

**TITLE:** Comparison of Radiographic Modalities to Assess the Constitutional Alignment and CPAK Phenotype: A Multicentre Comparative Study of Plain Long-leg Radiographs Versus Computerised Tomography.

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**ABSTRACT INTRODUCTION:** Long leg radiographs are used to measure native coronal 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 pre-operative planning in robotic-arm assisted knee arthroplasty.

**METHODS:** This international, multicentre cohort study across 3 tertiary centres, encompassed 300 patients undergoing primary, robotic-arm assisted TKA or UKA, for whom long leg radiographs and CT scanogram were available pre-operatively. Constitutional alignment was established by measuring the medial proximal tibial angle (MPTA), lateral distal femoral angle(LDFA), hip knee alignment(HKA), joint line obliquity (JLO), Joint-Line Convergence Angle (JLCA). Linear regression models were also employed to identify parameters associated with larger discrepancies.

**RESULTS SECTION:** 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. Bland-Altman plots for all variables showed that approximately 95% observations were within the limit of agreement. A slightly weaker correlation was evident for valgus knees compared with varus aligned knees. Regression models demonstrated the degree of agreement regarding JLCA measurements was associated with the severity of OA (JLCA angle on plain X-ray), while the agreement regarding aHKA was associated with positioning of the lower limb during the CT (lower limb rotational angle). Observations within JLCA  $\pm 5$  degrees and rotational angle within  $\pm 10$  degrees were associated with higher agreement between the two modalities.

**DISCUSSION:** We found a strong correlation between long-leg radiographs and the CT scanogram acquired during the pre-operative planning stage of robotic-arm assisted knee arthroplasty, implying 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, surgeons must remain vigilant regarding potential discrepancies in JLCA measurements in cases involving pronounced deformities.

**SIGNIFICANCE/CLINICAL RELEVANCE:** The CT scan can reliably be utilized to ascertain the constitutional alignment and the benefits of reducing irradiation and resource sparing should be considered. However, to attain a higher degree of agreement, particular attention should be paid by the CT technicians and radiographers to ensure appropriate patient positioning, while arthroplasty surgeons should remain vigilant in cases of pronounced deformities, such as when the JLCA falls outside of the  $\pm 5$  degrees range or when the rotational angle exceeds  $\pm 10$  degrees.

Table 1. Correlational analysis of measurement parameters between the two imaging modalities.

Variables	Pearson Correlation Co-efficient	Spearman's Correlation Co-efficient	Intra-Class correlation co-efficient (95% CI)
HKA	0.932, $P<0.001$	0.912, $P<0.001$	0.957 (0.946, 0.966)
LDFA	0.871, $P<0.001$	0.847, $P<0.001$	0.929 (0.910, 0.944)
MPTA	0.820, $P<0.001$	0.840, $P<0.001$	0.877 (0.783, 0.923)
aHKA	0.883, $P<0.001$	0.856, $P<0.001$	0.922 (0.848, 0.954)
JLO	0.778, $P<0.001$	0.795, $P<0.001$	0.863 (0.819, 0.895)
JLCA	0.725, $P<0.001$	0.690, $P<0.001$	0.773 (0.631, 0.850)

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, CI: Confidence Interval

Figure 1. Graph illustrating the mean difference in aHKA measurements between the two imaging modalities for different thresholds of the CT Limb rotational angle (CRA). Figure 2. Bland-Altman plots for aHKA, MPTA, LDFA and JLCA.

