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# Leak Complications in Laparoscopic vs Robotic Bariatric Surgery

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## Abstract

*Objective:* To assess if leak complication rates are higher in robotic bariatric surgery, specifically Roux-en-Y-Gastric Bypass and sleeve gastrectomy, compared to laparoscopic bariatric surgery.

*Design:* Systematic literature review.

*Methods:* Searches were done in PubMed and CINHAL using the search terms “robotic vs laparoscopic bariatric surgery”. The results were limited to full text availability and screened for bariatric related articles and comparison articles.

*Results:* Robotic and laparoscopic surgery comparison articles studied were by: Lainas et al., Buchs et al., Vilallonga et al., and Moon et al.

*Conclusion*: There is conflicting evidence for Roux-en-Y-Gastric Bypass if robotic or laparoscopic techniques result in less leak complications. As for sleeve gastrectomy, robotic technique has been shown to have less leak complications.

## Introduction

America spends billions of dollars every year on weight loss products and services, but obesity continues to increase in prevalence.[1] According to the CDC, from 1999-2000 to 2017-2020, the percentage of obese adults increased from 30.5% to 41.9%. Treatment options that are available include lifestyle changes, medication, and bariatric surgery. Lifestyle changes alone result in 5-7% weight loss, combination of lifestyle and medication therapy result in 10-15% weight loss, and bariatric surgery results in up to a 70% weight loss. Not only does bariatric surgery result in the highest percentage of weight loss, it provides up to an 89% relative risk reduction in mortality over the first 5 years post-surgery and improvement or resolution of up to 99% of comorbidities.[2]

The types of bariatric surgical procedures offered in the United States are Roux-en-Y gastric bypass, laparoscopic adjustable gastric band (lap-band), vertical sleeve gastrectomy (gastric sleeve), biliopancreatic diversion with or without duodenal switch, and vertical banded gastroplasty. Among these, the most common procedures are sleeve gastrectomy and Roux-en-Y gastric bypass. In 2011, it was estimated that 122,056 gastric sleeves and 21,380 Roux-en-Y gastric bypasses were performed.[3]

The techniques and approaches for bariatric surgery have significantly improved over the years, with the most recent approach being robotic. Robotic bariatric surgery was first introduced in 1998, when it was utilized in a laparoscopic gastric banding procedure without complications.[4] Since then, there has been increased use of this minimally invasive technique for multiple bariatric surgeries such as the longitudinal sleeve gastrectomy, Roux–en-Y gastric bypass and biliopancreatic diversion/duodenal switch. Minimally invasive approaches have become the standard of care in bariatric surgery patients and have provided better outcomes, less complications, faster recovery and decreased cost, thus they are considered the optimal long-term treatment for bariatric patients.[5]

It is clinically important to distinguish the efficacy and complications of robotic surgery compared to that of laparoscopic surgery because it could provide better patient outcomes and become the gold standard for bariatric surgery.

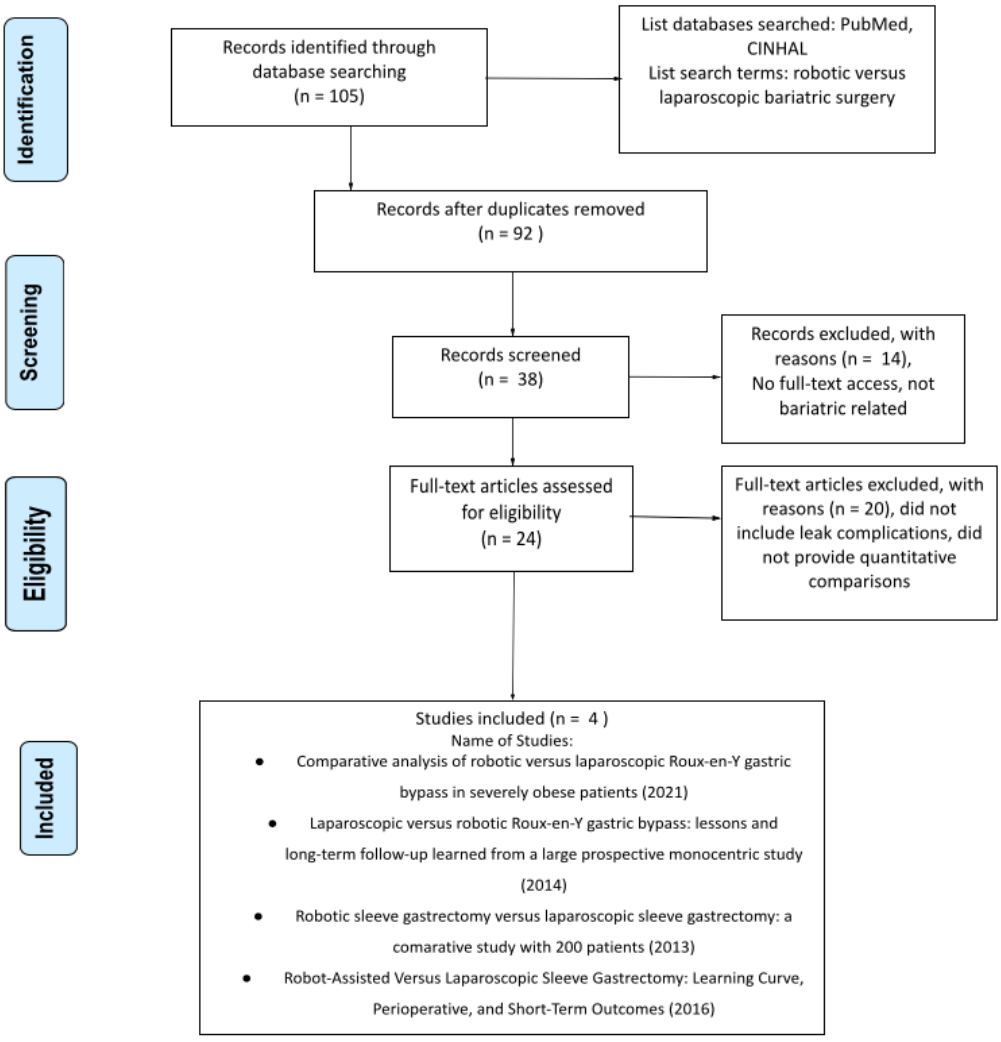
## Clinical Question

Among patients who have undergone bariatric surgery, does robotic as opposed to standard laparoscopic bariatric surgery result in more leak complications?

## Methods

PubMed and CINHAL were searched in September 2022 using the search terms “robotic vs laparoscopic bariatric surgery”. The results were limited to full text availability and initially screened for bariatric related articles and comparison articles. This yielded 24 articles.

Results that were not primary research, did not include leak complications, did not provide a quantitative comparison of leak complications, or included revisional surgery were eliminated from further assessment. Four articles remained and were reviewed in-depth.




## Results

**Study 1**: Comparative analysis of robotic versus laparoscopic Roux-en-Y gastric bypass in severely obese patients. Lainas et al.[6]

Objective: This study aimed to compare conventional laparoscopic (L-RYGB) to robotic RYGB (R-RYGB) and evaluate safety, efficacy, advantages and drawbacks of each procedure.

Study design: A prospective cohort study with a retrospective review was performed to analyze results of L-RYGB and R-RYGB at a prestigious bariatric center. Data was collected from 161 patients who underwent RYGB between May 2013 and December 2017. Patient groups were similar in age, sex distribution, median weight and BMI, American Society of Anesthesiologists (ASA) score (with an ASA score of 2 being most frequently reported in both groups), comorbidities and previous abdominal surgery. The patient's written informed consent and institutional review board approval were both required prior to data collection. All patients were

carefully evaluated prior to surgery by an endocrinologist, gastroenterologist, psychiatrist, nutritionist, anesthesiologist and surgeon. During the preoperative period, each patient underwent an esophagogastroduodenoscopy, upper gastro-intestinal series, abdominal ultrasonography, polysomnography, and endocrinologic and nutritional evaluations. In order to be eligible for surgery patients were required to either have a body-mass index (BMI) of at least >40 kg/m2, or a BMI between 35 and 40 kg/m2 with significant obesity-related comorbidities. Comorbidities that met this requirement were any that the patient took medication to control, or that required continuous positive airway pressure (CPAP) due to obstructive sleep apnea syndrome (OSAS).

All L-RYGB and R-RYGB that were performed utilized similar surgical techniques. Surgery type was assigned to patients based on the availability of the robotic platform. The R-RYGB were performed by two bariatric surgeons with no prior robotic surgical experience besides a 2-day course at a robotic surgery center. The machine used for the robotic surgeries was the Da Vinci Si robotic system 5. The R-RYGB used four abdominal trocars (one 10-mm port for the camera, two 10-mm operating ports and one 5-mm port for liver retraction) and the L-RYGB used 6 (one 10-mm port for the camera, two 10-mm operating ports and three 5-mm port for exposition and liver retraction). A Veress needle was used to obtain abdominal insufflation. A 30–45-mL gastric pouch was created by dissecting the lesser gastric curvature. “Section of the stomach was performed above the second vessel of the lesser curvature using an Echelon stapler with blue reloads (GST System ECHELON™, Johnson & Johnson Medical Devices, New Brunswick, NJ, USA) without buttressing. The jejuno-jejunal anastomosis was made after sectioning the jejunum 50 cm from the Treitz ligament and measuring a 150 cm antecolic antegastric alimentary limb. Both gastrojejunal and jejuno-jejunal anastomosis were hand-sewn, using continuous thread of 2.0 absorbable monofilament (same hand-sewn anastomosis technique for L-RYGB and R-RYGB in our department).” The gastrojejunal anastomosis diameter was 15–20 mm. A leak test was performed at the end of the procedure, with methylene blue and air insufflation. “Mesenteric defects were closed using a continuous suture of non-absorbable suture to prevent internal herniation. No drains were used.”

Study results: Of the 161 patients in this study, 61 underwent L-RYGB and 100 R-RYGB. Neither group converted to open surgery and operative blood loss was similar among the two groups, the median being 20 mL (p =0.91). There was never a need for blood transfusion during the operation. The R-RYGB was noted to have a noticeable shorter operating time (127 vs 160 min; $p < 0.001$). Seven patients (11.4%) in the L-RYGB group and 15 patients (15%) in the R-RYGB group had early postoperative complications ($p = 0.63$), with more major complications in the R-RYGB group but this was not a statistically significant difference (3.2% in the L-RYGB group versus 9% in the R-RYGB group; $p = 0.20$). The most common complications were pulmonary and abdominal wall complications in the L-RYGB group, and gastrojejunal anastomotic leak and abdominal wall complications in the R-RYGB group. Gastrojejunal anastomotic leak was slightly more common after R-RYGB, probably due to initial experience with robotic surgery and learning curve. There was no mortality in either group. Length of hospital stay was also similar for both the groups (median of 6 days; $p = 0.20$).

Study critique: Strengths of this study include the comparable qualities of the two groups, the near identical surgical techniques used between L-RYGB and R-RYGB, and the detailed postoperative report provided. This study does have several limitations. First, due to the study design, a retrospective analysis of prospectively collected data, there is the potential to introduce bias in the results. Also, even though the cohorts are mostly comparable, there is a limited number of patients in each group. In addition, the selection of the type of procedure was made mostly according to operation ward availability for robotic surgery, which could limit the

true amount of randomization used in the study. Lastly, the surgeons in this study had limited experience with the Da Vinci system for bariatric procedure, thus, there is a learning curve depicted, that was not present with the L-RYGB group.

**Study 2**: Laparoscopic versus robotic Roux-en-Y gastric bypass: lessons and long-term follow-up learned from a large prospective monocentric study. Buchs et al.[7]

Objective: The aim of this study was to report long-term experience with robotic Roux-en-Y gastric bypass (RYGB) and to compare outcomes with the laparoscopic approach.

Study design: A prospective monocentric study was conducted to collect data from 777 consecutive minimally invasive RYGB between January 2003 to September 2013. All the data from the consecutive RYGB was prospectively collected in a dedicated database during the study period. The robotic system used was a Da Vinci Si system. Each surgery was performed by various experienced surgeons, defined by having completed over 100 bariatric procedures in their career. Patients needed to meet inclusion criteria of the Swiss Society for the Study of Morbid Obesity and Metabolic Disorders. Before surgery, all patients underwent a multidisciplinary evaluation including a routine endoscopy as well as a psychiatric assessment. The exclusion criteria were the same for both groups: anesthesiological contraindication and/or evident hostile abdomen. There was no randomization and no specific selection criteria for robotics. The choice of the approach was based solely on the availability of the robotic system.

The surgical technique used for both groups was similar and standardizedand was as follows: “The pneumoperitoneum was created using an OPTIVIEW (Endopath Xcel, Ethicon) technique. All patients underwent a routine cholecystectomy. A small gastric pouch (around 20–30 cm3) was created using blue or green cartridge staplers. A standard RYGB with a 150-cm alimentary limb was constructed after the creation of the gastric pouch. In the robotic approach, a hand-sewn gastrojejunal (GJ) and jejunojejunal (JJ) anastomosis was performed, using a single layer running suture of 2.0 Vicryl (Ethicon). For the laparoscopic cases, a mechanical circular anastomosis was preferred with a transorally inserted anvil. Recently, we started to perform linear GJ anastomosis as well. The jejunojejunal anastomosis was performed with a linear stapler. A routine air leak test was performed at the end of the procedure. A drain was left close to the GJ anastomosis depending on the surgeon’s preference.”

Data collected focused on perioperative outcomes of both groups including operative time and complications/conversions. A conversion was defined as the need to finish the procedure by another approach than the initial one. Thirty-day morbidity and mortality was also evaluated using the Clavien-Dindo classification to grade complications, which is what we will be focusing on (Fig.1).

Figure 1: The Clavien-Dindo Classification[7]

| Grades | Definition |
|---|---|
| Grade I | Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions<br>Allowed therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside. |
| Grade II | Requiring pharmacological treatment with drugs other than such allowed for grade I complications.<br>Blood transfusionsand total parenteral nutritionare also included. |
| Grade III | Requiring surgical, endoscopic or radiological intervention |
| - IIIa | Intervention not under general anesthesia |
| - IIIb | Intervention under general anesthesia |
| Grade IV | Life-threatening complication (including CNS complications)* requiring IC/ICU-management |
| - IVa | single organ dysfunction (including dialysis) |
| - IVb | multiorgandysfunction |
| Grade V | Death of a patient |

Results of the parametric and nonparametric data were expressed as mean ± standard deviation (SD) and median (range), respectively. All statistical analyses were calculated with GraphPad Software (GraphPad, La Jolla, CA). Confidence intervals were set at 95 %. A two-sided *p* value of ≤0.05 was considered as statistically significant. Comparisons between both groups were determined using Fisher's exact test for discrete variables and Student's *t* test for continuous variables.

Study results: Of the 777 minimally invasive RYGB performed, 389 were performed with a laparoscopic approach (50.1 %) and 388 used a robotic approach (49.9 %). There were more males in the robotic group, but this was not statistically significant. Patients in in the laparoscopic group were slightly younger (42 vs. 43.8 years old for robotics; $p = 0.02$) and had a higher preoperative BMI (+0.8 kg/m2; $p = 0.05$). There were no differences in terms of American Society of Anesthesiologists (ASA) score or comorbidities.

There were less postoperative complications in the robotic group (11.6 %) in comparison with laparoscopy (16.7 %; $p = 0.05$). In the robotic group, there were 45 observed postoperative complications, with a majority of grades I and II (73.3 %). "There were 11 grade I complications: anastomotic edemas ($n = 3$; requiring a delay in postoperative diet), peripheral paresthesias ($n = 3$; successfully treated conservatively), atelectasis ($n = 2$), and wound problems ($n = 3$; hematoma, abscess, and delayed wound healing). Grade II complications were as follows: pulmonary embolism ($n = 12$) and deep venous thrombosis ($n = 2$), bacteremia ($n = 3$; requiring intravenous antibiotics), urinary tract infections ($n = 2$; requiring antibiotics), peripheral neuropathy ($n = 1$), hematemesis ($n = 1$; necessitating transfusion), and deep parietal abscess ($n = 1$; requiring oral antibiotics). In addition, there were five grade IIIb complications: four of them required a reoperation. In addition, one patient presented a bleeding anastomotic ulcer requiring endoscopic hemostasis. Finally, there were six grade IVa complications: respiratory failure ($n = 3$; requiring a prolonged intubation in the intensive care unit (ICU)), severe pneumonia ($n = 1$; necessitating intubation), pulmonary embolism ($n = 1$; requiring 5 days of monitoring in the ICU), and laryngeal edema ($n = 1$; necessitating prolonged intubation)."

In the laparoscopic group, 65 postoperative complications were recorded. "The majority were grades I and II (69.2 %). Grade I complications included: wound abscess ($n = 8$), self-limited GJ leak ($n = 5$; treated conservatively without removing the drain), atelectasis ($n = 2$), bile leak following a liver biopsy ($n = 1$; treated successfully by keeping the drain in place), phlebitis ($n = 1$), postoperative agitation ($n = 1$), and edema at the level of the GJ ($n = 1$; delaying the postoperative diet). Grade II complications consisted of: pulmonary embolisms ($n = 8$) and deep

venous thrombosis ($n = 1$), gastrointestinal bleeding ($n = 4$; requiring only blood transfusion and monitoring), urinary tract infection ($n = 4$; necessitating oral antibiotics), pneumonias ($n = 4$), intra-abdominal abscess ($n = 2$; requiring intravenous antibiotics), heparin-induced thrombocytopenia ($n = 1$; requiring oral anticoagulation), acute pulmonary edema ($n = 1$; necessitating oral diuretics and physiotherapy), and diarrhea with positive culture for Clostridium difficile ($n = 1$). Twelve grade III complications were observed. Three of them were graded IIIa: one duodenal leak after subtotal gastrectomy during the RYGB (resection for multiple polyps) requiring a radiological drainage. One pulmonary embolism necessitated a vena cava filter. And finally, one bile leak (from a liver biopsy) was diagnosed and required radiological drainage. Nine grade IIIb complications were also observed; all of them required a reoperation. Seven grade IV complications were reported. Two were graded IVa: one respiratory insufficiency requiring intubation, and one prolonged intubation in the ICU for another patient. Finally, five complications were graded IVb: four of them due to a gastrointestinal leak with septic shock requiring a reoperation. Another patient presented a pulmonary embolism with acute respiratory distress, associated with kidney failure."

Also, there were fewer early reoperations in the robotic groups (1 %) in comparison with laparoscopy (3.3 %; $p = 0.05$). In the robotic group, there were four reinterventions: one due to a staple line bleed, one because of an incarcerated port site hernia, one because of a late GJ leak (at POD 13 after a large meal), and one for a suspected infected hematoma. In the laparoscopic group, there were 13 reoperations. Eight of them were performed for intestinal leaks (four JJ anastomotic leaks, three GJ anastomotic leaks, and one at the level of the remnant stomach). One patient underwent a reoperation for suspicion of intestinal leak, but with no intra-operative finding. There was one reoperation for an incarcerated port site hernia at POD 3, resulting in a GJ blowout because of the overpressure. One patient presented a cystic duct leak on POD 1, requiring a reoperation. One patient underwent a reoperation for a large hematoma, necessitating exploratory laparoscopy and drainage. Lastly, one patient presented a kinking at the level of the common intestinal limb, resulting in a mechanical ileus requiring a reoperation and remnant gastrostomy.

Over the 10 years this study was conducted, there was no difference in complications, reoperation, or mortality rates between the first 100 robotic and laparoscopic cases and the last, but there was a noticeably shorter operative time with the last 100 robotic cases compared to the first 100. There were also fewer conversions in the last robotic cases in comparison with the last laparoscopic cases as well (0 vs. 8 %; $p = 0.007$). Finally, there was a shorter hospital stay for the robotic group in comparison to laparoscopy during the study period.

Study critique: This study's strength is that it is one of the largest comparative studies that evaluates laparoscopic and robotic approaches with one of the longest follow-ups, although it does have some limitations. First, since it is non-randomized, this study is considered only a large prospective comparative study. Next, different periods of time and different surgeons were taken into consideration, but the same standardized technique was used to be easily reproducible. There were no significant differences between the various periods, except for the operative time and the length of stay which may be explained by the learning curve. In addition, even though the technique was standardized, both groups used different anastomotic technique: mechanical in laparoscopic RYGB versus hand-sewn in robotic RYGB. This bias could potentially explain the difference of outcomes. Lastly, it is also noted the laparoscopic operative time remains typically longer than in previously reported studies.

**Study 3**: Robotic sleeve gastrectomy versus laparoscopic sleeve gastrectomy: a comparative study with 200 patients. Vilallonga et al.[8]

Objective: The study looked at the benefits, potentials, or problems of robot-assisted da Vinci Surgical System over standard laparoscopic sleeve gastrectomy.

Study design: This was a prospective clinical comparative study that looked at 200 patients that underwent sleeve gastrectomy bariatric surgery at Hospital Vall d'Hebron in Barcelona, Spain between September 2006 and November 2012. Robotic surgery was performed on 100 of the patients, and laparoscopic surgery on the other 100 patients. All surgeries were performed by surgeons trained in advanced laparoscopic surgery.

In the robotic group, trocar placement was done similarly in all patients and used a double cannulation technique. All gastric dissection was completely robotic. Sleeve calibration, section, and extraction had the same technical approach and utilized robotic assistance. A laparoscopic endostapler was used on the lateral edge of the stomach followed by continuous invaginating nonresorbable suture of the staple line. A buttress material reinforcement was used in some patients due to technical problems.

In the laparoscopic group, technical endpoints were similar to the robotic group. Trocar placement were done similarly in all patients.

Leaks at the staple line were tested perioperatively by filling the sleeve with diluted methylene blue and performing an air test.

A nasogastric tube was placed in all patients in both groups at the end of the surgery and removed 24hrs postoperatively. Three days postoperatively, an upper gastrointestinal contrast series was performed. Patients had follow-up appointments every 90 days for 2 years, and then were seen yearly.

Study results: Among the robotic-assisted surgery patients, 89 received a manual robotic reinforcement, and 11 received a buttress material reinforcement. Among the laparoscopic surgery patients 87 patients had their stapling line reinforced with sutures. The leak rate in the robotic-assisted group was 3% as opposed to 4% in the laparoscopic group. The leaks in the robotic-assisted group were in the patients with a buttress material reinforcement and were managed conservatively with a CT drain and antibiotics. There were no perioperative complications, morality, or conversions. The overall bleeding rate in the RS and LS groups (including extraluminal and intraluminal) were 2 and 4 %, respectively. Overall, robotic sleeve gastrectomy is a safe and good option in bariatric surgery.

Study critique: The strengths of this study include the use of a prospective cohort and that it used the same technical approach in all patients.

There are several marked limitations in the study. The study was small and nonrandomized. The authors did not describe what the medical criteria were for entering the study and how the patients were selected. This information is needed to properly evaluate if differences in leak complications among robotic versus laparoscopic surgery patients were due to the type of surgery itself or due to other factors or bias.

The effects of reinforcement of the staple line on leak complications were unclear. The "technical problems" and "extraordinary difficult cases" that required a buttress material

reinforcement in the robotic group were not explained or defined, making it difficult to determine if the leak complications were due to the use of buttress material reinforcement itself or other factors. There was also no explanation as to why some patients had suture reinforcement of the staple line while others did not.

Although the study discussed the management of leaks in the robotic group, it did not mention what form of management was used in the laparoscopic group.

**Study 4**: Robot-Assisted Versus Laparoscopic Sleeve Gastrectomy: Learning Curve, Perioperative, and Short-Term Outcomes. Moon et al.[9]

Objective: To compare the learning curve and perioperative outcomes of da Vinci assisted laparoscopic sleeve gastrectomy and laparoscopic sleeve gastrectomy.

Study design: This study was a retrospective review of a prospectively maintained database looking at 647 patients from June 1, 2008 to December 21, 2014, 267 of whom underwent robotic assisted sleeve gastrectomy and 378 who underwent standard laparoscopic sleeve gastrectomy. The patients attended an information seminar, did a one-on-one physician evaluation, and routine bariatric workup. All procedures were performed by one surgeon.

Laparoscopic and robotic-assisted sleeve gastrectomy were performed similarly. Stapling was performed by the surgeon.

In the robotic-assisted surgery, the dissection and suturing were performed robotically. Stapling was performed by a bedside assistant. Concomitant cholecystectomies and hernia repairs were done laparoscopically.

A leak test was performed at the end of the procedure. There was one conversion from robotic to laparoscopic due to a liver tear. Patients were followed up at 1, 3, 6, and 12 months postoperatively and yearly afterwards.

Study results: After excluding two procedures that had a conversion, there were 378 laparoscopic and 267 robotic assisted sleeve gastrectomy surgeries. The study evaluated the initial 100 RA-LSG and LSG patients and then evaluated all the patients in each group. In the initial 100 RA-LSG, 2 patients were readmitted for staple line leakage, and in the initial 100 LSG, 4 patients were readmitted. The total leaks in the initial 100 cases were 1.8% in the LSG group and 0.6% in the RA-LSG group.

Among the LSG, the overall number of leaks in the LSG group was 9, or 3.2%, as compared to 5, or 1.9%, in the RA-LSG group. The difference in the leak rate in the RA-LSG group between the initial and latter cases significantly decreased ($p<0.05$). Differences in the LSG group ($p>0.22$) were not significant.

All the leaks occurred high on the gastroesophageal junction portion of the staple line. The study did not identify obvious factors that caused the differences in leak rates between the two groups. RA-LSG is as safe as LSG.

Study critique: A strength of this study is that the procedures were nearly identical in dissection and transection.

The authors recognized that their study was limited by the use of one experienced bariatric surgeon, and therefore, the results are difficult to apply to other surgeons. They also

noted the potential for recall and selection bias as this was a retrospective observational study. One of the authors is a consultant for Intuitive Surgical, the manufacturer of da Vinci, which could be a potential conflict of interest.

## Discussion

The prevalence of obesity continues to rise as well as demand for treatment. Among the various treatment options for obesity, bariatric surgery results in the highest percentage of weight loss and decrease in morbidity and mortality as compared to conservative treatment alone. Once the laparoscopic approach was developed, this technique was applied to bariatric surgery and since then has been favored over open-abdominal surgery and has become the gold standard. (A brief history of bariatric surgery - PMC (nih.gov)) Robotic assisted bariatric surgery was introduced in 1998, and thereafter there have been numerous studies and comparative trials that explore the efficacy, complications, and utility of robotic assistance in bariatric surgery. The purpose of this paper is to evaluate if robotic or laparoscopic bariatric surgery results in more leak complications.

A table summarizing the findings of the four studies is provided (Table 1). Both Lainas et al. and Buchs et al. compared laparoscopic versus robotic Roux-en-Y-Gastric Bypass (RYGB), whereas Villalonga et al. and Moon et al. compared laparoscopic versus robotic sleeve gastrectomy.

Lainas et al included 161 patients in their study, 61 who underwent laparoscopic RYGB and 100 who underwent robotic RYGB, whereas Buchs et al. had 777, 389 who underwent laparoscopic RYGB and 388 who underwent robotic RYGB. The surgeons in the Lainas et al. study had no prior clinical experience with the Da Vinci Si robotic system 5 and did not have to meet any requirements, compared to the surgeons in the Buchs et al. study, who had to have performed at least 100 bariatric surgeries in their career. All patients in Buchs et al. underwent a routine cholecystectomy and had a 20-30mL gastric pouch created whereas Lainas et al. patients did not undergo a cholecystectomy and had a slighter larger gastric pouch created, 30-45 mL. Both studies used the same robotic system. Lainas et al. used hand-sewn techniques to make the gastrojejunal (GJ) and jejuno-jejunal anastomoses and a leak test was done at the end of each procedure without a drain. In Buchs et al. the anastomoses were mechanically done in the laparoscopic and hand-sewn in the robotic and a drain was left to close the GJ based on the surgeon’s preference.

Lainas et al. found that 7 out of 61 patients in the laparoscopic group and 15 out of the 100 in the robotic group had postoperative complications. Of the 7 complications in the laparoscopic group, 4 were due to pulmonary complications and 3 were due to abdominal wall complications. In the robotic group, 6 out of the 15 were due to GJ anastomotic leaks, 2 were from anastomotic stenosis, 2 from pulmonary complications and 5 to abdominal wall complications. Buchs et al., found that there were overall more complications in the laparoscopic group (65) compared to the robotic group (45). Of the 65 complications in the laparoscopic group 11 were due to leak complications. Of the 45 complications noted in the robotic group, none of them were related to leaks.

Both Vilallonga and Moon performed comparative studies of sleeve gastrectomy. Although this is an easier procedure than the gastric bypass, it has the longest staple line that is subject to leak complications and hemorrhages. Vilallonga compared 100 RSG patients to 100

LSG patients. The leak rate in the robotic-assisted group and laparoscopic group was 3% and 4%, respectively. The leaks in the robotic-assisted group were in the patients with a buttress material reinforcement and were managed conservatively. The study did not mention how leaks were managed in the laparoscopic group. Moon compared 267 RSG patients to 378 LSG. Among the RA-LSG, the overall number of leaks was 5 (1.9%) as compared to 9 (3.2%), in the LSG group. All the leaks occurred high on the gastroesophageal junction portion of the staple line. The differences in leak rates between the two groups could not be attributed to any obvious factors. The two studies concluded that robotic-assisted surgery is a safe option when compared to standard laparoscopic surgery.

Table 1. Summary of Studies

| *Study* | *Surgery Type* | *Total Number of Patients* | Leak complications | | | |
|---|---|---|---|---|---|---|
| | | | Laparoscopic | | Robotic | |
| | | | # of Patients | % | # of Patients | % |
| Lainas et al | RYGB | 161 | 0/61 | 0% | 6/100 | 6% |
| Buchs et al | RYGB | 777 | 11/389 | 2.8% | 0/388 | 0% |
| Vilallonga et al | GS | 200 | 4/100 | 4% | 3/100 | 3% |
| Moon et al | GS | 647 *2 excluded due to conversion procedures | 9/378 | 3.2% | 5/267 | 1.9% |

RYGB: Roux-en-Y Gastric Bypass; GS: Gastric Sleeve

Of the 161 patients in the Lainas et al. study, 0/61 patients who received laparoscopic RYGB surgery had leak complications whereas 6/100 (6%) patients who received robotic RYGB did have leak complications. In the Buchs et al. study, 11/389 (2.8%) who received laparoscopic RYGB had leak complications compared to 0/388 patients who received robotic RYGB. In the Vilallonga et al. study, 4/100 (4%) patients who received laparoscopic sleeve gastrectomy had leak complications in comparison to 3/100 (3%) of the patients who received robotic sleeve gastrectomy. In the Moon et al. study 9/378 (3.2%) patients who received laparoscopic sleeve gastrectomy had leak complications whereas 5/267 (1.9%) who received the robotic sleeve gastrectomy did.

## Conclusion

Robotic bariatric surgery is a newer surgical technique being utilized instead of the standard laparoscopic approach. The robotic assisted technique has been shown to have fewer leak complications than the laparoscopic technique in sleeve gastrectomy surgeries, and is a safe option for patients. On the other hand, there are disparities among studies regarding which

technique has fewer leak complications for the Roux-en-Y gastric bypass surgery, so more research is needed to investigate this. Ideally, large randomized control trials would provide the best results due to the number of subjects as well as the randomization. In addition, there is limited data on the difference in leak complication rates between the two types of bariatric surgery as well as what factors are contributing to leak complications.

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