Early Intraoperative and Clinical Outcomes of Robotic-Assisted Unicompartmental Knee Arthroplasty Using the VELYS System

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INTRODUCTION: Unicompartmental knee arthroplasty (UKA) is indicated for patients with advanced degenerative disease affecting a single compartment of the knee. New technologies, such as robotic assistance (RA), warrant clinical investigation for their incorporation into surgical practice. This series aimed to assess the surgical accuracy and clinical outcomes of a newly developed robotic UKA platform.

METHODS: This retrospective review of prospectively collected data included all instances of RA-UKAs (VELYS *v1.1.2.22*; Johnson & Johnson MedTech) using a single device (Sigma HP Partial Knee, MedTech) occurring between December 2, 2024, and March 27, 2025. All patients were indicated for the procedure with end-stage, isolated medial compartment arthritis. Patient demographics, intraoperative details, radiographic measurements, and KOOS JR scores preoperative and three months postoperative were collected. Radiographic measurements, including the hip-knee-ankle (HKA) angle, were measured both by the robot intraoperatively during final planning as well as the senior attending surgeon at three months postoperatively using full leg length films standardized at 51-inch source-to-image distance (TraumaCad, Brainlab AG). Patients were excluded if they were missing three-month films. HKAs were described as valgus (positive), varus (negative), or neutral (zero). Data were analyzed using student's t-tests. All cases were performed using a mid-vastus approach. Based on parameters obtained via the RA platform's registration and balancing functions, implant position and bone resections were adjusted to achieve patient-specific balance and alignment. Actual femoral resection depths were 5-8.5mm distal and 5.5-9.5mm posterior. Femoral rotation ranged from 1.5 internal rotation to 9° external rotation. Tibial slope ranged from 5-8°.

RESULTS: Twenty cases were reviewed, with mean age of 70.2 ± 8.7, body mass index was 29.1 ± 5.7kg/m^2, with a cohort of 50.0% females. The mean preoperative HKA angles were -2.8° ± 2.3, with three valgus (15%) and seventeen varus (85%) knees. Final planning mean robotic HKA was -1.1° ± 1.8, compared to mean three-month postoperative HKA of -1.0° ± 1.8, (P=.5) (Table 1). Alignment correction patterns included varus:varus (n=13), varus:valgus (n=4), valgus:valgus (n=2), and valgus:varus (n=1). Final intraoperative gaps were balanced, with a mean extension gap of 0.8mm ± 0.9 and flexion of 0.2mm ± 0.9 (n=19). The final maximum flexion achieved was 123.4° ± 8.4 (n=19). Of note, one patient's flexion and extension data were not saved. The average length of stay was 0.6 days. The mean preoperative KOOS JR was 55.6 ± 13.0 (95% response rate) and 73.9 ± 11.3 (85% response rate) at three months (P<.0001) (Table 2).

DISCUSSION: Early intraoperative and postoperative data suggest excellent accuracy in restoring alignment to patients with a variety of deformities as well as precision in balancing. Further, no difference was observed between the output HKA of the RA system compared to the surgeon's postoperative measurements, indicating the accuracy of this imageless RA system.

SIGNIFICANCE/CLINICAL RELEVANCE: This pilot study for a newly developed robotic unicompartmental knee arthroplasty platform demonstrates that appropriate use of the platform can safely affect appropriate implant positioning and joint alignment, with good clinical results.

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TABLES:

Table 1. HKA Progression Throughout Surgical Intervention.

Patient	Initial HKA (°)	Target HKA (°)	Final Planning HKA (°)	Three-Month Postoperative HKA (°)
1	0.5	-1	-0.5	-0.5
2	-2.5	-1.5	-0.5	-0.5
3	-1	-1	0.5	0.3
4	-1.5	-0.5	0	-1.1
5	-3.5	-1	-1.5	-1.2
6	-3	-1	1	0.9
7	-2	-1	-1	-0.6
8	-4	-1	-3	-2.9
9	1	-1.5	0	0.4
10	-2	-1	1	-1.9
11	-4.5	-1	0.5	1.3
12	-5.5	-2.5	-5	-4.8
13	2	0	-1.5	1.8
14	-4	-0.5	0.5	-1.4
15	-1.5	-0.5	-0.5	-0.4
16	-6.5	-3.5	-4	-3
17	-5	-1.5	-1	0.8
18	-5	-2.5	-5	-4.3
19	-3	-1.5	-2	-1.4
20	-5.5	-2	-0.5	-0.5

Table 2. Patient-Reported Outcomes of Patients Preoperatively and Three-Months Postoperative.

Patient-Reported Outcome	Preoperative (n=19)	Three-Months Postoperative (n=17)
KOOS JR	56.24 ± 12.97	73.89 ± 11.33
PROMIS-10 PCS	43.89 ± 4.87	50.43 ± 6.78
PROMIS-10 MCS	53.98 ± 6.98	54.29 ± 7.21
VAS	55.95 ± 24.52	21.29 ± 19.31