

# Comparison of Radiographic Modalities to Assess the Lower Limb Constitutional Alignment and Coronal Plane Alignment of the Knee Phenotype: A Multicenter Comparative Study of Plain Long-Leg Radiographs versus Computerized Tomography

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## INTRODUCTION:

Long leg radiographs are used to measure native alignment. The objective of this study was to compare the correlation of measuring the lower limb constitutional alignment with traditional long leg radiographs versus CT used for preoperative planning in robotic-arm assisted knee arthroplasty.

## METHODS:

This international, multicenter cohort study across 3 tertiary centers, encompassed 300 patients undergoing primary, robotic-arm assisted total knee arthroplasty (TKA) or unicompartmental knee arthroplasty (UKA), for whom long leg alignment views and CT scanogram were available preoperatively. Constitutional alignment was established by measuring the medial proximal tibial angle (MPTA), lateral distal femoral angle (LDFA), hip knee alignment (HKA), arithmetic hip knee alignment (aHKA), joint line obliquity (JLO), Joint-Line Convergence Angle (JLCA), and Coronal Plane Alignment of the Knee (CPAK). Linear regression models were also employed to identify parameters associated with larger discrepancies.

## RESULTS:

The mean difference in measurements between the two imaging modalities was  $0.35^\circ \pm 2.5^\circ$  for HKA;  $0.7 \pm 2.8$  JLO;  $0.7 \pm 2.2$ , MPTA;  $-0.2 \pm 1.7$  LDFA. No statistically significant difference was evident for any of the measured variables between the groups (independent samples t-test). Bland-Altman plots for all variables showed that approximately 95% observations were within the limit of agreement. The Pearson's correlation coefficient was 0.933 for HKA; 0.8 for MPTA; 0.85 for LDFA, and 0.756 for JLO,  $p < 0.001$  for all analyses. Regression models demonstrated that the discrepancy in JLCA measurement was associated with the severity of OA (JLCA angle on plain X-ray);  $\beta = 0.1$ , 95%CI 0.34, 0.166,  $p = 0.001$ , while the discrepancy in MPTA and LDFA measurements were associated with malpositioning of the lower limb during the CT (lower limb rotational angle);  $\beta = 0.052$ , 95%CI 0.031 0.073,  $p < 0.001$ .

## DISCUSSION AND CONCLUSION:

We found a very strong correlation between long-leg radiographs and the CT scanogram acquired during the preoperative planning stage of robotic-arm assisted knee arthroplasty, implying that the CT scan can reliably be utilized to ascertain the constitutional alignment. Nevertheless, it is crucial to ensure appropriate radiographic positioning of the lower limb. Additionally, clinicians should exercise awareness regarding potential discrepancies in JLCA measurements when dealing

with severe varus or valgus deformities.

Variables	Patient undergoing Robotic-arm assisted TKA or UKA (N = 300)
Age (mean, range)	69 (40 to 87)
Gender	
Female	122 (40.7)
Male	178 (59.3)
Timing of the operation	
2016	1 (0.3)
2019	4 (1.3)
2020	3 (1)
2021	21 (7)
2022	157 (52.3)
2023	114 (38)
Laterality	
Right	156 (52)
Left	144 (48)
Procedure	
TKA	252 (84)
UKA	48 (16)
UKA	
Medial	46 (95.8)
Lateral	2 (4.2)
JLCA (based on plain knee AP view)	3.4 (1, 5)
CT Lower Limb rotational Angle (degrees)	5 (1.2, 10.5)
KL Classification - Medial compartment	
0	0
1	1 (0.3)
2	38 (12.7)
3	89 (29.7)
4	172 (57.3)
KL Classification - Lateral compartment	
0	1 (0.3)
1	22 (7.3)
2	117 (39)
3	121 (40.3)
4	39 (13)
Time between Long Leg views and CT scanogram (days)	0 (0, 41)

Categorical variables are presented as absolute number (percentage), continuous variables are presented as median (Quartile 1, Quartile 2).  
 TKA: Total Knee Arthroplasty, UKA: Unicompartmental Knee Arthroplasty  
 JLCA: Joint Line Convergence Angle, KL classification: Kellgren and Lawrence system for classification of osteoarthritis, AP: Anteroposterior

Variables	Long-leg radiographs	Computerised Tomography	Pearson Correlation Co-efficient	Spearman's Correlation CO-efficient
HKA	174.6 (171.8, 179)	175 (172.8, 178)	0.933, $P < 0.001$	0.913, $P < 0.001$
LDFA	88.16 (3)	88.4 (3.2)	0.850, $P < 0.001$	0.819, $P < 0.001$
MPTA	87 (3.3)	86.1 (3.7)	0.803, $P < 0.001$	0.824, $P < 0.001$
aHKA	-1.07 (5.1)	-2.3 (5.3)	0.868, $P < 0.001$	0.843, $P < 0.001$
JLO	175.3 (3.9)	174.5 (4.3)	0.756, $P < 0.001$	0.771, $P < 0.001$
JLCA	3.3 (0.8, 5.3)	2 (0.3, 3.2)	0.613, $P < 0.001$	0.681, $P < 0.001$

Categorical variables are presented as absolute number (percentage), continuous variables are presented as median (Quartile 1, Quartile 2).  
 HKA: Hip-Knee-Ankle angle, aHKA: arithmetic Hip-Knee-Ankle angle, LDFA: Lateral Distal Femoral Angle, MPTA: Medial Proximal Tibial Angle, JLCA: Joint Line Convergence Angle, JLO: Joint Line Obliquity