Comparative Outcomes of Robotic-Assisted vs. Conventional Revision Knee Arthroplasty: A Propensity-Matched Analysis

Majd Mzeihem, MD[1]; Ali Rteil, MD, MSc[2]; Omar Martini, MD[1]; Yasser Farid, MD[1]; Hristo Piponov, MD[2]; Lalit Puri, MD[2]; Farid Amirouche, PhD[1,2]

[1]Department of Orthopaedic Surgery, University of Illinois at Chicago, Chicago, Illinois, USA

[2]Department of Orthopaedic Surgery, Northshore University Health System, an Affiliate of the University of Chicago Pritzker School of Medicine. Skokie, Illinois, USA

Disclosure: Majd Mzeihem (N), Ali Rteil (N), Omar Martini (N), Yasser Farid (N), Hristo Piponov (N), Lalit Puri (N), Farid Amirouche (N)

Introduction: Robotic-assisted knee arthroplasty (KA) is increasingly employed in revision procedures; however, comprehensive comparative outcome data remain insufficient. Existing research has primarily concentrated on primary KA or limited revision cohorts with abbreviated follow-up durations. This situation highlights the necessity for further investigation to determine whether robotic assistance provides significant advantages over conventional techniques in revision total knee arthroplasty (TKA).

Methods: Data were retrospectively sourced from the TriNetX Collaborative Network database. Revision knee arthroplasties were identified using CPT codes and classified as either conventional or robotic-assisted with ICD-10 procedure codes. Cohorts were balanced using 1:1 propensity score matching for age, sex, BMI, tobacco use, cardiac disease, hepatic disease, dementia, osteoporosis, chronic kidney disease, and pulmonary disease. Complication rates were assessed at 3, 6, and 12 months, as well as over the whole follow-up period, using chi-square testing.

Results: An initial query identified 23,279 conventional revision knee arthroplasties (rKA) and 800 robotic-assisted rKAs. After 1:1 propensity score matching, 799 patients remained in each cohort. At both 3 and 6 months postoperatively, conventional rKA was not associated with overall higher odds of surgical complications compared to robotic-assisted rKA. However, specific complications occurred more frequently in the traditional group. As shown in Table 1, this included higher odds of periprosthetic joint infection (PJI; OR 1.54 at 3 months, 1.49 at 6 months, 1.41 at 12 months), periprosthetic fracture (OR 2.31, 2.21, and 2.12, respectively), re-revision (OR 1.64 at 1 year, 1.43 at 2 years), and hospital readmission (OR 1.66 at 3 and 6 months).
No significant differences were observed between groups in patellar dislocation or surgical wound infection. Across the entire follow-up period, conventional rKA was associated with significantly greater odds of prosthetic complications, excluding prosthetic fracture, and demonstrated higher rates of prosthetic instability (7.2% vs. 3.5%). At one year, patients undergoing conventional rKA had a 1.89-fold increased hazard of prosthetic complications compared to those treated with robotic-assisted rKA (HR 1.89; 95% CI, 1.48–2.32; Figure 1).

Discussion: Although overall surgical complication rates did not differ between groups, essential distinctions were observed in specific outcomes. Conventional revision knee arthroplasty (rKA) was associated with higher odds of periprosthetic joint infection, periprosthetic fracture, re-revision, readmission, and prosthetic instability across follow-up. The nearly twofold increase in prosthetic complications at one year highlights the potential advantages of robotic-assisted rKA in improving implant performance and durability. These findings suggest that robotic technology may help mitigate complications directly linked to implant longevity and revision burden, even when broader surgical complication rates appear similar.

Clinical Relevance: Robotic-assisted rKA may reduce key adverse events such as PJI, prosthetic complications, and instability, which are critical determinants of patient outcomes and healthcare resource use in complex revision surgery. These results support the growing role of robotic assistance in enhancing the safety and long-term success of revision arthroplasty, though prospective validation and cost-effectiveness analyses remain necessary.

Table 1. Comparison of Outcomes Between Conventional and Robotic-Assisted RKA at 3 & 6 Months Postoperatively.

	3 Months				6 Months			
	Conventional rKA (N=799)	Robotic Assisted rKA (N=799)	OR (95% CI)	P-value	Conventional rKA (N=799)	Robotic Assisted rKA (N=799)	OR (95% CI)	P-value
Patellar dislocation, n(%)	10 (1.3%)	10 (1.3%)	1 (0.414, 2416)	1.00	10(1.3%)	10 (1.3%)	1(0.414, 2416)	1.00
Prosthetic Complications, n(%)	144 (18.0%)	74 (9.3%)	2.15 (1.60, 2.90)	**<0.001**	174(21.8%)	98(12.3%)	1.99(1.52, 2.61)	**<0.001**
Periprosthetic fracture, n(%)	25 (3.1%)	11(1.4%)	2.31 (1.13, 4.74)	**0.02**	26(33%)	12(1.5%)	2.20(1.10, 4.40)	**0.02**
Prosthetic Fracture, n(%)	31 (3.9%)	18 (2.2%)	1.75 (0.97, 3.16)	0.06	29(37%)	21(2.7%)	1.39(0.79, 2.48)	0.25
Aseptic loosening, n(%)	49 (6.1%)	20 (2.5%)	2.55 (1.50, 4.32)	**<0.001**	51(6.4%)	24(3%)	2.20(1.34, 3.614	**0.001**
Prosthetic Instability, n(%)	29 (3.6%)	12 (1.5%)	2.47 (1.25, 4.88)	**0.007**	30(3.9%)	15(2.9%)	2.04(1.09, 3.82)	**0.02**
PJI, n(%)	129 (16.1%)	89(11.1%)	1.54 (1.15, 2.05)	**0.004**	143(17.9%)	96(12%)	1.490(1.17, 1.89)	**0.001**
Mortality, n(%)	10 (1.3%)	10 (1.3%)	1 (0.41, 2.42)	1.00	10(1.3%)	10(1.3%)	1(0.414, 2416)	1.00
Re-Revision, n(%)	31 (3.9%)	20 (2.5%)	1.57 (0.89, 2.78)	0.12	55(6.9%)	39(4.9%)	1.44(0.94, 2.21)	0.09
DVT, n(%)	20(2.5%)	27(3.4%)	0.73(0.41,1.32)	0.30	25(3.1%)	30(3.7%)	0.83(0.49, 1.42)	0.49
Postop Transfusion, n(%)	20(2.5%)	23(2.9%)	0.87(0.47, 1.59)	0.64	24(3%)	25(3.1%)	0.96(0.54, 1.69)	0.89
Opioid use, n(%)	719(89.4%)	666(82.8%)	1.08(1.4, 1.12)	**<0.001**	730(90.8%)	677(84.2%)	1.85(1.36, 2.51)	**<0.001**
Opioid abuse, (n%)	10(1.2%)	10(1.2%)	1(0.41, 2.41)	1.00	10(1.2%)	10(1.2%)	1(0.414, 2.416)	1.00
ER visits, n(%)	96(11.9%)	112(13.9%)	0.83(0.62, 1.12)	0.23	125(15.5%)	132(16.4%)	0.93(0.71, 1.22)	0.63
Readmission, n(%)	284 (35.5%)	199 (24.9%)	1.66 (1.34, 206)	**<0.001**	293(36.7%)	207(25.9%)	1.65(1.34, 2.05)	**<0.001**
Infection, n(%)	10 (1.3%)	10 (1.3%)	1 (0.41, 2.42)	1.00	10(1.3%)	10(1.3%)	1(0.414, 2.416)	1.00
Wound Complications	24(3%)	23(2.9%)	1.04(0.58, 1.9)	0.88	29(3.6%)	25(3.1%)	1.17(0.68, 2.01)	0.59
Surgical Complication, n(%)	66 (8.3%)	58 (7.3%)	1.15 (0.80, 1.66)	0.45	74(9.3%)	67(8.4%)	1.11(0.79, 1.57)	0.54

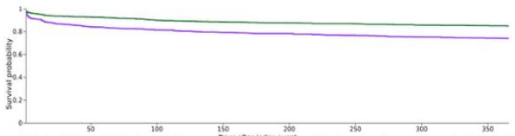

Figure 1. Kaplan–Meier Survival Analysis for Prosthetic complications Following rKA: Comparison Between Conventional (Purple Line) and Robotic-Assisted (Green Line) Techniques.