Robotic assistance for low-volume total knee arthroplasty surgeons yields comparable perioperative outcomes related to those of high-volume surgeons using conventional techniques.

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INTRODUCTION: In total knee arthroplasty (TKA), robotic-assisted TKA (R-TKA) use has grown exponentially in recent years, attempting to enhance precision and minimize variability compared to conventional TKA (C-TKA). However, literature on the clinical utility of robotic assistance in TKAs has been mixed. Separately, higher surgeon case volume has consistently been associated with lower complications, lower mortality, and shorter operative times in TKAs. Considering the above-noted factors, it was hypothesized that robotics might preferentially benefit lower-volume surgeons, for whom lesser outcomes have been reported. The current study leveraged a large, national, administrative database to address this question.

METHODS: Patients undergoing TKAs were identified from the PearlDiver M170Ortho administrative database. The annual case volume of the performing TKA surgeon was determined, and patients were categorized into low-volume TKA (LV-TKA) and high-volume TKA (HV-TKA) cohorts. Annual case volume cutoffs for low-volume and high-volume surgeons were determined through the American Joint Replacement Registry 2023 Annual Report, corresponding to the 25th (7 TKAs) and 75th (69 TKAs) percentiles of TKA surgeons, respectively. Further, the LV-TKA and HV-TKA cohorts were subcategorized into robotic and conventional TKA subcohorts based on the presence or lack of concurrent coding for robotic platform utilization.

Three matched comparisons were performed among the four resultant TKA sub-cohorts (Figure 1). The first comparison examined differences between the low-volume surgeon sub-cohorts, conventional low-volume (C-LV-TKA) and robotic low-volume (R-LV-TKA). The second comparison was between the high-volume surgeon sub-cohorts, conventional high-volume (C-HV-TKA) and robotic high-volume (R-HV-TKA). The final comparison was between C-HV-TKAs and R-LV-TKAs. The conventional and robotic sub-cohorts were matched 4:1 based on age, sex, and ECI in each comparison. Aggregated 90-day adverse events (AEs), 5-year implant-related events, and reoperation rates were assessed.

RESULTS: Among matched low-volume surgeons, C-LV-TKAs had 8,923 patients and R-LV-TKAs had 2,235 patients. R-LV-TKAs had lower odds of 90-day any (OR 0.63, p<0.001), severe (OR 0.71, p=0.002), and minor (OR 0.66, p<0.001) AEs. At 5 years, no differences existed in implant-related events or reoperations. Among matched high-volume surgeons, C-HV-TKAs had 19,732 patients and R-HV-TKAs had 4,939 patients. R-HV-TKAs had lower odds of 90-day any (OR 0.79, p<0.001) and minor (OR 0.74, p<0.001) AEs. At 5 years, R-HV-TKAs had lower odds of prosthetic joint infection (OR 0.56, p<0.001) and lower reoperation rates (2.2% vs. 3.3%, p=0.02). Comparing matched conventional high-volume and robotic low-volume, C-HV-TKAs had 8,923 patients and R-LV-TKAs had 2,235 patients. No differences existed in aggregated 90-day AEs (any, severe, or minor), 5-year implant-related events, or reoperation rates. A visual representation and condensed summary of the matched comparisons are organized in Figure 1 and Table 2.

DISCUSSION: Consistent with existing literature, robotics offers inconsistent advantages for TKA. For perioperative adverse events, robotic assistance had reduced the odds of aggregated complications for low-volume and high-volume surgeons. Regarding longer-term knee-specific measures, robotic advantage was only demonstrated for high-volume surgeons. Notably, robotics usage by low-volume surgeons elevated outcomes to become comparable to non-robotic high-volume surgeons, suggesting outcomes gaps due to case volume can be closed through robotics.

SIGNIFICANCE/CLINICAL RELEVANCE: The present study is the first to investigate the interplay between robotic assistance and surgeon volume in TKAs using a large database. These findings may inform whether the potential benefits of robotic platforms are worth the investment for trainees, surgeons, or hospital systems.

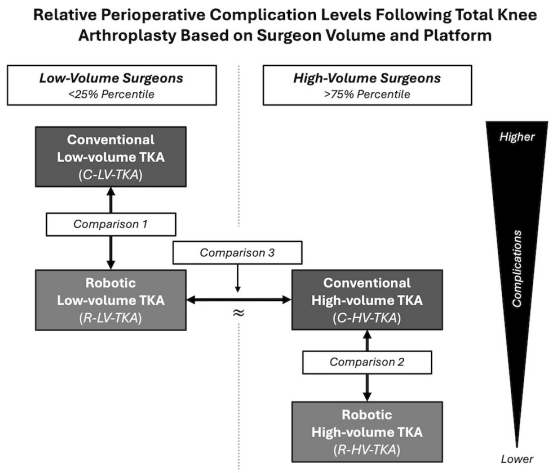

Figure 1: Graphical representation of matched comparisons and relative perioperative complications levels among total knee arthroplasty procedures varied by surgeon volume (low-volume versus high-volume) and platform (conventional versus robotic-assisted).

Table 1: Condensed summary of the relative odds of 90-day and 5-year adverse events for each matched comparison

	Comparison 1: *C-LV-TKA vs R-LV-TKA*	Comparison 2: *C-HV-TKA vs R-HV-TKA*	Comparison 3: *C-HV-TKA vs R-LV-TKA*
90-Day Complications			
Any	↓ (OR 0.63)	↓ (OR 0.79)	↔
Severe	↓ (OR 0.71)	↔	↔
Minor	↓ (OR 0.66)	↓ (OR 0.74)	↔
5-Year Adverse Events			
Implant-related	↔	↓ (OR 0.56) Periprosthetic Joint Infection	↔
Reoperations	↔	↓	↔

** The conventional TKA groups are the reference groups in all noted trends*