FEASIBILITY LEARNING CURVE (CUSUM ANALYSIS) OF ROBOT-ASSISTED MINIMALLY INVASIVE ESOPHAGECTOMY (RAMIE)

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Aim

To investigate the feasibility learning curve of implementing robotic-assisted minimally invasive esophagectomy (RAMIE) at a tertiary referral center

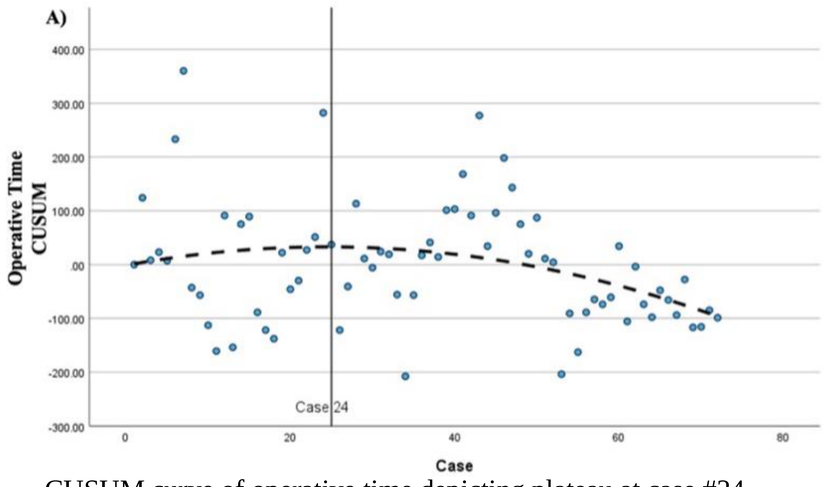
Materials and Methods

Retrospective observational study of patients over 18 years old between June 2019 and June 2024 of consecutive esophageal cancer patients who underwent RAMIE. The primary outcome was operative time. Secondary outcomes included estimated blood loss, conversion rate, lymph node yield, positive proximal margin and in-hospital mortality rate. Cumulative sum (CUSUM) analyses were performed to identify trends for the operating time and intraoperative blood loss. The CUSUM formula generated a positive, neutral, or negative value for a case when subtracted from the mean of the particular outcome. The occurrence of a learning effect was defined as a decreasing CUSUM curve. The patients were compared based on whether they underwent surgery before the plateau occurred and those who underwent surgery after the plateau in the CUSUM analysis. Categorical variables were depicted as counts (with percentage) and compared utilizing chi square or Fisher's exact tests. Continuous variables were shown as means (with standard deviation) or medians (IQR) and computed by either Student's t-test or Mann–Whitney U test, depending on the distribution of data.

Results

71 RAMIE procedures were performed during the study period. The operative time curve showed technical proficiency was acquired after 24 cases (**Figure 1**). No significant differences in intraoperative blood loss, conversion rates, lymph node yield (24.0 (±SD=6.8) vs 27.2 (±SD=12.4) p=0.239), or positive proximal margins were found between the groups. The complication rates were lower in the second group (**Table 1**, **p<0.001**) with no difference in 30 days/in-hospital mortality (4.3% vs 4.2% , p=0.986).

Figure 1



CUSUM curve of operative time depicting plateau at case #24

Table 1. Intraoperative and postoperative outcomes

	Total cohort (case 1–71)	Before plateau (case 1–24)	After plateau (case 25–71)	P-value
RAMIE time, median minutes [IQR]	280 [187–351]	291 [195–361]	270 [187–317]	0.433
Blood loss, median milliliters [IQR]	25 [15–100]	37.5 [10–95]	20 [20–100]	0.631
Conversion to open, number (%)	2 (2.8)	1 (4.2)	1 (2.1)	1.000
Lymph node yield, [mean (± SD)]	1.22 [2.2]	1.83 [2.9]	0.89 [1.7]	0.093
Margins, positive number (%)	5 (7.0)	3 (12.5)	2 (4.3)	0.655
Postoperative complications, number (%)				
No complication	38 (54.3)	8 (33.3)	30 (63.8)	**< 0.001**
I	1 (1.4)	0 (0.0)	1 (2.1)	
II	11 (15.7)	5 (20.8)	6 (12.8)	
IIIa	8 (11.4)	3 (12.5)	5 (10.6)	
IIIb	4 (5.7)	2 (8.3)	2 (4.3)	
IVa	4 (5.7)	3 (12.5)	1 (2.1)	
V	4 (5.7)	2 (8.3)	2 (4.2)	
In-hospital Mortality, number (%)	3 (4.2)	1 (4.2)	2 (4.3)	0.564

IQR, interquartile range; RAMIE, robot-assisted minimally invasive esophagectomy.

Conclusions

RAMIE appears to have a short learning curve. Perioperative complications tend to decrease once technical proficiency is acquired based on CUSUM analysis of operative time.

References

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