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REVIEW

Training Programs Influence in the Learning Curve of Laparoscopic Gastric Bypass for Morbid Obesity: A Systematic Review

Raquel Sánchez-Santos · Sergio Estévez · Catherine Tomé · Sonia González · Antonia Brox · Raul Nicolás · Rosario Crego · Miguel Piñón · Carles Masdevall · Antonio Torres

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Abstract The makeup of a new surgical bariatric team may be associated with a higher number of postoperative complications due to the learning curve. The aim of this study was to evaluate the outcomes during the learning curve of laparoscopic gastric bypass (LGBP) depending on surgeons' training. A systematic approach was used to review studies from the Pubmed, Embase (Ovid), Cancer Lit, Biomes Central via Scirus, Current Contens (ISI), and Web of Science (SCI) databases. Two reviewers independently screened all titles/abstracts and included/excluded studies based on full copies of manuscripts. The outcomes included were: specific training of the surgeon, postoperative complications (leaks, occlusion, hemorrhage, pneumonia, etc.), mortality, and surgical technique. One reviewer put data onto an Excel spreadsheet. Statistical analysis was performed with weighted linear regression. We identified 448 citations, of which 120 abstract and 50 full-text publications were reviewed. Fourteen papers were selected. Data from 1,848 patients were included. Eighteen different surgeons were analyzed during their learning curve (including the first author of this study). Surgeons were divided into two groups: (1) without formal laparoscopic bariatric training (13 surgeons) and (2) with formal laparoscopic bariatric training (five surgeons). Postoperative complications were more frequent in group 1: 18.1% (±7.6) vs. 7.7% (±1.96, $p=0.046$); also, mortality was more frequent in group 1: 0.57% (±0.87) vs. 0% ($p=0.05$). An appropriated training in laparoscopic bariatric surgery contributes to a significant reduction in postoperative complications and mortality during the learning curve of LGBP.

Keywords Bariatric surgery · Training programs · Learning curve · Systematic review

R. Sánchez-Santos · S. Estévez · C. Tomé · S. González · A. Brox · R. Nicolás · R. Crego · M. Piñón
Servicio de Cirugía General y Digestiva,
Complejo Hospitalario Pontevedra,
Pontevedra, Spain

R. Sánchez-Santos (✉)
Servicio de Cirugía General y Digestiva, Hospital Montecelo,
C/Mourente s/n,
36161 Pontevedra, Spain
e-mail: raquelsanchezsantos@gmail.com

C. Masdevall
Hospital de Bellvitge,
Barcelona, Spain

A. Torres
Hospital Clinico San Carlos,
Madrid, Spain

Introduction

The prevalence of morbid obesity has experienced an exponential growth over the last few years [1]. Surgical treatment is the only effective method to improve life span and enhance the comorbid conditions of these patients [2–5]. Due to the latter, bariatric surgery is in great demand and a high number of experienced surgeons are needed. Laparoscopic gastric bypass (LGB) can be a technically challenging operation, and surgeons must master the technique in order to provide a safe surgery and must perform long-term follow-up on the patient. Surgeons must overcome a long learning curve before mastering LGB; some authors estimate that 75–120 procedures are needed to achieve optimum postoperative outcomes [6–9]. During the learning curve, the complication rate can be even two to three times higher

than suspected [8, 10]. There is great concern in the scientific community about the training of bariatric surgeons [11, 12]. IFSO and ASMBS guidelines recommend a formal bariatric training, consisting of 2-day courses, mini-fellowship programs, and a mentoring process with the first cases under the supervision of an experienced surgeon [13]. The Spanish Society of Surgery Obesity and Metabolic Diseases (SECO) has developed a new bariatric training program including theoretical and practical courses, a 2-month fellowship, and a mentoring process during the first 40 cases. Many surgeons who embark on laparoscopic bariatric surgery have not received formal bariatric training; however, they usually have had practical experience [14–16]. There is a lack of consensus about how much training is enough to master LGB.

In this study, we have compared postoperative outcomes during the learning curve of different surgeons to formal bariatric training and non-formal bariatric training.

Methods

Search Strategy

In order to find eligible studies for the systematic review, we searched Medline-Pubmed (1990–2009), Embase (Ovid) (1990–2009), Cancer Lit (1990–2004), Biomes Central via Scirus (1990–2009), Current Contents (1990–2009), and Web of Science (SCI) databases.

The following search strategy was used: with all terms mapped to the appropriate Mesh/EMTREE (subject headings: "gastric bypass" AND "learning curve" AND "laparoscopic"). No limits regarding language or publication type were applied. We also hand-searched personal files and the reference list of relevant review articles. For all articles included in the systematic review, we reviewed the reference lists.

Study Selection

Two reviewers independently screened all titles/abstracts and included/excluded studies based on full copies of manuscripts to select eligible studies for review. All citations selected by either author or abstract review were included, and subsequent disagreement regarding eligibility was resolved by consensus.

Studies were selected for review if they included: (1) specific information about the training of the surgeon previous to the learning curve and (2) all the outcome variables: postoperative complications (leaks, occlusion, hemorrhage, pneumonia, etc.), mortality, and surgical technique. Only the papers containing complete information about the considered variables were included.

Data Collection, Synthesis, and Study Quality

For each eligible study, two authors independently measured baseline variables (leaks, occlusion, hemorrhage, stenosis, pneumonia, embolism, other postoperative complications, mortality, surgical technique, hospital stay, etc.). Regarding surgical training, a bariatric training was considered to be formal when theoretical courses, fellowship, and a mentoring program were conducted (with mentoring being the most important). Differences were resolved by consensus. One reviewer put data onto an Excel database.

Analysis Strategy

Due to the limited number of studies included in the review and the fact that the rate of complications was low, we considered that there was not enough information recovered to perform a quantitative meta-analysis regarding each postoperative complication: leaks, hemorraghe, oclusion, tromboembolism... Global rate of postoperative complications and mortality were selected as the main variables for quantitative analysis. A meta-analysis of weight mean differences using a weighted linear regression was performed.

Results

Search Results and Study Characteristics

We identified 448 citations, of which 120 abstract and 50 full-text publications were reviewed. We have included one report accepted for publication with the personal experience of the first author. A total of 14 reports describing 18 learning curves of different surgeons were eligible for the review. Of the 14 independent studies reviewed, five were conducted in the USA, two in the UK, three in Spain, one in Mexico, one in Taiwan, one in Norway, and one in Switzerland. Data from 1,848 patients who underwent LGB were analyzed. Surgeons were divided into two groups: group 1—those without formal laparoscopic bariatric training (13 surgeons) and group 2—those with formal laparoscopic bariatric training (including the mentoring by an experienced bariatric surgeon, five surgeons).

Learning Curve

The average number of LGB that surgeons in the study subjectively considered enough to overcome the learning curve ranged from 75 to 152 (mean 102.67±18.43, Table 1). There

Table 1 Demographic data

	N	Sex (female, %)	Age	BMI
Group 1				
Schauer et al. [8]	100	74	44.5	>55 (21%)
Shikora et al. [10]	100	98	39	44
Huang et al. [15]	100	66	31.2±7.2	43±7.5
Ballesta et al. [30]	100	62	39	45.3
Suter et al. [14]	107	76.6	39.7 (19–58)	–
Hsu et al. [6]	95	81	43	50.6
Sovik-2 et al. [24]	152	80	39.4±9.2	46.7±5.6
Pournaras et al. [16]	100	78.7	44.2±10.4	50±6.7
Sovik et al. [24]	140	71	40.5±9.8	46.7±5
Oliak et al. [35]	75	83	39 (14–60)	46 (35–65)
Breaux et al. [44]	107	91.7	44±11	49±6
Stoopen-margain et al. [23]	100	63	31±5	50±9
Lublin et al. [9]	100	83	42 (18–67)	48.7 (36–68)
Group 2				
Abu-hilal et al. [34]	100	90	42 (19–64)	46 (26–63)
Sanchez-Santos et al. [40]	109	85.8	38.2±9.97	49.1±6.6
Oliak-2 et al. [35]	75	77	40 (24–64)	49 (37–86)
Hsu-3 et al. [6]	88	90	42	45.2
Hsu-2 et al. [6]	100	87	41	45.6

were differences between groups. Those without formal bariatric formation required an averaged 105.85±19.59 LGB and an average of 94.4±13.16 for those with formal training ($p<0.005$). Formal training with mentoring by an experienced bariatric surgeon reduces by more than 10 cases the number of LGB needed to overcome the learning curve.

Training Evaluation

All surgeons mentioned previous experience in advanced laparoscopic surgery.

Surgeons without formal training did not go through a mentoring program. Three of them attended 2-day courses in laparoscopic bariatric surgery

Only the five surgeons included in group 2 followed a mentor-initiated program with an experienced bariatric surgeon (Table 2).

Postoperative Complications and Mortality

The postoperative complication rate for those without formal training was 18.1±7.6% vs. 7.7±1.96% for those with ($p=0.046$, Table 2). A 0.57±0.87% difference was noted in the mortality rate of LGB operated by non-formally vs. formally trained surgeons ($p=0.05$).

Although differences did not reach statistical significance, we can observe a higher incidence of leaks (3.28±2.75% vs. 1.56±1.5%), stenosis (3.2±3.32% vs. 0.36±0.064%), and occlusion (3.15±1.67% vs. 1.37±1.1%) in group 1 (Table 2). Nevertheless, there were no differences between groups in mean hospital stays (3.40±0.97 vs. 3.5±1.18 days).

Discussion

Over the last several years, there has been a great concern about the ideal characteristics of bariatric centers and bariatric surgeons. In 2006, The Bariatric Training Committee of the ASMBS published the guidelines for granting privileges in bariatric surgery [17]. Also, in 2007, the IFSO guidelines for safety, quality, and excellence in bariatric surgery were published [18]. Surgeons are recommended to work at an accredited facility within a multidisciplinary team [11]. To be proficient at ASMBS, surgeons need to document 100 bariatric procedures, 50 of those as the primary surgeon with satisfactory outcomes from residency and/or fellowship under the supervision of an experienced surgeon [19]. This is the most difficult point to achieve in surgeons training in other countries different from the USA [20]. The fellowship bariatric program was not well established in Spain or other European countries. Because of this, the SECO developed a bariatric training program with the aim of offering a mentor-initiated approach to bariatric surgery for Spanish Surgeons (SECO Training Program). This program started in 2009; surgeons previously underwent very diverse ways of training before starting their bariatric cases (Tables 3 and 4).

Table 2 Training of different surgeons before their LGB learning curve

	Fellowship (laparoscopic bariatric surgery)	Training in a highly experienced center in bariatric surgery and supervision of an expert surgeon	Theoretical and practical courses in bariatric surgery	Fellowship (laparoscopic surgery)	Experience in open bariatric surgery	Experience in laparoscopic surgery	Specific training
Group 1							
Schauer et al. [8]	−	−	−	−		+	−
Shikora et al. [10]	−	−	−	−		+	−
Huang et al. [15]	−	−	−	−		+	−
Ballesta et al. [30]	−	−	−	−	+	+	−
Suter et al. [14]	−	−	−	−		+	−
Hsu et al. [6]	−	−	−	−		+	−
Sovik-2 et al. [24]	−	−	−	−	−	+	−
Pournaras et al. [16]	−	−	+	−	−	+	−
Sovik et al. [24]	−	−	−	−	+	+	−
Oliak et al. [35]	−	−	+	−		+	−
Breaux et al. [44]	−	−	+	+		+	−
Stoopen-margain et al. [23]	−	−	−	−		+	−
Lublin et al. [9]	−	−	−	−		+	−
Group 2							
Abu-hilal et al. [34]	−	+	+	−	−	+	+
Sanchez-Santos et al. [40]		+	+	+	+	+	+
Oliak-2 et al. [35]	+	+	+	−		+	+
Hsu-3 et al. [6]	−	+	−	+		+	+
Hsu-2 et al. [6]	+	+	+	−		+	+

Table 3 Morbidity and mortality

	Year	*N*	Mortality (%)	Morbidity (%)
Group 1				
Schauer et al. [8]	2002	100	0	36
Shikora et al. [10]	2005	100	1	26
Huang et al. [15]	2007	100	0	24
Ballesta et al. [30]	2005	100	1	21
Suter et al. [14]	2003	107	0.9	20
Hsu et al. [6]	2005	95	0	20
Sovik-2 et al. [24]	2008	152	0	15.1
Pournaras et al. [16]	2009	100	0	15
Sovik et al. [24]	2008	140	0	14.3
Oliak et al. [35]	2004	75	2.6	13
Breaux et al. [44]	2007	107	0	13
Stoopen-margain et al. [23]	2004	100	2	10
Lublin et al. [9]	2005	100	0	8
Group 2				
Abu-hilal et al. [34]	2007	100	0	10
Sanchez-Santos et al. [40]	2009	109	0	9.1
Oliak-2 et al. [35]	2004	75	0	8
Hsu-3 et al. [6]	2005	88	0	6.8
Hsu-2 et al. [6]	2005	100	0	5

Table 4 Postoperative complications

	N	Leaks (%)	Hemorrhage (%)	Occlusion (%)	Stenosis (%)	Other (%)	Total complications
Group 1							
Schauer et al. [8]	100	7	2		6	19	36
Shikora et al. [10]	100	3		5		18	26
Huang et al. [15]	100	4	3		10	7	24
Ballesta et al. [30]	100	9				18	21
Suter et al. [14]	107	4.6		2.8		12.6	20
Hsu et al. [6]	95	4.20	1	6.30	1	7.5	20
Sovik-2 et al. [24]	152	2.6	5.26		0.65		15.1
Pournaras et al. [16]	100	5	5	2	1	2	15
Sovik et al. [24]	140	0	6.42		0	7.88	14.3
Oliak et al. [35]	75	1.3	5.3	1.3		5.1	13
Breaux et al. [44]	107	0		2.8	1.9	8.3	13
Stoopen-margain et al. [23]	100	0	0	2	4	4	10
Lublin et al. [9]	100	2		3	1	2	8
Group 2							
Abu-hilal et al. [34]	100	3				7	10
Sánchez-Santos et al. [40]	109	1.8	2.8	1.8	0	2.7	9.1
Oliak-2 et al. [35]	75	0	4	2.60		1.4	8
Hsu-3 et al. [6]	88	0	0	1.1	1.1	4.6	6.8
Hsu-2 et al. [6]	100	3	0	0	0	2	5

The rapid assimilation of laparoscopy in bariatric surgery has resulted in a higher incidence of complications, especially early in a surgeon's learning curve [9, 21–25]. LGB needs advanced laparoscopic skills to be performed, and with obese patients, difficulty is increased because of the huge amount of abdominal fat, the liver size, and the thickness of the abdominal wall [7, 26–28]. We believe that adequate training can improve the postoperative outcomes in bariatric surgery, but we found little evidence in the literature to support this affirmation. Most of the published papers are cohort studies and descriptive series [29–33]. We performed a systematic review of the literature to better know the influence of specific bariatric training (BT) in the postoperative outcomes during the learning curve for LGB.

In order to evaluate the possible impact of the SECO Training Program on the learning curve of future bariatric surgeons, we divided surgeons training' into two groups: those with similar training to the SECO Training Program (theoretical courses, practicing in experimental laboratory, and mentor-initiated program with an experienced bariatric surgeon) and the other group without mentoring by an experienced bariatric surgeon.

The systematic review of the influence of specialized bariatric training in the postoperative outcome in 1,848 bariatric patients has three major findings. First, global morbidity is significantly lower in the group with specific bariatric training. Second, mortality is also diminished in the BT group. Third, the number of patients needed to master LGB was significantly lower in the BT group.

The results of our systematic review show that the mentoring program with an experienced bariatric surgeon significantly reduces the complication rate in the first cases of a new bariatric surgeon, being on a level with those of the experienced groups [32, 34]. The same conclusion is derived from the work to assess the impact of bariatric surgery fellowship that takes place in the USA [6, 19, 20, 35].

The supply of courses of 1–2 days where real-time surgeries are displayed in order to learn the technical details of laparoscopic gastric bypass has increased [30, 36–38]. However, attendance at such short courses may not be enough to ensure the acquisition of necessary technical skills to perform a technique that required the manipulation of structures in various quadrants and intracorporeal sutures in patients with large intra-abdominal fat, frequent hepatomegaly, and very thick abdominal wall. As Scott et al. [39] described, most of those attending these courses considered them as insufficient to prepare the surgeon to perform the LGB. In many cases, the consequences of poor training have been disastrous, as demonstrated in studies based on Medicare [25] which show that mortality is higher than the accepted rate (almost five times higher) in centers with low volume and few experienced surgeons.

This systematic review has a number of methodological limitations. First, there is some bias in the original studies included. Patients were not risk-stratified in most of the studies; nevertheless, it is well known that super-obesity, male sex, and central obesity have postoperative complications more frequently [40, 41]. Despite the increased scrutiny associated with bariatric procedures and the recommendation of ASMBS and IFSO to trainees, which might favor operating on lowest risk individuals only in the learning curve, there were high-risk patients in the analyzed series [17, 18, 42]. The inability to risk-stratified patients does not allow for the accurate comparison of outcomes among surgeons [13].

Also, the technique has been demonstrated as a risk factor of complications, and malabsortive techniques as duodenal switch or biliopancreatic diversion have been associated with higher morbidity than lap-band or LGB [41, 43]. However, this review only considered studies related to LGB and provide a general understanding of morbidity in the learning curve of only one bariatric technique.

Second, there is a lack of prospective randomized studies about this subject. We only found cohort studies and descriptive series. Because of this, we were not able to perform a proper statistical meta-analysis to determine the real influence of bariatric training in postoperative outcomes. Only a weighted linear regression was performed to better know the prevalence of general morbidity and mortality in each group.

Risk adjustment strategies and prospective randomized studies are needed in future to better understand the "surgical training" relationship with outcome in bariatric surgery.

In spite of methodological limitations, reports were consistent between them and systematic review results are consistent with most of the studies and with the consensus status.

Regarding the number of patients needed to overcome the learning curve, we must be cautious about making conclusions. The authors in the reviewed manuscripts considered their learning curve between 75 and 152 patients in order to publish their postoperative outcomes retrospectively. However, perhaps this result would have been different in a prospective study with an independent observer. In our review, bariatric training with mentoring by an experienced bariatric surgeon reduces by more than 10 cases the number of LGB needed to overcome the learning curve. Although this difference reached statistical significance, the clinical significance may not seem so important because a larger separation would be expected. Prospective studies with independent and homogeneous external evaluation would be needed to better assess this item.

However, we cannot forget that there is some variability in the learning capacity of each surgeon, his technical ability, and previous experience in laparoscopic surgery [44–46]. Undoubtedly, some surgeons require less practice than others to master a technique, and those who have experience in laparoscopic gastric surgery and usually perform intracorporeal sutures have less difficulty in performing bariatric surgery techniques, both mixed and complex [26, 32, 47–50]. However, scientific society recommendations should be oriented to the most common type of surgeon who decides to start in laparoscopic bariatric surgery and usually has experience in laparoscopic surgery (Nissen fundoplication, splenectomy, etc.), but requires more specific training to safely perform the first cases of LGB. Although the choice of 1-year fellowship seems the best option to ensure adequate training for a bariatric surgeon, it is not operational because the absence of official government programs in most countries makes it difficult to universalize [6, 19, 20, 35]. As described in the article of Schimer et al. [13], a stay of 6 weeks of training with active participation in the activity of a high-volume unit of bariatric surgery and with extensive experience and the mentoring during the first cases may be sufficient to provide adequate training for selected groups of surgeons who have already received other theoretical and practical courses in the past.

The systematic review that we have done is a boost to the SECO Training Program as it shows that training influences significantly postoperative outcomes by reducing morbidity, mortality, and the number of cases to master the technique.

Conclusion

In conclusion, our systematic review of 14 studies including the learning curve of 18 surgeons involving 1,848 patients demonstrated that specific bariatric training with mentoring by an experienced bariatric surgeon improves the laparoscopic gastric bypass outcome during the learning curve. A specific bariatric training program with mentor-initiated approach can enable well-selected practicing surgeons to successfully implement laparoscopic gastric bypass with similar outcomes to published series.

Risk adjustment strategies and prospective randomized studies are needed in the future to better understand the "surgeon training" relationship with the outcome in bariatric surgery.

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