Losing the edge: Does adoption of robotic-assisted sleeve gastrectomy compromise hemorrhage risk in traditional laparoscopic sleeve gastrectomy?

Katharine Playter, Bradley Colarusso, Philip Cohen MD, Richard Perugini MD

UMass Chan MEDICAL SCHOOL

Background

The rise in global obesity has made it a leading preventable cause of morbidity and mortality, prompting an increased reliance on bariatric surgery for sustainable weight loss and management of obesity-related conditions. Longitudinal sleeve gastrectomy (LSG) is the most commonly performed bariatric operation. The advent of robotic assisted surgery (RAS) has improved the landscape of bariatric surgery by offering improved ergonomics, visualization and a shorter learning curve when compared to traditional laparoscopy.[1] Although laparoscopic LSG remains the primary approach nationwide, the adoption of RAS is steadily increasing. The learning curves for laparoscopic longitudinal sleeve gastrectomy (L-LSG) and robotic assisted longitudinal sleeve gastrectomy (RA-LSG) have been studied, though this has typically been done with regards to operative time. We studied the adoption of RAS in an established minimally invasive bariatric program. This study aims to investigate the relationship between RAS integration into an existing minimally invasive program and the rate of postoperative hemorrhage, the most common serious adverse event, following LSG in both the robotic and conventional approach.

Methods

This is a retrospective study performed in a well established, MBSAQIP accredited, bariatric surgery program including five experienced surgeons. The incidence of hemorrhage following primary LSG was studied from 2020 to 2022. Hemorrhage is defined by MBSAQIP registry criteria. L-LSG and RA-LSG groups were compared using t-tests and Fisher's exact tests as appropriate. Statistical analysis was performed in RStudio and Prism. Trends over time were analyzed with CUSUM, which is a standard method of tracking deviations in the outcome of a process.

Historically used in manufacturing and engineering, CUSUM has more recently been utilized in quality initiatives within the healthcare industry. This methodology enables detection of subtle variations in procedure outcomes. CUSUM, short for cumulative summation analysis, functions by incrementally summing the impact of events or outcomes in a specific context, in this case hemorrhage following longitudinal sleeve gastrectomy. Each occurrence of the event in question contributes positively to the cumulative sum, whereas its absence detracts by the expected value of the event. This was derived from the patients' risk profile in the MBSAQIP database. The trajectory of the curve offers a comprehensive overview of the trend in outcomes over time. In this analysis, the cumulative sum was reset after each calendar year to gain insight into hemorrhage trends on a yearly basis.

Results

A total of 1021 patients underwent LSG during this period. Laparoscopic and robotic groups were similar in age, sex, and known risk factors for postoperative bleeding including BMI, hypertension, anticoagulant use, functional status, and hyperlipidemia. Overall, postoperative hemorrhage rate was 0.98% (n=10). Between 2020 and 2022, the percentage of RA-LSG increased from 31% to 80%, as the RAS program grew. CUSUM analysis of postoperative hemorrhage rate demonstrated an advantage for L-LSG over RA-LSG during the early adoption period of RAS (2020). Hemorrhage rates in both groups were similar in 2021. However, as utilization of RAS peaked and then plateaued in 2022, hemorrhage rates increased in L-LSG while a decrease in hemorrhage was observed in RA-LSG (Figure 1).

Table 1

Basic demographics of the study population for known risk factors of

	Bleed n=10	No-Bleed n=1011	P value
Age			
Age 18-29	1	160	0.468
Age 30-39	1	304	
Age 40-49	4	286	
Age 50-59	3	188	
Age >=60	1	73	
Sex			
Male	4	195	0.111
Female	6	816	
Race			
White	9	636	
Black	0	100	0.675
Other	1	181	
Unknown/Not Reported	0	94	
BMI			
BMI <35	0	11	
BMI 35-40	4	177	
BMI 40-50	6	54	0.345
BMI 50-60	0	199	
BMI 60-70	0	53	
BMI >70	0	17	
Functional Status			
Independent	10	1005	
Partially dependent	0	1	>0.999
Unknown	0	5	
ASA Category			
II	4	216	
III	6	782	0.33
IV	0	13	
Smoker	1	85	0.587
Diabetes			
No diabetes	9	753	
Insulin	0	57	0.83
Non-Insulin	1	201	
Hypertension	5	5	0.748
GERD	3	296	>0.999
COPD	0	16	>0.999
Hyperlipidemia	5	228	0.054
Anticoagulant	0	31	>0.999

Figure 1: CUSUM By Year

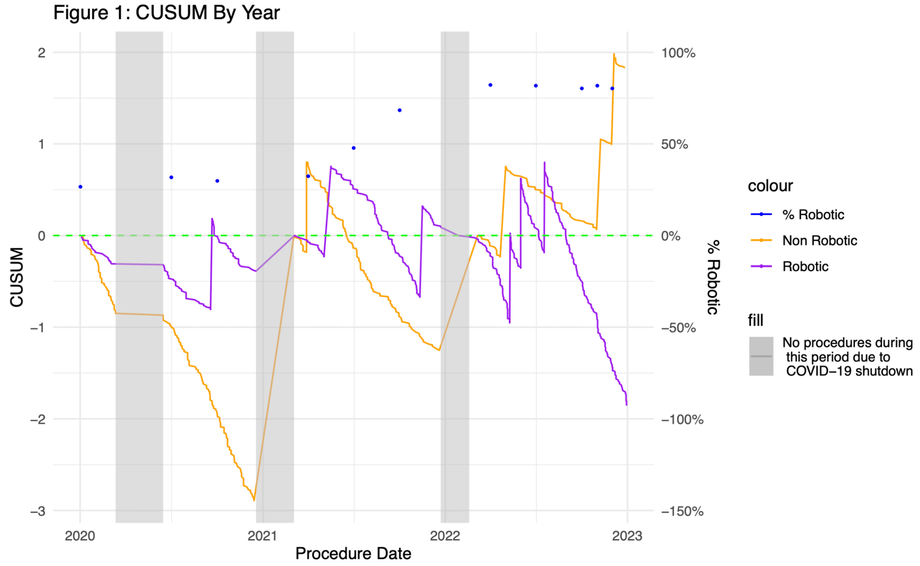


Figure 1: Cumulative summation (CUSUM) of hemorrhage events from 2020 – 2023. Grey indicates a period during which no procedures were performed due to COVID-19 related state prescribed moratoriums.

References

1. Bellorin O, Vigiola-Cruz M, Dimou F, At R, Al Hussein Alawamlh O, Pomp A, Dakin G, Afaneh C. Robotic-assisted surgery enhances the learning curve while maintaining quality outcomes in sleeve gastrectomy: a preliminary, multicenter study. Surg Endosc. 2021 May;35(5):1970-1975. doi: 10.1007/s00464-020-08228-6. Epub 2021 Jan 4. PMID: 33398577.

2. Bindal V, Bhatia P, Dudeja U, Kalhan S, Khetan M, John S, Wadhera S. Review of contemporary role of robotics in bariatric surgery. J Minim Access Surg. 2015 Jan-Mar;11(1):16-21. doi: 10.4103/0972-9941.147673. PMID: 25598594; PMCID: PMC4290112.

Conclusion

This analysis demonstrates an expected improvement in postoperative hemorrhage with increasing adoption of RA-LSG. During this early adoption phase of the RAS approach, a relatively higher rate of occurrence of hemorrhage is detected by the CUSUM analysis. This effect may be similar to the characteristic learning curve, defined by procedure length, that is observed in the adoption of both the laparoscopic and robotic approaches to sleeve gastrectomy in a trainee. Contrary to our expectations, as RA-LSG became the more frequently utilized approach, the risk of hemorrhage with L-LSG increased. This latter period reflects a clear benefit with respect to the RAS approach. This observation appears to be related to a higher rate of occurrence of hemorrhage in the L-LSG approach, coupled with a simultaneous decrease in the rate of occurrence of hemorrhage in the robotic approach. This unexpected trend is observed despite all surgeons being well beyond their learning curve for L-LSG, suggesting a potential risk associated with the use of the laparoscopic approach when it is supplanted by the robotic approach. This effect may be important to take into consideration in quality improvement initiatives.

Future Work

In future investigations, this analysis will be expanded to include a larger cohort of patients over a longer period, allowing for a more comprehensive assessment of these trends. To better characterize the observed reduction in hemorrhage rate in the robotic approach, we also intend to employ advanced robotic metrics to these analyses.

Further analysis will involve applying similar analytical approaches to investigate additional complications of LSG, such as gastric leak. CUSUM analysis can also be applied to outcome measures, such as weight loss and resolution of comorbidities, to better understand their relationship. Beyond the realm of bariatric surgery, there is potential to apply similar analyses to data involving the adoption of new technologies in other surgical subspecialties, offering insights into the broader impact of these technological advancements.

By expanding the scope of this analysis and exploring new avenues of research, we aim to enhance our understanding of the evolving landscape of minimally invasive surgery and its implications for patient safety.

UMass Chan MEDICAL SCHOOL