Learning Curve and Operative Time Efficiency of Robotic-Assisted Total Shoulder Arthroplasty

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INTRODUCTION: Robotic-assisted reverse total shoulder arthroplasty (RA-RTSA) is a growing area of innovation, offering potential advantages in component positioning and surgical accuracy. However, the learning curve and impact on operative efficiency during adoption of this procedure remain under-investigated. The purpose of this study was to evaluate surgical efficiency, learning curve progression, and comparative operative times between RA-RTSA and manual techniques.

METHODS:

This retrospective cohort study compared operative times between a single surgeon's first 30 consecutive RA-RTSA cases and his 30 preceding manual RTSA cases for primary reverse total shoulder arthroplasty. A two-sample t-test assuming unequal variances assessed differences in average operative time between cohorts. An f-test was used to evaluate the variance between groups. A linear regression model evaluated the learning curve across sequential RA-TSA cases. Manual cases served as the time baseline. Additionally, cumulative summation (CUSUM) analysis was used to calculate the learning curve based on time of robot use for each case.

RESULTS:

The average operative time for RA-RTSA cases was significantly shorter compared to manual RTSA (48.3 vs. 55.0 minutes, $p = 0.006$). Trendline analysis of RA-RTSA cases revealed a slight negative slope ($y = -0.1423x + 50.492$), indicating decreasing case times over the series. However, the trend was not statistically significant ($R^2 = 0.0325$), suggesting variability in the learning effect during the early adoption phase. F test revealed a difference in variance between the two groups(42.1 vs 140.8, $p=.006$). CUSUM analysis of time of robot use revealed a learning phase of six cases.

DISCUSSION AND CONCLUSION:

RA-RTSA demonstrated a statistically significant reduction in operative time compared to manual RTSA within the first 30 cases. The significant decrease in variance indicates decreased operative time in RA-RTSA even in the most complex cases. While the trend in operative time suggests a modest improvement with increased experience, the variability implies that additional cases may be necessary to reach a stable efficiency threshold. These findings support the feasibility and safety of early robotic integration without prolonging surgical duration and provide early evidence for its efficient adoption. Further studies are needed to demonstrate the efficacy and clinical benefit of this novel RA-RTSA platform.