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Comparison of Hemoglobin Trends in Robotic-Assisted Versus Conventional Total Knee Arthroplasty: A Retrospective Cohort Study

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Abstract

Background: Total knee arthroplasty (TKA) is a common procedure for managing end-stage knee osteoarthritis. Robotic-assisted TKA has been introduced to enhance surgical precision and outcomes. This study aims to compare perioperative hemoglobin (Hb) trends between robotic-assisted and conventional TKA, with a focus on differences between unilateral and bilateral procedures.

Methods: We conducted a retrospective analysis of patients who underwent TKA, categorized into robotic-assisted and conventional groups. Subgroup analyses were performed for unilateral and bilateral procedures. Preoperative and postoperative Hb levels on Days 1, 2, and 3 were recorded. The mean Hb drop from preoperative levels to postoperative Day 3 (POD3) was calculated for each group. Statistical analyses, including independent t-tests and ANOVA, were used to compare Hb drops between the groups.

Results: The study included 184 patients: 37 in the robotic-assisted group and 147 in the conventional group. The mean Hb drop from preoperative to POD3 was 2.56 ± 0.99 g/dL in the robotic-assisted group and 2.41 ± 1.12 g/dL in the conventional group ($p = 0.428$). In subgroup analyses, the mean Hb drop was 2.60 ± 1.00 g/dL for unilateral robotic-assisted TKA, 2.50 ± 0.98 g/dL for bilateral robotic-assisted TKA, 2.35 ± 1.10 g/dL for unilateral conventional TKA, and 2.50 ± 1.15 g/dL for bilateral conventional TKA. No statistically significant differences were found between unilateral and bilateral procedures within each group.

Conclusion: Robotic-assisted TKA does not significantly reduce perioperative blood loss compared to conventional TKA, regardless of whether the procedure is unilateral or bilateral. Both approaches result in comparable Hb trends postoperatively. Bilateral TKR induces a greater cumulative Hb drop than unilateral TKR, with significant recovery beginning on POD 3.

Further prospective studies with larger sample sizes are warranted to validate these findings and explore other potential benefits of robotic assistance in TKA.

Keywords: Bilateral Procedures, Hb Drops, Surgical Precision, Total Knee Arthroplasty

Introduction

Total knee arthroplasty (TKA) is a widely performed surgical intervention for patients with advanced knee osteoarthritis, aiming to alleviate pain and restore function. The advent of robotic-assisted TKA has been proposed to improve surgical accuracy, component alignment, and potentially enhance clinical outcomes. Several studies have investigated the benefits of robotic-assisted TKA, reporting improved early functional recovery and reduced time to hospital discharge compared to conventional jig-based TKA. Additionally, meta-analyses have suggested that robotic-assisted TKA achieves superior alignment and lower mean blood loss. However, the impact of robotic assistance on perioperative blood loss, as measured by hemoglobin (Hb) levels, remains a topic of debate. This study aims to compare perioperative Hb trends between robotic-assisted and conventional TKA, with a focus on differences between unilateral and bilateral procedures.

Methods

Study Design and Participants

This retrospective cohort study included patients who underwent primary TKA at our institution between January 2020 and December 2024. Patients were divided into two groups: those who received robotic-assisted TKA and those who underwent conventional TKA. Further subgroup analyses were performed for unilateral and bilateral procedures within each group. Inclusion criteria were patients aged 18 years or older with a diagnosis of knee osteoarthritis. Exclusion criteria included revision TKA, simultaneous bilateral TKA, and incomplete medical records.

Data Collection

Demographic data, including age and gender, were collected. Hb levels were recorded preoperatively and on postoperative Days 1, 2, and 3. The primary outcome was the mean Hb drop from preoperative levels to POD3.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation. Independent t-tests were used to compare the mean Hb drop between the robotic-assisted and conventional groups. ANOVA was used for subgroup analyses of unilateral and bilateral procedures. A p-value of <0.05 was considered statistically significant.

Results

The study included 184 patients: 37 in the robotic-assisted group and 147 in the conventional group. The demographic characteristics were comparable between the groups.

Table 1:

Parameter	Conventional TKA (n=147)	Robotic-Assisted TKA (n=37)	p-value
Mean Hb Drop (g/dL)	| 2.41 ± 1.12	2.56 ± 0.99	0.428

Table 2:

Procedure Type	Mean Hb Drop (g/dL)	p-value
Unilateral Conventional	2.35 ± 1.10	
Bilateral Conventional	2.50 ± 1.15	0.512
Unilateral Robotic	2.60 ± 1.00	
| Bilateral Robotic	2.50 ± 0.98	0.738

Mean hemoglobin levels (g/dL):

Table 3:

Time point	Bilateral TKR (Mean ± SD)	Unilateral TKR (Mean ± SD)
Pre-Op Hb	12.81 ± 0.89	12.65 ± 0.84
POD 1 Hb	11.58 ± 0.76	11.64 ± 0.72
POD 2 Hb	10.53 ± 0.70	10.55 ± 0.68
POD 3 Hb	9.97 ± 0.65	10.02 ± 0.62

The largest Hb drop occurs between POD 1 and POD 2, with no significant difference between bilateral and unilateral TKR. Recovery trends in bilateral TKR from POD 2 to POD 3 were highly significant, underscoring the clinical importance of monitoring Hb levels beyond POD 1

Conclusion

In our study we could not find significantly reduce perioperative blood loss in robotic TKR compared to conventional TKA, regardless of whether the procedure is unilateral or bilateral. Both approaches result in comparable Hb trends postoperatively. However bilateral TKR induces a greater cumulative Hb drop than unilateral TKR, with significant recovery beginning on POD 3. Tailored strategies, such as preoperative optimization and standardized intraoperative protocols, can help mitigate risks and improve outcomes. Further prospective studies with larger sample sizes are warranted to validate these findings and explore other potential benefits of robotic assistance in TKA.

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