Progression of Lateral Laxity After Robotic-Assisted TKA Using Functional Alignment: A Prospective Two-Year Follow-up Study

Abstract

Purpose: Progression of lateral laxity after total knee arthroplasty (TKA) is a concern, particularly in varus knees where soft-tissue imbalance and joint line obliquity may predispose to instability. Functional alignment (FA), a balance-driven alignment philosophy facilitated by robotics, aims to optimize gap symmetry while respecting patient-specific anatomy. This study evaluated progression of lateral laxity at 2-year follow-up in patients undergoing robotic-assisted TKA using FA principles.

Methods: Eighty-five consecutive patients (85 knees) with primary osteoarthritis and varus deformity underwent MAKO robotic-assisted TKA (Stryker, Kalamazoo, MI, USA) between 2022–2023. Radiographic assessment included joint line convergence angle (JLCA), lateral tibial plateau width (LTPW), and fibular height (FH) on standardized long-leg scanograms pre-operatively and at 2 years. Coronal Plane Alignment of the Knee (CPAK) classification was calculated for each patient. The primary outcome was change in lateral laxity indices over 2 years. Secondary outcomes included CPAK transition and correlation between residual alignment and laxity progression. Statistical analysis included paired t-tests or Wilcoxon signed-rank tests for pre- vs post-operative comparisons and ANOVA for subgroup analysis.

Results: At 2 years, there was a significant reduction in JLCA (pre-op 5.6° ± 1.9 vs post-op 2.1° ± 1.3, $p<0.001$), LTPW (6.8 ± 1.4 mm vs 3.2 ± 1.2 mm, $p<0.001$), and FH (11.9 ± 2.7 mm vs 9.1 ± 2.2 mm, $p<0.001$). Across CPAK classes, FA achieved consistent reductions in lateral laxity, with the largest improvement observed in CPAK-I knees (mean JLCA reduction 4.1°). At 2 years, no patient demonstrated radiographic progression of lateral laxity compared with early post-op values. CPAK phenotype was preserved in 48% of knees, with phenotype change not associated with instability.

Conclusion: Functional alignment achieved durable correction of lateral laxity at 2 years following robotic-assisted TKA. No progression of lateral laxity was observed, supporting the balance-driven philosophy of FA. While CPAK phenotype frequently changed post-operatively, this did not translate into clinical instability. Longer-term follow-up is warranted to assess survivorship and patient-reported outcomes.