

Standard vs robot assisted technique in medial UKA: preliminary results of a static rsa and gait analysis study

Giulio Maria Marcheggiani Muccioli, Domenico Alesi, Stefano Fratini, Alberto Fogacci, Raffaele Zinno, Erika Pinelli, Laura Bragonzoni, Stefano Zaffagnini

INTRODUCTION:

Unicompartmental knee arthroplasty (UKA) is an effective option for isolated osteoarthritis, with faster recovery and better joint kinematics than total knee arthroplasty. However, outcomes depend on surgical accuracy. Robot-assisted UKA was developed to enhance precision and implant positioning. While theoretical advantages are supported, high-quality comparative data remain limited. This study evaluates whether robotic assistance improves clinical, biomechanical outcomes and reduces early micromotion compared to the conventional technique.

METHODS:

This prospective randomized controlled single blind and single center study included 42 patients undergoing medial UKA using either robotic and standard UKA technique with same implant design. Inclusion criteria were medial unicompartmental knee osteoarthritis, osteonecrosis of medial femoral condyles or tibial plateau, stable knee, moderate varus deformities ($<10^\circ$), 50-80 years old patients. Clinical scores, Knee Society Score (KSS), Oxford Knee Score (OKS), and EQ-5D, were assessed before surgery and at 1,3,6,12,24 months postoperatively. Physical function, measured by the Short Physical Performance Battery (SPPB) and gait test, before surgery and at 6,12,24 months postoperatively.

Radiostereometric analysis (RSA) to assess implant micromobilisation over time is still currently being processed.

A two-way repeated measures ANOVA was used to analyze differences between groups and over time.

RESULTS:

13 patients in the standard group and 13 patients in the robot group underwent 12-month post-operative follow-up.

Demographic and Preoperative Characteristics

Mean age was comparable (61.6 years in the robot group vs. 62.9 years in the standard group), with a slightly higher proportion of males in the robotic group (14M/8F) compared to the standard group (8M/12F). Mean BMI was nearly identical (27.4 vs. 27.2 kg/m²), and preoperative hip-knee-ankle (HKA) angles were also similar (173.72° vs. 173.25°), indicating homogeneity between two groups.

Intraoperative and Early Postoperative Parameters

Mean surgical time was significantly longer in the robot-assisted group (91.4 minutes vs. 70.5 minutes). Despite the prolonged operative duration, stay length was comparable between groups (4.5 vs. 4.8 days), and no intra- or postoperative complications were reported. A significant difference was observed in polyethylene insert thickness: thinner inserts (8 mm) were used in 81% of patients in the robotic group compared to only 35% in the standard group ($p = 0.0172$), suggesting that robotic surgery is bone sparing procedure enabled more precise and conservative resections.

Clinical Outcomes at 12-Month Follow-Up

Both groups exhibited significant improvement in range of motion (ROM) at 12 months compared to baseline (robot: $127.3^\circ \pm 4.2 +14.2^\circ$, standard: $126.5^\circ \pm 5.3 +10.7^\circ$) although the degree of improvement did not differ significantly between the groups.

No postoperative complications, such as infections, thromboses, or reinterventions, were reported.

Functional Outcomes (SPPB) and PROMs

Functional performance was evaluated using the Short Physical Performance Battery (SPPB), which includes gait speed (4-meter walk test), balance tests, and repeated chair-stand test. In the robot group, the mean SPPB score increased from 9.1 ± 1.6 preoperatively to 9.7 ± 1.6 at 12 months. In the standard group, the score improved from 8.3 ± 2.2 to 9.5 ± 2.0 . While both groups showed meaningful clinical improvement, the between group difference in SPPB scores was not statistically significant.

Gait Analysis

Quantitative gait assessment was conducted using time-based tests such as the Timed Up and Go (TUG) and a 7-meter walk test with BTS sensor analysis.

- TUG Test: Both groups demonstrated improvement over time. The robot group began with slightly better preoperative function, but the standard group showed more pronounced improvement from baseline to 12 months. However, no statistically significant difference in TUG test duration was found between the two groups at 12 months.

- Sub-phase Analysis (Rising, Sitting, Walking): Improvement with no significant differences were observed between the groups in the durations of individual gait phases (rising, sitting, walking 7 meters round-trip), indicating that the recover of functional mobility was similar in both cohorts

- Gait Symmetry and Quality Index: Improvement with no significant differences were found in lower limb symmetry during ambulation or in the BTS-calculated gait quality index (range 0–100).

DISCUSSION AND CONCLUSION:

Robot-assisted UKA allows more conservative bone resections, as shown by the significantly higher use of thinner polyethylene inserts. Both techniques led to substantial clinical and functional improvement at 12 months, with no significant differences in ROM, PROMs, or gait parameters. Although robotic assistance offers greater surgical precision and bone preservation, these advantages do not translate into superior short-term outcomes. This is consistent with existing literature, which highlights improved component alignment with robotics but limited clinical benefit in the early postoperative period. Operative time was longer in robotic group but do not affect complication rates or length stay. While robot-assisted UKA is safe and effective, results of RSA analysis on early prosthetic implant micromobilisation, that it's still in progress and the results will be presented at the upcoming congress, will help to understand whether the robot-assisted technique, in addition to being bone sparing and preventing malpositioning approach, significantly reduces early micromobilisation rate (within two years of surgery) of implant compared to the standard technique.