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CLINICAL RESEARCH

Reducing Cost of Surgery by Avoiding Complications: the Model of Robotic Roux-en-Y Gastric Bypass

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Abstract
Background Robotic surgery is a complex technology offering technical advantages over conventional methods. Still, clinical outcomes and financial issues have been subjects of debate. Several studies have demonstrated higher costs for robotic surgery when compared to laparoscopy or open surgery. However, other studies showed fewer costly anastomotic complications after robotic Roux-en-Y gastric bypass (RYGBP) when compared to laparoscopy.
Methods We collected data for our gastric bypass patients who underwent open, laparoscopic, or robotic surgery from June 1997 to July 2010. Demographic data, BMI, complications, mortality, intensive care unit stay, hospitalization, and operating room (OR) costs were analyzed and a cost projection completed. Sensitivity analyses were performed for varied leak rates during laparoscopy, number of robotic cases per month, number of additional staplers during robotic surgery, and varied OR times for robotic cases.
Results Nine-hundred ninety patients underwent gastric bypass surgery at the University Hospital Geneva from June 1997 to July 2010. There were 524 open, 323 laparoscopic, and 143 robotic cases. Significantly fewer anastomotic complications occurred after open and robotic RYGBP when compared to laparoscopy. OR material costs were slightly less for robotic surgery (USD 5,427) than for laparoscopy (USD 5,494), but more than for the open procedure (USD 2,251). Overall, robotic gastric bypass (USD 19,363) was cheaper when compared to laparoscopy (USD 21,697) and open surgery (USD 23,000).
Conclusions Robotic RYGBP can be cost effective due to balancing greater robotic overhead costs with the savings associated with avoiding stapler use and costly anastomotic complications.

Keywords Robotic surgery · Costs · Cost analysis · Gastric bypass · Obesity surgery

Introduction

Over the past decade, obesity has grown to the dimensions of a worldwide epidemic, significantly impacting patients' overall health [1]. Currently, Roux-en-Y gastric bypass (RYGBP) is the most effective therapy for morbid obesity [2]. Laparoscopy is the gold standard for gastric bypass surgery due to the decreased level of invasiveness when compared to an open procedure [3].

Technical advances have led to the addition of robotic assistance for the laparoscopic technique [4, 5]. The only system for this type of surgery on the current market is the da Vinci Surgical System by Intuitive Surgical (Sunnyvale, CA, USA, www.intuitivesurgical.com). This computer-assisted manipulator offers 3-D views, highly articulated instrumentations, and various software solutions to facilitate complex surgery. Technically, this system is clearly advanced when compared to laparoscopic surgery, but also very expensive: the purchase of a da Vinci Surgical System currently varies between USD 500,000 and 2.2 million depending on the model, age, and choice of components. Instrument costs range between USD 1,100 and 8,000 with a limited number of uses. Additionally, maintenance costs equivalent to 10% of the purchase price are due yearly.

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Despite the technical advantage of robotic surgery over conventional laparoscopy, its clinical value remains undetermined for most surgical procedures, including RYGBP: While a number of publications suggest a clinical advantage in terms of a reduced rate of anastomotic complications after robotically sutured anastomoses during RYGBP when compared to stapled anastomoses during laparoscopy [6–8], other authors did not confirm this finding [9, 10]. Anastomotic complications during laparoscopy seem to be induced by the use of staplers. Laparoscopically sutured anastomoses are theoretically possible, but technically challenging. One of the main advantages of robotic assisted surgery is the ability to perform "hand suturing", which replicates the open technique and facilitates intestinal enteral anastomosis, potentially reducing anastomotic complications in comparison to the use of staples. A reduction of anastomotic complications may reduce the overall cost of treatment since these kinds of complications are often very severe [11]. In addition to the potential for reducing cost by avoiding complications, robotically sutured anastomoses may also result in considerable savings by eliminating the need for costly laparoscopic staplers. Combined, these savings might be significant enough to balance the greater overhead associated with a robotic approach.

Therefore, we hypothesize that:

- Robotic RYGPB results in fewer anastomotic complications when compared to laparoscopy.
- Avoiding complications by applying robotics to RYGPB results in significant cost savings.
- Savings on laparoscopic staplers are significant and can balance the material costs of the robot.

Material and Methods

Data for all patients who underwent gastric bypass surgery since 1997 at the University Hospital Geneva, Switzerland were captured prospectively. Demographic data, comorbidities, BMIs, method of procedure (open, laparoscopic, and robotic), intra- and postoperative complications, and overall hospital stay were entered into a continuous database for all patients. Intensive care unit (ICU) stay was captured retrospectively for the robotic and laparoscopic patients and estimated based on a representative example for the open patients due to limited data availability.

Clinical data were analyzed and compared across cohorts using the SAS Software, (version 9.02, Cary, NC, USA). Discrete variables were compared using a chi-squared test with continuity correction or a Fisher's exact test, while continuous variables were compared using t test. In all instances, a p value of <0.05 was considered statistically significant.

Operating room (OR) times for robotic surgeries were prospectively captured for all patients. The robotic docking time, which includes moving the robotic system into the field of surgery, attaching the trocars to the robotic arm, and installing the camera and instruments, was assessed separately for all cases. OR time for the laparoscopic procedure was estimated based on a sample comparable to the robotic cohort.

The use of robotic and laparoscopic instruments was documented and overall costs of OR instrumentation were deduced. The material costs for the open procedure were estimated based on OR protocols.

The costs of a day in the ICU or in a conventional hospital ward (including drugs, materials, and employees) and OR time (including anesthesia and surgeon's charge) were provided by the University's financial department. All costs were collected in Swiss Francs (CHF) and converted to US dollars (USD) at a rate of 0.91.

A decision analytic model was constructed using commercially available software (TreeAge Pro 2009 Healthcare, version 1.0.2, Williamstown, MA, USA) to estimate and compare the overall costs of open, laparoscopic, and robotic RYGBP. The software was used to model average cost for each type of surgical approach based on the costs and the probability of each possible scenario with regard to clinical complications. Parameters of the decision model were derived from the clinical results and included OR materials, postoperative ICU stay, overall hospitalization, and amortization of the costs to purchase the robotic system.

One-way sensitivity analyses were used to assess the effects of varying the percentage of anastomotic leaks after laparoscopic RYGBP, the number of robotic procedures performed per month, the number of laparoscopic staplers used to perform the jejuno-jejunal anastomosis during the robotic approach, and the OR time needed to perform robotic RYGBP. Base for the robotic amortization was an initial purchase price of USD 1,592,500, a yearly maintenance fee of 10%, an interest rate of 5%, and a duration of use of 7 years.

Surgical Techniques

All gastric bypass patients were treated with a gastric restriction to a remnant pouch of about 25 cc, an alimentary loop of 150 cm, and a biliary loop of 75 cm. Surgical methods (open, laparoscopic, and robotic) differed mainly in the size and location of the abdominal access and the methods applied to the formation of the gastro-jejunal and the jejuno-jejunal anastomoses. All gastro-jejunal anastomoses were intra-operatively tested for leaks with air and methylene blue. Patients underwent cholecystectomy in the same session if not performed previously and most patients also underwent a surgical liver biopsy.

Open gastric bypass was performed via upper median laparotomy. Both gastro-jejunal and jejuno-jejunal anastomoses were hand-sutured using 3-0 vicryl thread.

During laparoscopic gastric bypass, five trocars were used for access. A circular gastro-jejunal anastomosis was formed with trans-oral placement of the anvil of the stapler (EEA, Covidien, Wollerau, Switzerland). A laparoscopic port incision in the upper right abdomen was widened to at least the diameter of the stapler (28 mm) for the introduction of the shaft of the stapler. The jejuno-jejunal anastomosis was formed using linear laparoscopic staplers (Echelon, Ethicon Endosurgery, Dietlikon, Switzerland).

For the robotic cases, our technique developed from a hybrid one using the robot only for suturing during the gastro-jejunal and the jejuno-jejunal anastomoses to a totally robotic technique. However, all patients in this cohort received robotically sutured gastro-jejunal anastomoses performed with 2-0 vicryl thread. All patients underwent routine upper GI study on postoperative day 2.

Results

Nine-hundred ninety patients underwent Roux-en-Y gastric bypass surgery at the Division of Digestive Surgery at the University Hospital in Geneva from June 1997 to July 2010. Of these patients, 524 underwent open surgery, 323 laparoscopy, and 143 robotic gastric bypass surgery. The female to male ratio was about 4:1, the mean age was 42 years, and the mean BMI was 44.2 kg/m^2. All demographic data were comparable between the three groups (Table 1). The open group contained significantly more patients with ASA class 3 and 4 than the laparoscopic and the robotic groups.

Four different board certified surgeons with specific training performed the gastric bypass cases. Two were involved in open and laparoscopic cases; one performed open, laparoscopic, and robotic cases; and one performed only robotic procedures.

Significantly more anastomotic leaks and strictures occurred after laparoscopic RYGBP (4%, 6.8%) when compared to the open (1.9%, 1.1%) and robotic approaches (0%, 0%). No significant differences were found among the three groups for overall complication rate or for individual complications, including those resulting in death. Three deaths occurred in the open surgery group and none in the other two groups. There were significantly fewer conversions to open surgery during robotic RYGBP (1.4%) when compared to laparoscopy (4.9%). Please see Table 2 for detailed complications.

The slightly shorter ICU stays after robotic RYGBP (mean 0.2 days) was not significant when compared to laparoscopy (mean 0.6 days). Median duration of hospitalization was 9 days for open (range 5–220 days, mean 10.9 days), 8 days for laparoscopy (range 5–249 days, mean 11 days), and 7 days for robotic patients (range 4–24 days, mean 7.4 days). These differences were significant between all groups (Table 3).

The robotic procedure showed prolonged OR times with a steep learning curve. Mean OR time for all cases was 293 min. The last 31 cases had a mean duration of 236 min (median 225 min). The estimated duration of the laparo-

Table 1 Patient demographics

Parameters	Laparotomy (N=524)	Laparoscopy (N=323)	Robotic (N=143)	p values
Age, years				
Mean (standard deviation)	41.4 (10.1)	41.5 (10.1)	42.6 (11.2)	0.22[a], 0.30[b]
Range	19–64	18.6–63.7	18.6–69.0	
Gender				
Male, n (%)	115 (22)	64 (18.9)	38 (26.6)	0.30[a], 0.13[b]
Female, n (%)	409 (78)	259 (80.2)	105 (73.4)	
BMI, kg/m^2				
Mean (standard deviation)	45.3 (6.8)	44.5 (5.3)	44.5 (5.3)	0.13[a], 1.00[b]
Range	22.1–89.9	30–70	30.9–65.6	
ASA 1–2				
n (%)	330 (63.5%)	245 (75.8%)	106 (75.7%)	0.01[a], 0.97[b]
ASA 3–4				
n (%)	194 (37%)	78 (24.2%)	34 (24.3%)	0.01[a], 0.97[b]

[a] Comparison between open and robotic

[b] Comparison between laparoscopic and robotic

Table 2 Complications

Parameters	Laparotomy (N=524)	Laparoscopy (N=323)	Robotic (N=143)	p values
Overall complications (%)[a]	65 (12.4)	58 (18.0)	23 (16.1)	0.3111[b] 0.7192[c]
Anastomotic leaks, n (%)	10 (1.9)	13 (4.0)	0	0.2104[b] 0.0349[c]
Anastomotic strictures, n (%)	6 (1.1)	22 (6.8)	0	0.2336[b] 0.0002[c]
Pulmonary complications, n (%)	21 (4.0)	12 (3.7)	7 (4.9)	0.8150[b] 0.7338[c]
Death, n (%)	3 (0.5)	0	0	0.2363[b] –
Bleeding, n (%)	3 (0.6)	5 (1.5)	3 (2.1)	0.0952[b] 0.1739[c]
Wound infections, n (%)	2.3	3.4	2.1	0.2320[b] 0.3637[c]
Neurologic complications, n (%)	0.8	0.6	2.1	0.2637[b] 0.2722[c]
Other, n (%)	20 (3.8)	8 (2.5)	8 (5.6)	0.4813[b] 0.1513[c]
Conversions, n (%)	–	16 (4.9)	2(1.4)	0.0388[c]
Reoperations, n (%)	10 (1.9)	13 (4.0)	1 (0.7)	0.2104[b] 0.0349[c]

[a] Reflects the number of complications not necessarily the number of patients with unique complications

[a] Comparison between open and robotic

[b] Comparison between open and robotic

Table 3 Hospitalization

Parameters	Laparotomy (N=524)	Laparoscopy (N=323)	Robotic (N=143)	p value
ICU stay, all patients (days)				
Mean	2.0	0.6	0.2	<0.0001[a]
Standard deviation	9.85	4.2	1.1	0.0517[b]
Range	0–220	0–58	0–8	
ICU stay, patients with anastomotic leaks (days)	N=10	N=13	0	0.216
Mean	33.8	10.23		
Standard deviation	64.54	16.10		
Range	2–220	2–58		
Hospitalization (days)				
Mean	10.9	11.0	7.4	<0.0001[a]
Standard deviation	11.4	19.1	2.6	0.0010[b]
Range	3–220	5–249	3.0–24.0	
Hospitalization, patients with anastomotic leaks (days)				
Mean	61.2	68.62	0	
Standard deviation	55.45	72.38		
Range	14–220	17–249		

[a] Comparison between open and robotic

[b] Comparison between laparoscopic and robotic

scopic procedure is 206 min in a comparable setting to the robotic procedure (Fig. 1).

There were additional costs for the robotic cases due to specialized instruments and accessories of USD 1,582 per case. Specific drapes for the robot incurred costs of USD 546, while drapes for laparoscopy cost USD 147 and USD 113 for the open procedure. Disposable materials and reprocessing costs for re-usable instruments were higher during laparoscopy (USD 5,299 per case) when compared to robotic surgery (USD 3,229 per case) mainly due to the costs of stapling devices. Overall material costs were USD 5,494 for a laparoscopic gastric bypass case and USD 5,427 for a robotic case. Material costs for the open approach were 2,251 USD (Table 4). Hospital administration stated costs of USD 3,572 per day for the ICU, USD 1,297 per day for hospitalization on a conventional ward, and USD 236 per each 15 min increment of OR time.

Applying the abovementioned clinical results and costs, the decision tree model (Fig. 2) generated baseline costs of USD 23,000 for the open, USD 21,697 for the laparoscopic, and USD 19,363 for the robotic approach.

Sensitivity analysis based on reducing anastomotic leaks during laparoscopy showed that the robotic approach remained cost effective if the anastomotic leak rate during the laparoscopic procedure was at least 2%. The laparoscopic approach became more cost effective compared to the robotic approach when the anastomotic leak rate dropped under 2% (Fig. 3).

Sensitivity analysis based on varying the number of robotic procedures performed per month (affecting the costs per procedure associated with amortization of the robotic system) showed that the robotic procedure was cheaper when at least seven cases were performed per month assuming a laparoscopic leak rate of 4%. If the laparoscopic leak rate can be reduced to 2%, at least 10 robotic procedures have to be performed to achieve cost effectiveness (Fig. 4).

Sensitivity analysis based on the addition of the use of staplers during the robotic procedure showed that the use of three staplers did not make the robotic approach more expensive when assuming a 4% leak rate for the laparoscopic procedure. When considering a theoretical laparoscopic leak rate of 2%, the use of two or more staplers made the robotic approach more expensive than laparoscopy (Fig. 5).

Sensitivity analysis based on varying OR time demonstrated that up to 135 additional OR minutes could be added to the robotic procedure without exceeding the costs of a laparoscopic procedure with a 4% leak rate. Assuming a 2% laparoscopic leak rate, the robotic approach remained cost effective when 30 min or less additional OR time was needed (Fig. 6).

Discussion

Our data demonstrate that it is possible to perform robotic surgery cost effectively. Based on our laparoscopic and robotic techniques with our specific profile of complications and their direct costs, we were able to reduce our overall costs for gastric bypass surgery through the introduction of the da Vinci Surgical System for this technically challenging procedure.

Our savings are mainly based on three very important findings:

- Robotically sutured anastomoses showed significantly fewer leaks when compared to stapled anastomoses during laparoscopy in our setting.
- Anastomotic leaks generated high costs.

Fig. 1 Robotic OR times

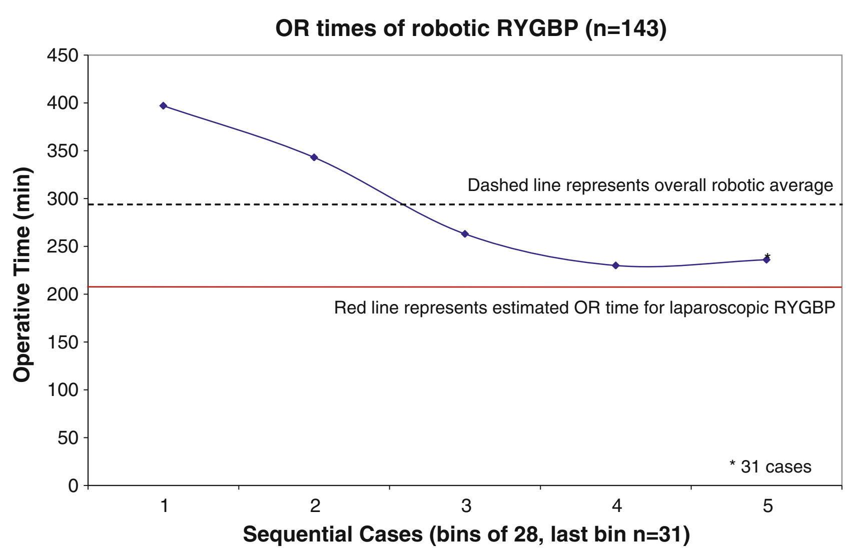


Table 4 Costs of OR material

Parameters	Laparotomy	Laparoscopy	Robotic
Drapes	112.84	147.36	546.22
Instruments and accessories			
Specific for robot			1,582.91
Staplers	1,860.95	3,560.83	1,860.95
Others	187.1	1,737.84	1,368.01
Suturing material	90.45	48.076	69.37
Total	2,251.34	5,494.11	5,427.46

– It was possible to balance expenses that are attributed to the robot including the initial purchase, maintenance, instruments, and accessories by avoiding complex and expensive laparoscopic instruments such as staplers.

While we are very enthusiastic about our overall cost savings as a result of introducing the robotic approach, we are aware that a significant difference in costs between the laparoscopic and robotic approaches is attributed to a relatively high leak rate in our laparoscopic group. While we fall well within the previously published result of low volume, academic centers, a realistic leak rate of 2% after laparoscopic gastric bypass should be assumed [12–15]. Our rate of 4% is in part due to experiencing a certain number of leaks during our early learning curve for laparoscopic RYGBP, with fewer leaks experienced during our post-learning curve period. Therefore, this overall leak rate of 4% is at least partly addressable to learning effects. However, we did not experience any leaks during our robotic learning curve. It is possible that this is due to an additive learning effect from open and laparoscopic cases performed prior to the introduction of robotics; however, other authors have described advantages of the robotic system during the learning curve for robotic gastric bypass [6]. Therefore, the da Vinci Surgical System might be a suitable tool for teaching advanced minimally invasive procedures.

Due to the significant contribution of the relatively high leak rate in our laparoscopic group to the cost savings seen with robotic surgery, we performed a sensitivity analysis that varied this leak rate. The results showed that the robotic approach is still cheaper in our setting when the more realistic 2% leak rate is assumed for the laparoscopic approach. However, if the leak rate of the laparoscopic approach can be further reduced, a robotic approach seems less interesting in financial terms. Therefore, this analysis suggests that the da Vinci system should be applied to procedures that are very complex and are at the surgeon's personal limit of laparoscopic abilities. The advanced technology of robotics does not result in improved clinical results when the laparoscopic method is mature and

Fig. 2 Decision model tree

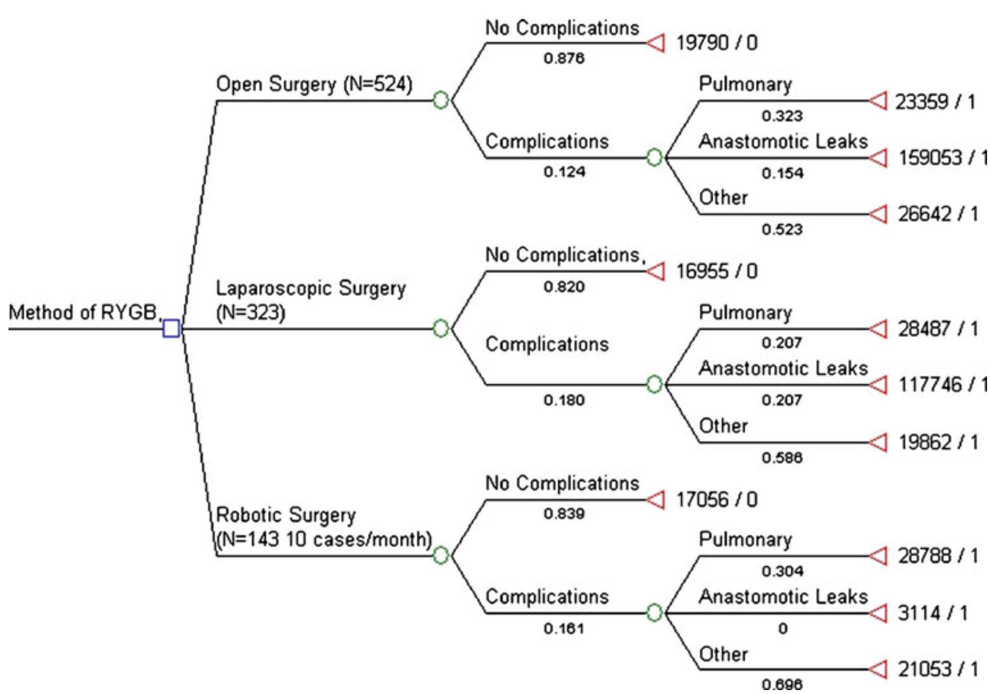
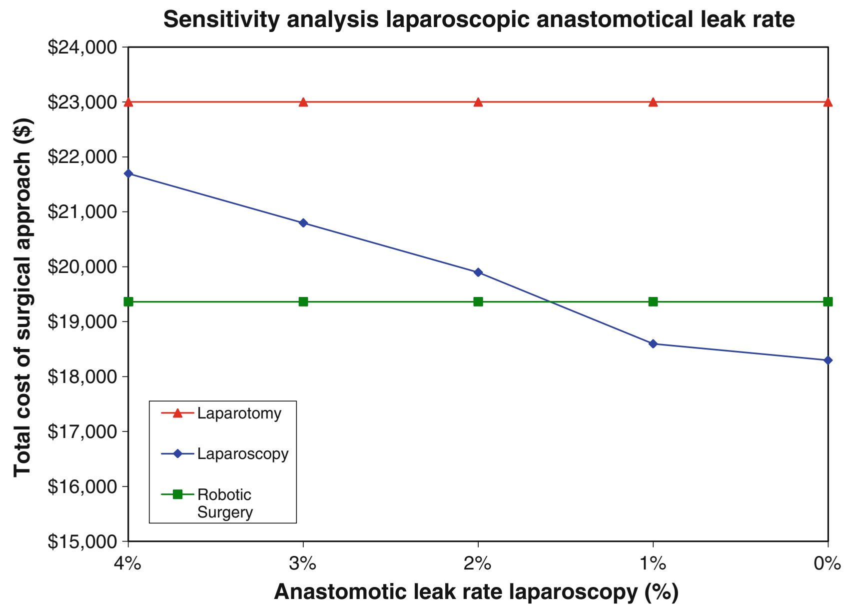


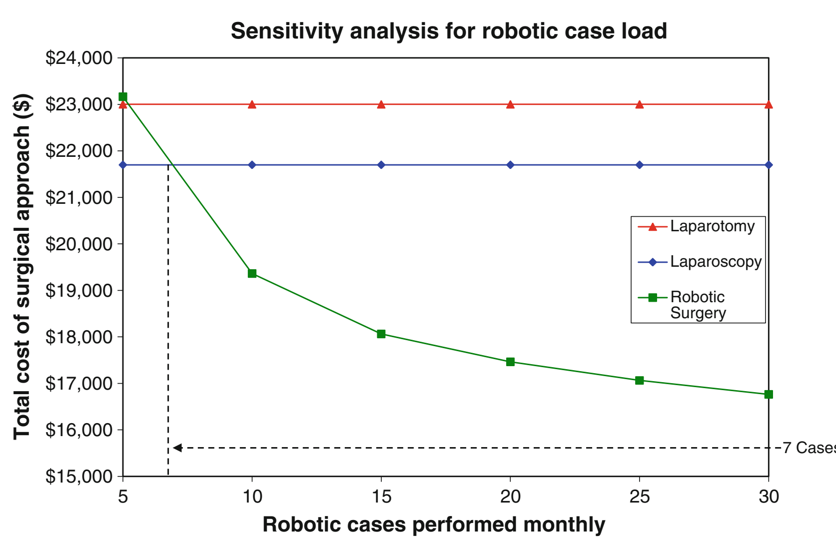
Fig. 3 Sensitivity analysis for laparoscopic leak rate



technically feasible. This explains how clinical outcomes after surgical procedures of moderate complexity such as cholecystectomy, Nissen fundoplication, and others are very similar for laparoscopy and robotics, with the robotic approach resulting in significantly increased costs [16, 17]. Based on a cost-effectiveness view, these procedures should not be considered as robotic indications unless used as training cases.

Another very important factor in the cost of robotics is the volume of robotic procedures. Initial purchase of the robot and yearly maintenance fees are associated with significant costs and should be considered on a per case basis. Understandably, costs per procedure can be reduced by a higher utilization. Our sensitivity analysis demonstrates that at least seven robotic cases have to be performed to stay cost effective in our setting. However, if other parameters such as the laparoscopic leak rate or robotic OR time varied, more robotic cases needed to be performed to balance the overall robotic overhead. Also, not every robotic program includes such a strong cost saver as the RYGBP in our setting. If clinical benefits of a robotic approach result in more subtle financial advantages, the overall cost per robotic procedure can be minimized through increased robotic utilization, which results in decreased amortization costs of the robotic system. Also, as soon as a financial advantage of the robotic approach is established, this gain can be maximized by optimization of robotic utilization. In that sense, surgical robots can be seen as very similar to aircrafts in commercial aviation where profits are maximized by sophisticated flight plans that keep the aircrafts up in the air for as long and often as

Fig. 4 Sensitivity analysis for robotic case load



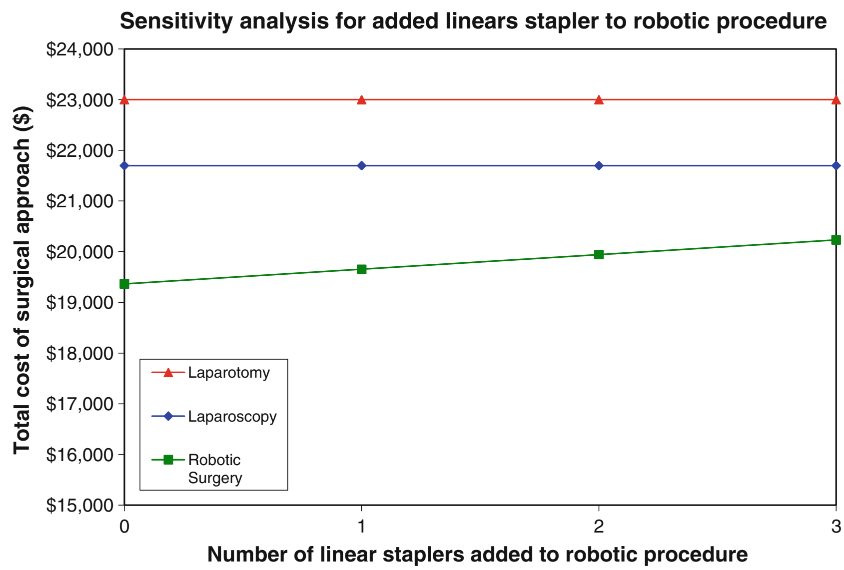


Fig. 5 Sensitivity analysis for the use of additional stapling material during the robotic procedure

possible with very quick turnover times. Hospitals that wish to build financially successful robotic surgery programs should consider the importance of using the robot to its full capacity in order to reduce costs. Multi-specialty programs with committed staff and professional management such as a robotic co-coordinator are most likely to be successful not only clinically, but also financially.

A very important factor in our overall costs analysis was the fact that we were able to lower material costs for the robotic procedure when compared to laparoscopy. These savings are mainly explained by the fact that we robotically suture the gastro-jejunal and the jejuno-jejunal anastomosis and by doing so we achieved significant savings on laparoscopic staplers. These savings were enough to balance the high costs of additional equipment that was needed for the robotic approach. We are also aware that there are modifications to the robotic technique and some groups might prefer methods with totally stapled and partially stapled jejuno-jejunal anastomoses. If we assume a 4% leak rate, we could also entirely staple the jejuno-jejunal anastomoses without driving the robotic costs beyond the one of laparoscopy. However, at a leak rate of 2%, we could maximally use one additional stapler if it is assumed that the OR time is not prolonged with the robotic approach. Overall, we feel that suturing the jejuno-jejunal anastomoses entirely provides us with an excellent opportunity to maximize savings on laparoscopic staplers as one stapling recharge induces incremental costs of about 5% for the robotic procedure. Additionally, this relatively straight-forward anastomosis serves as a great training opportunity both during our early cases in order to speed up our learning

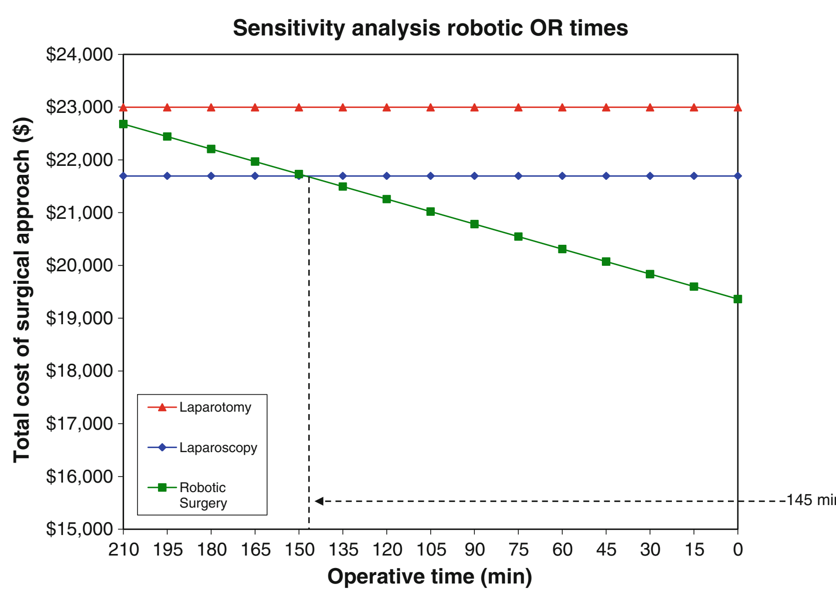


Fig. 6 Sensitivity analysis for robotic OR time

curve as well as for the introduction of new surgeons to this technique or for the training of residents and fellows.

An important point of discussion in a cost analysis is the time that is needed to perform a procedure. It is easy to understand that prolonged times have a negative impact on the overall costs. Unfortunately, a direct analysis was not possible for this study due to the lack of available data. We estimated that our robotic procedures are currently about 30 min longer than a laparoscopic gastric bypass in our setting (comparing prospectively captured robotic OR times with representative laparoscopic sample). As previously published—in our experience—docking times add to some of the costs but only in moderate amounts [18]. Additionally, robotically sutured anastomoses are more time consuming than their stapled counterparts. Our sensitivity analysis that varied the robotic OR times demonstrated that we could spend an additional 145 min for the robotic approach with a 4% laparoscopic leak rate. Assuming a 2% leak rate, the robotic approach was still slightly cheaper when 30 min longer when compared to laparoscopy. Therefore, we feel that we are cost effective now that our robotic procedure has matured. However, we must assume significantly increased costs during our robotic learning curve. These additional costs during the learning curve have to be considered, especially when the entire robotic program is new. Still, similar learning costs must have been caused during the laparoscopic learning curve, but we are not able to access these data and a more detailed analysis could not be performed. On the contrary, previously published studies have suggested shorter OR times during the robotic learning curve with better clinical results and shorter robotic OR timed per BMI unit [19, 20].

Overall, our operative times might appear longer than in other institutes both for the laparoscopic as well as for the robotic procedures. As mentioned above, we are an academic center with a relatively low rate of this kind of procedure. While training of inexperienced colleagues might not influence the direct outcome of the anastomoses, overall skin-to-skin time might be affected as easier parts of the procedure such as laparoscopic cholecystectomy or wound closure might be performed by surgeons in training. Additionally, since these data are part of a longitudinal, observational study, we have effects of learning curves of four different surgeons influencing the results.

This study has several shortcomings that need to be mentioned: any cost analysis is very complex and it is difficult to include all relevant parameters. We included the available and most relevant data in this study. We tried to picture the most realistic scenario by assembling sensitivity analyses for several parameters. However, some data points are estimated while others were not included. These parameters might influence both the laparoscopic and the robotic costs in many ways. Additionally, other parameters might have influenced the overall assumption in an incorrect way. As stated in the data, open surgery was associated with significantly higher costs when compared to laparoscopy and open surgery. This is mainly based by the significantly longer ICU stays after open surgery. However, this prolonged stay might not have been caused by medical necessity but rather by the common practice of the anesthesiologists at our hospital: Until 2003, every gastric bypass patient had to spend at least a day in the ICU as per the rule. Therefore, all costs of the open approach cannot be compared to laparoscopy and robotic surgery. In addition, other undetected changes in clinical practice with its general shift toward faster track patient's management might have financially favored the more recent cases that are mainly robotic.

Additionally, there are limitations in our study design: We present here a non-randomized, comparative observational study that certainly comes short when compared to a prospectively randomized trial. The cohorts are not matched—however demographic data are comparable across groups—and patients as well as different surgeons contribute to a greater chance of bias. Still, we believe that the data are valuable despite the limitations of the study design: high volume, comparable patient characteristics, single center, and evolving surgical experience. The purpose of this paper is to demonstrate how we were able to improve clinical results after the introduction of a new surgical method. The deciding factor for the anastomotical leak rate seems to be the underlying technique. Laparoscopic hand suturing of anastomoses during RYGBP is technically challenging and a significant learning curve has been described. This suture is facilitated by the use of the da Vinci Surgical System and resulted in satisfying clinical and financial results at our institution.

Overall, we see this paper as an initial attempt to assess the costs that are imposed on our hospital by the use of the da Vinci Surgical System. Our positive findings encourage us to continue with our practice of robotic RYGBP and we will further explore indications in our field of digestive surgery. While the results might not be applicable at other institutions, we wish to emphasize with this paper that robotic surgery can be cost effective if clinical results are improved and material costs of the robot are balanced.

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Conflict of Interest Monika Hagen acts as a consultant for Intuitive Surgical. Usha Kreaden is an employee of Intuitive Surgical.

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