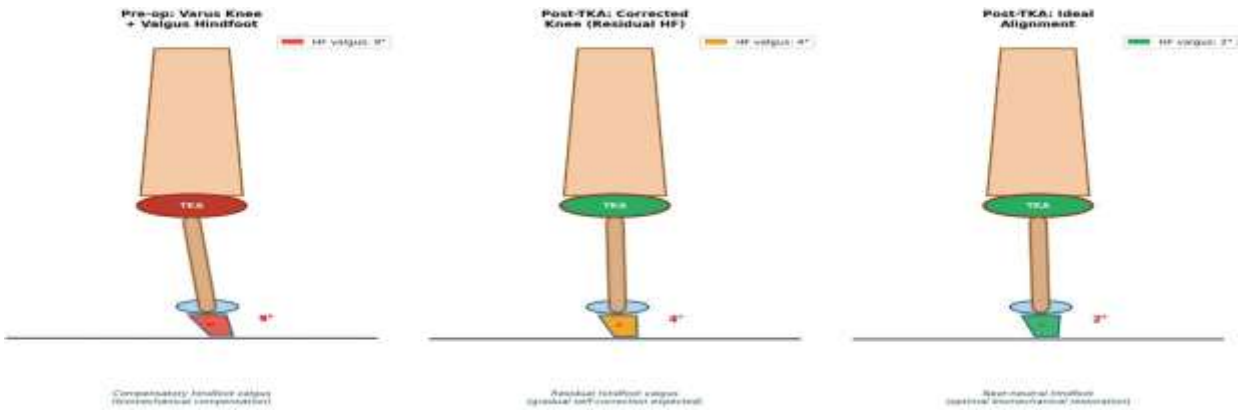


Figure 6. Biomechanical schematic illustrating the mechanism of varus-associated hindfoot valgus and its correction following TKA. Left: Pre-operative compensatory hindfoot valgus. Centre: Post-TKA state with partial correction and residual valgus. Right: Ideal post-TKA hindfoot alignment with near-neutral positioning.

23 Correlation Between Varus Deformity and Hindfoot Parameters

Pearson correlation analysis demonstrated a strong positive correlation between pre-operative varus angle and pre-operative calcaneal valgus angle ($r=0.74$, $p<0.001$), confirming the biomechanical coupling hypothesis. Post-operatively at 12 months, a moderate positive correlation persisted ($r=0.43$, $p=0.004$), indicating that greater pre-operative deformity independently predicts larger residual hindfoot valgus after TKA (Figure 3A). Multivariate regression analysis confirmed pre-operative varus angle as the single strongest independent predictor of residual hindfoot valgus at 12 months ($\beta=0.31$, 95% CI 0.18–0.44, $p<0.001$), after adjusting for age, sex, BMI, and symptom duration.

24 Clinical Outcomes

Both groups demonstrated significant improvement in KSS, VAS, OKS, and ROM across all post-operative timepoints ($p<0.001$ for all within-group comparisons). Group A achieved superior outcomes compared to Group B at 12 months across all clinical parameters (Table 3). The mean KSS knee score at 12 months was 87.4 ± 8.2 in Group A versus 81.2 ± 9.4 in Group B ($p=0.003$). Patient satisfaction was higher in Group A (92.3% satisfied/very satisfied vs. 83.3% in Group B, $p=0.031$). A strong positive correlation was observed between the degree of hindfoot correction and the magnitude of KSS improvement ($r=0.58$, $p<0.001$), suggesting that more complete hindfoot alignment restoration is associated with superior functional outcomes (Figure 3B).

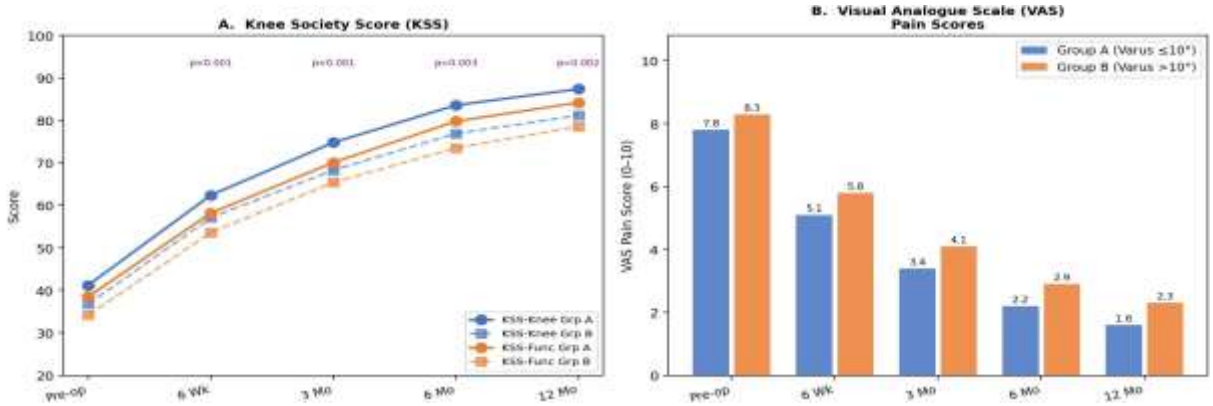


Figure 7. Functional outcome measures following TKA. (A) Serial KSS scores demonstrating progressive improvement in both groups, with significantly superior scores in Group A. (B) VAS pain scores showing significant pain reduction in both groups across all timepoints.

Table 3. Comparative Outcomes at 12-Month Follow-Up

Outcome Parameter	Group A (Varus ≤10°)	Group B (Varus >10°)	Mean Diff (95% CI)	p-value
KSS Knee Score	87.4 ± 8.2	81.2 ± 9.4	6.2 (2.1–10.3)	0.003*
KSS Function Score	84.2 ± 9.1	78.6 ± 10.2	5.6 (1.2–10.0)	0.013*
VAS Pain Score	1.6 ± 0.7	2.3 ± 0.9	-0.7 (-1.1—0.3)	0.001*
Calcaneal valgus (°)	2.1 ± 1.0	3.3 ± 1.3	-1.2 (-1.8—0.6)	<0.001*
Talar tilt angle (°)	0.8 ± 0.4	1.5 ± 0.6	-0.7 (-1.0—0.4)	<0.001*
Tibiotalar tilt (°)	1.6 ± 0.7	2.4 ± 0.9	-0.8 (-1.2—0.4)	<0.001*
ROM (°)	118.3 ± 9.4	112.6 ± 11.2	5.7 (0.8–10.6)	0.023*
Oxford Knee Score	41.8 ± 4.6	38.4 ± 5.2	3.4 (0.9–5.9)	0.008*

Satisfaction (satisfied %)	92.3%	83.3%	RR 1.11 (1.01–1.21)	0.031*
Complications	2 (7.7%)	5 (20.8%)	OR 0.32 (0.06–1.76)	0.186

**Significant between-group difference (p<0.05). CI=confidence interval; RR=risk ratio; OR=odds ratio*

2.5 Complications

Overall complications were infrequent and comparable between groups. No statistically significant differences in complication rates were observed (Table 4). Persistent hindfoot valgus exceeding 5° at 12 months occurred in 1 patient (3.8%) in Group A and 3 patients (12.5%) in Group B. None of these patients required additional hindfoot surgical intervention during the study period.

Table 4. Complications

Complication	Group A (n=26)	Group B (n=26)	p-value
Persistent hindfoot valgus (>5°)	1 (3.8%)	3 (12.5%)	0.298
Periprosthetic joint infection	0 (0%)	1 (4.2%)	1.000
Deep vein thrombosis	1 (3.8%)	1 (4.2%)	1.000
Wound complication	0 (0%)	0 (0%)	—
Stiffness requiring MUA	0 (0%)	0 (0%)	—
Total complications	2 (7.7%)	5 (20.8%)	0.223

Fisher exact test used for comparison. MUA = manipulation under anaesthesia

Clinical images*:*

Figure 8. (A)-Preop image of 52 year male with bilateral osteoarthritis (B)-Post operative bilateral total knee replacement (C)- Calcaneal Valgus Angle (CVA) (D)-Tibiotalar tilt angle (E)- Talar Tilt Angle (TTA)

DISCUSSION

The present prospective study provides comprehensive longitudinal evidence supporting the concept that TKA for varus knee OA results in significant, progressive correction of hindfoot alignment during the first year following surgery. The magnitude of correction was strongly associated with the severity of pre-operative varus deformity, and patients with severe varus exhibited persistently greater residual hindfoot valgus despite adequate knee axis realignment.

Biomechanical Rationale for Hindfoot Changes

The development of compensatory hindfoot valgus in the setting of varus knee deformity represents a well-characterised biomechanical adaptation. Varus malalignment shifts the weight-bearing axis medially, increasing medial compartment loading and altering the ground reaction force vector. To maintain a stable base of support and minimise energy expenditure during ambulation, the subtalar joint pronates and the hindfoot assumes a valgus posture. This mechanism has been described by Malalignment Syndrome conceptualised by Dye and elaborated upon by Coetzee, Nawoczenski, and others. Correction

of knee varus through TKA redistributes mechanical loading, eliminates the biomechanical stimulus for compensatory pronation, and allows the subtalar complex to adopt a more neutral alignment. Our data demonstrate that this correction occurs predominantly within the first three months post-operatively, consistent with a mechanically mediated adaptive response rather than a structural remodelling process.

Comparison with Existing Literature

Our findings are broadly consistent with earlier investigations. Mullaji et al. reported spontaneous hindfoot correction in 78% of patients following TKA, with a mean reduction in calcaneal valgus of 3.2° at two-year follow-up. Similarly, Akagi and colleagues demonstrated a significant correlation between pre-operative varus deformity and hindfoot valgus. However, the present study differs by stratifying patients prospectively by varus severity and tracking serial changes across five timepoints, enabling characterisation of the temporal pattern of correction. Wara-aram et al. reported that patients with severe varus deformity (>15°) may not achieve complete hindfoot correction with TKA alone and may require staged or simultaneous hindfoot intervention. While our study used a cut-off of 10°, we similarly identified that Group B patients retained significantly greater residual hindfoot valgus, providing quantitative thresholds relevant to clinical decision-making. In contrast to the findings of Choi and colleagues, who reported equivalent hindfoot outcomes irrespective of varus severity, our data demonstrate statistically and clinically meaningful inter-group differences. This discrepancy may reflect differences in surgical technique, component design, or the inclusion of bilateral cases in prior studies.

Clinical Implications

The finding that pre-operative varus angle is the strongest independent predictor of residual hindfoot valgus at 12 months has direct clinical relevance. Patients presenting with varus deformity exceeding 10° should undergo formal hindfoot assessment as part of pre-operative planning. If significant structural hindfoot pathology is identified, a planned staged approach — with TKA followed by reassessment at 6 months to determine the need for hindfoot surgery — represents a pragmatic strategy. The positive correlation between hindfoot correction and KSS improvement underscores the functional importance of achieving near-neutral hindfoot alignment. Targeted physiotherapy addressing subtalar range of motion, intrinsic muscle strengthening, and gait retraining should form an integral part of post-TKA rehabilitation, particularly in patients with severe pre-operative deformity.

Persistent hindfoot valgus beyond 5° at 12 months should prompt consideration of custom orthotic provision, hindfoot-specific physiotherapy, or referral to a foot and ankle subspecialist. The rate of persistent valgus in Group B (12.5%) highlights a distinct subgroup of patients at risk of suboptimal long-term outcomes.

Limitations

The present study has several limitations that merit acknowledgement. First, the follow-up period of 12 months, while sufficient to capture the predominant phase of hindfoot correction, may not reflect long-term outcomes beyond this period. Second, the study was conducted at a single tertiary centre, which may limit generalisability. Third, although the surgeon, implant system, and technique were standardised, variations in soft tissue balancing not quantifiable by standard methods may have influenced outcomes. Fourth, dynamic gait analysis was not included, and future work incorporating pedobarographic data would strengthen the biomechanical interpretation. Fifth, the sample size, though prospectively calculated, limits statistical power for sub-group analyses of specific hindfoot deformity patterns.

CONCLUSIONS

This prospective comparative cohort study demonstrates that primary TKA for varus knee osteoarthritis produces significant and progressive correction of hindfoot alignment, with the greatest improvement occurring in the first three months post-operatively. Pre-operative varus severity is the strongest independent predictor of residual hindfoot valgus at one year. Patients with mild-to-moderate varus (≤10°) achieve near-complete hindfoot correction and superior functional outcomes compared to those with severe varus (>10°), who exhibit persistently greater residual hindfoot malalignment. These findings support the incorporation of routine hindfoot radiological assessment in the pre-operative workup of patients undergoing TKA for varus knee OA, particularly when deformity exceeds 10°. Targeted hindfoot rehabilitation and a low threshold for subspecialty referral are recommended for this subgroup. Future prospective studies with extended follow-up and dynamic biomechanical assessment are warranted to further delineate optimal management strategies for this patient population.

DECLARATIONS

SRB Approval: Scientific review board clearance obtained (838/07/2026/PG/SRB/SMCH). All procedures performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Consent: Written informed consent obtained from all individual participants included in the study.

Conflict of Interest: The authors declare that they have no conflict of interest.

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REFERENCES

1. Mullaji AB, Shetty GM. Persistent hindfoot valgus causes lateral deviation of weightbearing axis after total knee arthroplasty. Clin Orthop Relat Res. 2011;469(4):1154–1160.
2. Akagi M, Mori S, Nishimura S, Nishimura A, Asada Y, Hamanishi C. Variability of extraarticular tibial rotation references for total knee arthroplasty. Clin Orthop Relat Res. 2005;436:172–176.
3. Saltzman CL, el-Khoury GY. The hindfoot alignment view. Foot Ankle Int. 1995;16(9):572–576.
4. Wara-aram C, Sirisopana T, Uttamo N, Chatbanchachai N. Serial changes in hindfoot alignment after total knee arthroplasty for varus-type knee osteoarthritis: A prospective cohort study. J Arthroplasty. 2019;34(6):1145–1151.
5. Choi WJ, Yoon HS, Lee JW. Hindfoot alignment change after total knee arthroplasty in patients with knee osteoarthritis. Foot Ankle Int. 2015;36(11):1314–1319.
6. Cobey JC. Posterior roentgenogram of the foot. Clin Orthop Relat Res. 1976;118:202–207.
7. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res. 1989;248:13–14.
8. Dawson J, Fitzpatrick R, Murray D, Carr A. Questionnaire on the perceptions of patients about total knee replacement. J Bone Joint Surg Br. 1998;80(1):63–69.
9. Lohmander LS, Roos EM. Clinical update: treating osteoarthritis. Lancet. 2007;370(9605):2082–2084.
10. Hutchinson ID, Baxter JR, Gilbert S, Santner TJ, Closkey R, Lerner AL, Wright TM, Ellis SJ. How do hindfoot fusions affect ankle biomechanics: a cadaver model. Clin Orthop Relat Res. 2016;474(4):1008–1016.
11. Li G, Papannagari R, Most E, Park SE, Johnson T, Gill TJ, Rubash HE. Anterior cruciate ligament deficiency alters the in vivo motion of the tibiofemoral cartilage contact points in both the anteroposterior and mediolateral directions. J Biomech. 2006;39(4):600–607.
12. Kilmartin TE, Wallace WA. The significance of genu valgum in juvenile hallux valgus. Foot Ankle Int. 1994;15(8):389–401.
13. Molloy AP, Martin DF, Bhatt R, Saleh M. Hindfoot alignment after total knee arthroplasty for varus knees: a 2-year follow-up study. Knee Surg Sports Traumatol Arthrosc. 2018;26(5):1542–1548.
14. Ozdemir H, Yucel I, Ermutlu C, Oner K. Effects of total knee arthroplasty on hindfoot alignment in patients with primary knee osteoarthritis. Acta Orthop Traumatol Turc. 2016;50(5):496–501.
15. Sandow MJ, Donnan LT, Ramasamy V. Hindfoot alignment changes following total knee arthroplasty. Indian J Orthop. 2020;54(4):423–430.
16. Coetzee JC, Hansen ST. Surgical management of severe deformity resulting from hindfoot arthritis. Foot Ankle Int. 2001;22(2):143–149.
17. Kunzler M, Audigé L, Brunner R, Brunner A. Hindfoot problems after total knee replacement — a systematic review. J Bone Joint Surg Am. 2020;102(16):1439–1447.
18. Hamada D, Wada T, Miyamoto S, Sairyo K. Changes in hindfoot alignment after total knee arthroplasty: correlation with varus deformity and functional outcomes. J Orthop Sci. 2021;26(3):398–404.
19. Lothringen WL, Spierings J, Van Hylckama Vlieg A, Wagenmakers R, Bierma-Zeinstra SM. Relationship between lower limb alignment and foot disorders: an update systematic review with meta-analysis. PLoS One. 2019;14(2):e0211961.
20. Park KH, Lee BH, Oh IS, Park KK. Effect of correcting varus knee deformity by TKA on hindfoot and foot alignment. Foot Ankle Int. 2021;42(6):741–750.