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A Stepwise Approach in Learning Surgical Residents a Roux-en-Y Gastric Bypass

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Abstract

Introduction This study describes a stepwise training program to teach a laparoscopic Roux-en-Y gastric bypass (LRYGB). Results of a resident are compared to experienced bariatric surgeons (EBS).

Methods The resident performed a varying amount of surgical steps and the duration of every step was measured using video analysis. In order to compare the resident's results to EBS, the average time per step was calculated for 30 procedures.

Results The total procedure time of LRYGB was 61.15 ($\pm$ 8.74) min for a novice resident. In comparison, the average of three EBS was 36.22 ($\pm$ 9.06) min. Creation of the gastric pouch had an average of 12.82 ($\pm$ 4.08) versus 6.93 ($\pm$ 2.58) min. Duration of creating the stapled gastrojejunostomy was 7.43 ($\pm$ 2.11) versus 4.48 ($\pm$ 2.02) min. Suturing of the gastrojejunostomy was 12.60 ($\pm$ 3.31) compared to 6.31 ($\pm$ 2.53) min. Creating the jejunojejunal anastomosis had a duration of 7.12 ($\pm$2.31) versus 4.22 ($\pm$ 1.60) min and suturing this anastomosis was 13.93 ($\pm$ 3.81) compared to 8.51 ($\pm$ 3.37) min. At the end of the traineeship, the observed progression approximated the skills level of the EBS.

Conclusion The stepwise LRYGB-training program, analysed in this study, can result in an efficient and safe way to approach the learning curve to the level of the EBS. Within this training program, the total time of the operation is kept low in order to prevent adverse events for the patient and loss of efficiency in the bariatric program. The results of this study could act as a guideline for the development of such training programs.

Keywords Bariatric surgery · Roux-en-Y gastric bypass · Morbid obesity · Surgical residents · Training program · Learning curve

Introduction

The prevalence of morbid obesity has risen to global epidemic proportions, and bariatric surgery is the most effective treatment to achieve substantial and long-lasting weight loss in morbid obese patients [1–3]. In the past decades, the number of bariatric procedures performed has increased exponentially [4]. Currently, the laparoscopic Roux-en-Y gastric bypass (LRYGB) and the laparoscopic sleeve gastrectomy (LSG) are the most commonly performed bariatric procedures [5–7].

LRYGB is a technically challenging operation and not easy to learn due to several factors: the constitution of the patient, the technically demanding laparoscopic steps and the considerable risk of complications in these high-risk patients. All these factors contribute to the risk of severe morbidity and mortality after LRYGB [7]. The number of procedures that need to be performed to master the procedure is defined as the learning curve. The learning curve phenomenon is based on the theory that people and organisations become better and faster in their task when these tasks are being repeated [8]. In surgery, the learning curve includes duration of the procedure, length of stay in hospital (LOS) and the number of complications. It has been reported that 103 procedures (range 50–152) are needed to complete the learning curve in LRYGB [9–16]. Sanchez et al. showed that a mentoring program or fellowship program with an experienced bariatric surgeon significantly improves the LRYGB-outcome during the learning curve and reduces the complication rate in this period in contrast to non-formal bariatric training [17]. The technical skill of practicing bariatric surgeons, measured using the Objective Structured Assessment of Technical Skills, varied widely, and greater skill was associated with fewer postoperative complications and lower rates of reoperation [18, 19].

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Within our clinic, an educational program was developed to teach residents to perform LRYGB procedures in a safe and efficient manner under supervision of experienced bariatric surgeons. This study investigates how the resident improves, in terms of operation time, in a program where the LRYGB is taught in a step-by-step manner in order to reach the level of performance of the experienced bariatric surgeon. The main goal of this study was to describe an educational program in which a surgical resident will complete the bariatric learning curve efficiently, in order to improve patient safety and recovery.

Methods

Study Population

Eligibility for bariatric surgery was assessed using the international IFSO-criteria [20]. When patients met the criteria, they were treated according to our bariatric program. This bariatric program ensures for a comprehensive provision of information to the patient in several grouped workups: group information meeting, intake day, analysis day and planning day [21]. Within this program, our bariatric clinic educates residents to become bariatric surgeons. The residents start the program by operating parts of the procedure with low-complex bariatric procedures i.e. patients with no previous major abdominal surgery (e.g. laparotomy or > 2 abdominal surgeries), BMI 39–43 kg/m^2 and no obesity-associated co-morbidities. After sufficient experience and acquired surgical skills, they perform more complex procedures.

Surgical Technique

Our bariatric clinic mainly performs LSG and LRYGB, respectively 327 and 446 procedures in 2016. The postoperative complication rate of all 965 bariatric procedures in 2016 was 3.2%. Postoperative complications of Clavien-Dindo grade III or higher were abdominal haemorrhage (44%), suture leakage (22%), intra-abdominal abscess (8%), obstruction (3%), bowel injury (3%), infected haematoma (3%) and others (17%) [22, 23].

Within the resident training program, both procedures are taught. Within this study, we focus on the LRYGB. The LRYGB is created with a small gastric pouch of 15 cc, which is anastomosed over 3 cm with a linear stapler to a 150-cm alimentary limb. The gastrojejunostomy is created with a linear technique using an Ethicon Echelon Flex 60 powered stapler with a blue cartridge. After stapling, the stapler defect is closed with a double layer Stratafix suture (Ethicon, Somerville, New Jersey, USA), after which a side-to-side jejunojejunostomy is created with a 60-cm biliopancreatic limb by using the same Ethicon Echelon Flex 60 and after

stapling the defect is closed with suture. At the end of the procedure, the mesenterial defects (Petersen space and the defect of the jejunojejunostomy) are closed with clips [24]. By administering methylene blue through the nasogastric tube, the integrity of the proximal anastomosis is tested. One resident, one EBS, one scrub assistant and one anaesthetist are involved in this procedure.

Training Program

Within our resident training program for bariatric surgery, the bariatric procedure was divided in five different steps. The resident starts with performing separated steps of the procedure, instead of an entire operation at once, since the total complication rate is higher when the time of the total operation is longer and the performance of a total operation by trainees takes significantly longer [25, 26]. The resident will start to perform the total operation after the teaching surgeon expects that he or she can perform it sufficiently and in a timely manner.

The five different steps of the LRYGB procedure are the following:

1. Creation of the gastric pouch
2. Identification of the ligament of Treitz, measuring the biliopancreatic limb and creating the stapled gastrojejunostomy
3. Laparoscopic suture closure of the linear stapled gastrojejunal anastomosis
4. Measuring the alimentary limb and creating the stapled jejunojejunostomy
5. Laparoscopic suture closure of the linear stapled jejunojejunal anastomosis

For this analysis, one surgical resident in training for bariatric surgery was followed from the start of his training in January 2016 until September 2016. All LRYGBs performed in this period were included in the study. The duration of each step was measured by two independent researchers using the intraoperatively recorded videos. Video recording started when the camera entered the abdomen and stopped when the camera was removed. This is noted as total operation time. In addition, insufflation of the abdomen comprises 2 min and during camera removal, simultaneously suture closing of the incision wounds was performed which takes 3 min. This is done according to our fast-track/ERABS protocol as described before [21]. A few steps were omitted from this study, such as opening and closing the skin and the closure of mesenteric defects or the division of the connecting limb, since the duration of these steps can be largely dependent on patient characteristics or the skills of other members of the operating team.

In order to compare the resident's results to experienced bariatric surgeons, the average time for each step was calculated in ten different procedures of each experienced bariatric

surgeon within our clinic. To compare the average time, we used the EBS-resident ratio. This ratio is the average time of the EBS divided by the average time of the resident. The resident would start with low-complex procedures. Therefore, the average procedural times for the bariatric surgeons were also calculated with most of low-complex procedures. Thirty-day complications were recorded and graded according the Clavien-Dindo classification [22, 23].

Statistics

The statistical analysis was performed using the SPSS version 24.0 (SPSS, Chicago, Illinios, USA). Means with standard deviation (SD) was used for the comparison of operation times. A Mann-Whitney U test (numeric data) or Pearson Chi-square analysis (nominal and ordinal data) was performed in order to assess statistical significance of difference between the resident and the EBS. A p value < 0.05 was taken as level of statistical significance.

Results

Between January 2016 and September 2016, the resident performed 29 consecutive bariatric procedures. While the resident only performed separate steps of the procedure at the beginning of the training program, he was able to perform the complete LRYGB at the end of this traineeship. For each experienced bariatric surgeon, 9–11 procedures have been analysed with a total of 30 procedures.

Baseline characteristics of the patients are described in Table 1. A significant difference was observed in mean BMI, which was 42.19 ($\pm$ 4.22) kg/m^2 in the group of the resident and 39.54 ($\pm$ 2.60) kg/m^2 in the group of the EBS ($p = 0.013$). No other significant differences were seen in the baseline characteristics.

The 30-day complications of Clavien-Dindo grade III or higher were abdominal haemorrhage ($n = 2$) and obstruction in the small bowel caused by adhesion ($n = 2$) in the EBS group, while those in the resident group were stapled line bleeding ($n = 2$) and suture leakage ($n = 1$). There was no postoperatively mortality in either groups.

The resident created the pouch 21 times, made the gastrojejunostomy 16 times, sutured the gastrojejunostomy 18 times, made the jejunojejunostomy 15 times, sutured the jejunojejunostomy 26 times and completed a total of 15 LRYGBs from start to end by himself. Measuring the alimentary limb and creating the stapled jejunojejunostomy (step 4) was the step with the fastest progression, with an average of − 0.290 min (17.4 s (6.67%)) faster each time, as shown in Table 2. The last step, laparoscopic suture closure of the linear stapled jejunojejunal anastomosis, was the step with the smallest progression with an average of − 0.107 min (6.42 s

Table 1 Baseline characteristics

	EBS ($n = 30$)	Resident ($n = 29$)	p value
Age[a]	40 ($\pm$ 12)	44 ($\pm$ 9)	0.174
Sex[b] female	25 (83.3%)	25 (86.2%)	0.759
Height (m)[a]	1.67 ($\pm$ 0.09)	1.68 ($\pm$ 0.09)	0.814
BMI (kg/m^2)[a]	39.54 ($\pm$ 2.60)	42.19 ($\pm$ 4.22)	0.013
Medical history			
Type 2 diabetes[b]	4 (13.3%)	7 (24.1%)	0.287
Hypertension[b]	9 (30.0%)	5 (17.2%)	0.249
Dyslipidemia[b]	3 (10.0%)	3 (10.0%)	0.965
GERD[b]	9 (30.0%)	4 (13.8%)	0.133
OSAS[b]	1 (3.3%)	4 (13.8%)	0.149
COPD[b]	2 (6.7%)	0	0.157
Major abdominal surgery[b]	1 (3.3%)	3 (10.3%)	0.284
Current smoker[b]	5 (16.7%)	4 (13.8%)	0.573
LOS (> 1 night)[b]	7 (23.3%)	2 (6.9%)	0.079
Morbidities[b]	2 (6.7%)	1 (3.4%)	0.511
Complications < 30 days[b]	4 (13.3%)	3 (10.3%)	0.613
Perioperative complications[b]	2 (6.7%)	1 (3.4%)	0.574

Values are mean ($\pm$ SD) or absolute number (percentage). *GERD* gastroesophageal reflux disease, *OSAS* obstructive sleep apnea syndrome, *COPD* chronic obstructive pulmonary disease, *LOS* length of stay in hospital

[a] p values were measured using Mann-Whitney U test

[b] p values were measured using Pearson Chi-square test

Table 2 The comparison resident to EBS

Steps of the operation	Number of procedure resident	Average time of the resident	Average time of the surgeon	Ratio	Progression
Step 1	21	12.82 (± 4.08)	6.93 (± 2.58)	1.85	− 0.291 (4.76%)
Step 2	16	7.43 (± 2.11)	4.48 (± 2.02)	1.66	− 0.313 (6.25%)
Step 3	18	12.60 (± 3.31)	6.31 (± 2.53)	2.00	− 0.271 (5.56%)
Step 4	15	7.12 (± 2.31)	4.22 (± 1.60)	1.69	− 0.290 (6.67%)
Step 5	26	13.93 (± 3.81)	8.51 (± 3.37)	1.64	− 0.107 (3.85%)
Total operation	15	61.15 (± 8.74)	36.22 (± 9.06)	1.69	− 0.251 (6.67%)

Average time is in minutes (± SD) and progression is in minutes (%). *Step 1*, creation of the gastric pouch; *step 2*, identification of the ligament of Treitz, measuring the biliopancreatic limb and creating the stapled gastrojejunostomy; *step 3*, laparoscopic suture closure of the linear stapled gastrojejunal anastomosis; *step 4*, measuring the alimentary limb and creating the stapled jejunojejunostomy; *step 5*, laparoscopic suture closure of the linear stapled jejunojejunal anastomosis
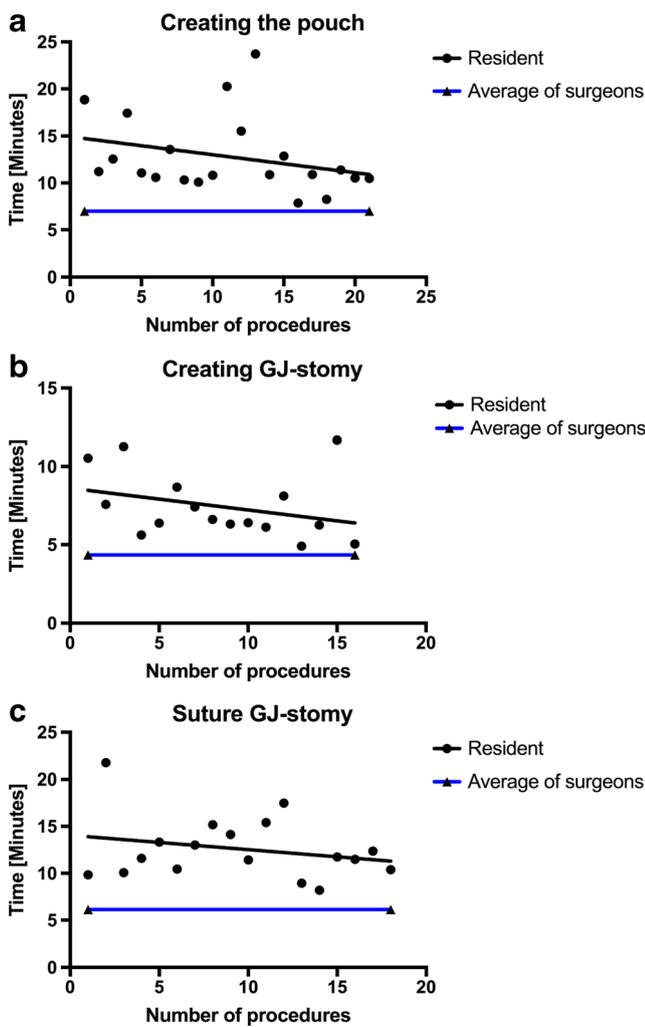

Fig. 1 **a–f** The times of the resident (dots with the black line) compared to the average time of the experienced bariatric surgeons (triangles with the blue line). **a** Creating the gastric pouch. **b** Identification of the ligament of Treitz, measuring the biliopancreatic limb and creating the stapled gastrojejunostomy. **c** Laparoscopic suture closure of the linear stapled gastrojejunal anastomosis. **d** Measuring the alimentary limb and creating the stapled jejunojejunostomy. **e** Laparoscopic suture closure of the linear stapled jejunojejunal anastomosis. **f** The total operation

Fig. 1 continued.

(3.85%)). However, this step was also the step with the best EBS-resident ratio (1.64). Step 3, laparoscopic suture closure of the linear stapled gastrojejunal anastomosis, was the step with the highest ratio (2.00). Figure 1 and Table 2 demonstrate the results of the resident compared to the EBS.
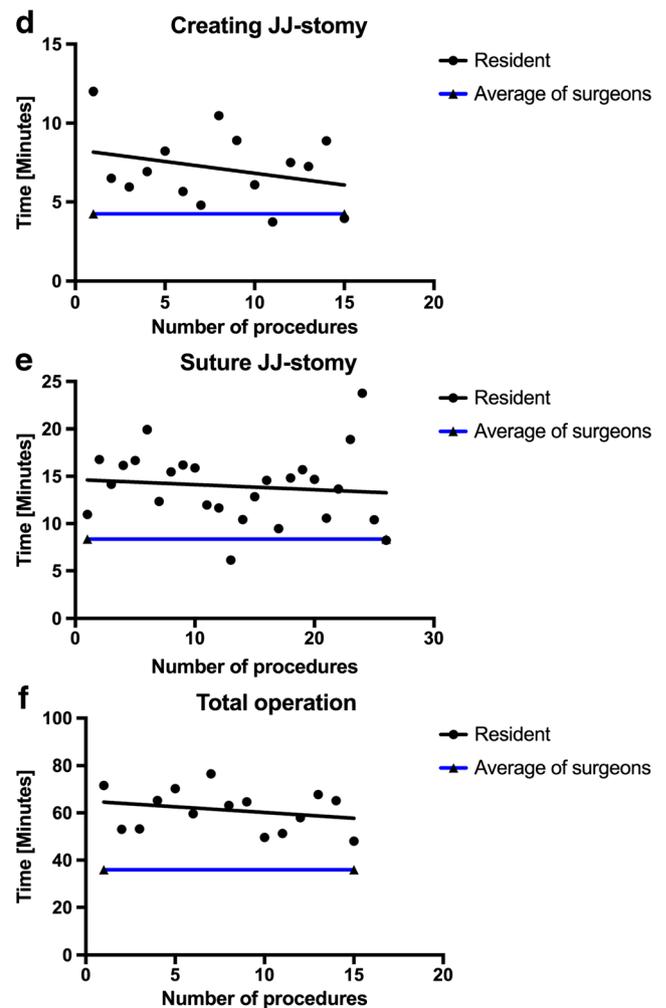
Discussion

To our knowledge, this is the first study that investigates the learning curve of different surgical steps of a LRYGB. Iordens et al. investigated the same LRYGB-procedures with three separate steps, but only looked at the total duration of the operation [27]. The present study showed a stepwise approach for surgical residents who want to learn a LRYGB as safe and efficiently as possible. The increasing number of morbid obese patients worldwide creates a high demand for bariatric surgery. Therefore, the interest for bariatric training programmes and fellowships increases. Fellowship programmes have proven to significantly eliminate the learning curve without the increase of perioperative complications [28]. However, most of the studies have focused on already certified surgeons. Our clinic is a high-volume bariatric centre with between 900 and 1000 procedures a year and ideal to learn the LRYGB procedure step by step. We wanted to show the learning curve of every surgical step in LRYGB.

The significant differences in the baseline characteristics between the group of the resident and the EBS can be explained by the low number of patients in both groups and the fact we randomly chose the procedures. No significant differences were seen in perioperative complications or postoperative complications within 30 days, which is in accordance with current literature [28].

Figure 1 demonstrates the performance of the resident and the experienced surgeons. The first step was creating the pouch; the average time of the resident was 1.85 times longer. However, in the video analysis, the resident used the stapler more frequently; sometimes four or even five times instead of three times as usually done by the EBS. The use of every new stapler takes more time, which increases the duration of creating the pouch. It is hard to estimate the length of the pouch with the stapler machine, so sometimes you have to use the stapler an extra time. More experience with the use of the stapler can reduce the duration of step 1. Suturing the gastrojejunostomy was one of the most difficult parts in the program; the average time for the resident was twice as long compared to the EBS. However, laparoscopic suturing can be practiced in many different ways, like a simulator training, and with practice the duration will improve over time [29]. Most improvement was seen in step 4, creating the jejunojejunostomy, with 15 procedures and an improvement of − 0.290 min (6.67%) each time. The last step (suturing the jejunojejunal anastomosis) was in relation to the EBS, the step with the highest progression. For this step, the ratio was 1.64 and the learning curve of the resident came closest to the EBS. Lastly, the total operation had a ratio of 1.69, and this will decrease over time after doing more operations in total.

This study has several limitations. The main limitation of this study is its selection bias, with the use of one resident. In future studies, this stepwise training program could be studied with multiple residents. The present training program was performed in a training environment, occasionally intervention by an EBS was necessary. The resident was able to perform the full LRYGB by himself at the end of the program, but always supervised by an EBS. Another limitation of this study is the focus on a time-based learning curve.

In conclusion, our stepwise training program results in a fast and efficient way to approach the learning curve of the experienced bariatric surgeons. Within this program, the total time of the operation will be kept low and the operation will be less intensive for the patients. The results of this study could act as a guideline for the development of such a training program.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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