Surg Endosc (2015) 29:2278–2283
DOI 10.1007/s00464-014-3942-7

Outcomes of linear-stapled versus hand-sewn gastrojejunal anastomosis in laparoscopic Roux en-Y gastric bypass

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Received: 22 June 2014 / Accepted: 7 October 2014 / Published online: 8 November 2014

Abstract

Background In laparoscopic Roux en-Y gastric bypass (LRYGB), the gastrojejunal anastomosis (GJA) may be performed using linear-stapled (LS) or completely hand-sewn (HS) techniques. No published study has compared operative and clinical outcomes following LS and HS LRYGB when performed by surgeons beyond the learning curve. This study examined outcomes of both techniques performed by two 'technique-specific' bariatric fellowship-trained surgeons.

Methods Data on consecutive primary LRYGB undertaken in two university hospitals were prospectively collected over 28-months and included demographics, co-morbidities, postoperative morbidity, mortality, length of stay (LOS), reoperations, and excess weight loss (EWL). Data were presented as mean ± SD.

Results There were 366 LRYGB studied (LS = 144 and HS = 222 patients) with 96 % 12-month follow-up. All procedures were completed laparoscopically with no anastomotic leak or mortality. The LS cohort had a lower body mass index (48.3 ± 5.0 vs 53.8 ± 7.1, $P < 0.001$), greater incidence of diabetes mellitus ($P = 0.009$) and sleep apnea ($P = 0.007$). The HS cohort had more patients in Obesity Surgery Mortality Risk Score classes B and C ($P = 0.004$ and $P = 0.01$), and shorter operating time (127 ± 30 vs 172 ± 30 min, $P < 0.001$). There were no differences in LOS, complications, or reoperations. The HS technique was associated with more GJA stenoses requiring endoscopic dilatation (7.7 vs 0 %, $P < 0.001$). At 12 months, EWL (%) was comparable between the two techniques (LS 71.0 ± 15.5 vs HS 66.5 ± 13.7, $P = 0.09$).

Conclusions When performed by 'technique-specific' surgeons, both LS and HS GJA in LRYGB may be performed safely with no significant differences in morbidity, reoperations, or EWL.

Keywords Morbid obesity · Linear-stapled · Hand-sewn · Anastomosis · Bypass · Outcomes

Laparoscopic Roux en-Y gastric bypass [LRYGB] is the commonest procedure performed worldwide for the treatment of morbid obesity, contributing to approximately 46 % of all procedures [1]. LRYGB results in sustained weight loss, resolution of obesity-related co-morbidities, and reduced long-term mortality [2, 3]. While the operative principles underlying LRYGB remain consistent, the technique utilized to perform the gastrojejunal anastomosis

Agrawal and Ahmed are joint senior authors.
Preliminary data were presented at the 4th Annual Conference of the British Obesity and Metabolic Surgery Society (BOMSS), Glasgow, January 2013 and were published in abstract form in British Journal of Surgery 2013; 100 (S3): p 20 (1–22). The final data were presented at the 18th World Congress of International Federation for the Surgery of Obesity & Metabolic Disorders (IFSO), Turkey, Aug 13 and were published in abstract form in Obesity Surgery 2013; 23(8): p 1068 (1017–1243).

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(GJA) varies among surgeons. This anastomosis is of crucial importance due to the attendant high morbidity associated with it, such as postoperative leak (0–6.6 %) [4], marginal ulceration (0–8 %) [4, 5], and stenosis (0–33 %) [4, 6]. The GJA is usually fashioned using a circular-stapled (CS [7]), linear-stapled (LS [8, 9]), or completely hand-sewn (HS [10]) technique. Proponents of each approach cite technique-specific advantages: a more consistent size of GJA with CS [11], an anastomosis less prone to stenosis with LS [12], while the HS technique is considered cheaper to perform [13] but is thought more technically demanding [6]. Only two published studies permit a direct comparison of the LS versus HS techniques [6, 13], but these series were limited by small numbers of procedures that were performed early in the learning curve. No published study has compared operative and clinical outcomes following LS and HS LRYGB performed by surgeons beyond the learning curve. This study compared operative and clinical outcomes of LS versus HS GJA in LRYGB performed by two 'technique-specific' fellowship-trained surgeons who were beyond their learning curve.

Materials and methods

This study prospectively collected data on consecutive primary LRYGB performed by two bariatric surgeons since their consultant appointment at two bariatric centers in the United Kingdom (UK). Both surgeons were appointed after completion of one year of bariatric fellowship training. One consultant (S.Ag) exclusively utilized the LS technique to perform the GJA and collected data from 26 April 2010 to 30 May 2012 (25 months). The other (J.A) solely utilized a HS technique and collected data from 17 Sept 09 to 30 May 12 (32.5 months). The study was approved by the appropriate hospital regulatory bodies. Recorded data included patient demographics, co-morbidities, Obesity Surgery Mortality Risk Score (OSMRS) [14], operative time, postoperative morbidity, mortality, length of hospital stay (LOS), reoperations, and excess weight loss (EWL). The last date for inclusion of patients into this study was 30 May 2012 to allow patients a minimum follow-up period of 12 months.

Operative technique

Both centers employed a preoperative low carbohydrate low calorie (800 kCal/day) diet to reduce liver size and improve intraoperative exposure. LS LRYGB was performed as previously described [15]. In brief, an isolated lesser curve-based (approx. 15–20 ml) gastric pouch was created using a 30F orogastric tube and either a retrocolic or antecolic-antegastric Roux limb fashioned (100 cm for body mass index [BMI] ≤40 kg/m^2 or 150 cm for BMI >40 kg/m^2) with a 25 cm biliopancreatic limb. The Echelon Flex™ 45 (blue) linear stapler (Ethicon EndoSurgery™, Berkshire, UK) was used to fashion the GJA, the enterotomy of which was subsequently hand sewn (3/0 Monocryl®, Ethicon, Livingston, UK) over the 30F orogastric tube. A methylene blue dye leak test via the orogastric tube was routinely performed. HS LRYGB was undertaken with few modifications of the retrocolic-antegastric technique described by Higa et al. [16]. A 30 cm biliopancreatic limb and 100 cm Roux limb were fashioned allowing a side-to-side linear-stapled jejuno-jejunostomy. A vertical lesser curve-based gastric pouch (approx. 20 ml) was constructed and sized using a 34F orogastric tube. The HS GJA was performed using a running 2/0 Vicryl® (Ethicon, Livingston, UK) suture (2 layers posteriorly and a single layer anteriorly) sized over the orogastric tube. This resulted in a gastroenterostomy diameter of approximately 12–14 mm. An intraoperative air/methylene blue leak test was performed at the end of the procedure, and additional sutures were placed in the presence of an abnormal intraoperative leak test. Both surgeons sutured the jejuno-jejunostomy mesenteric, Petersen, and mesocolic defects routinely, as appropriate.

Postoperative pathway

In both centers, a fast-track recovery pathway was employed that permitted sips of water on the evening of surgery, mobilization within 4 h of surgery, chest physiotherapy, and commencement of oral fluids on the first postoperative day. Nasogastric tubes and urinary catheters were not utilized in either center. Abdominal drains were routinely utilized in the LS cohort. Patients were deemed fit for hospital discharge on days 1–3 postoperatively if they were clinically stable (normal postoperative physiological observations and bloods), tolerated adequate fluid intake (aiming for 1.5 L/day) and were fully mobile. Patients were discharged on proton pump inhibitor, multivitamin and mineral supplements, analgesics, laxatives, and enoxaparin.

Statistics

Data were analyzed using IBM SPSS Statistics® for Mac v21 software (IBM SPSS Statistics, Feltham, UK). Data were presented as mean ± SD or median (interquartile range, IQR) as appropriate. The OSMRS was calculated as previously prescribed [14]. The unpaired samples t test, Mann–Whitney or Fisher's exact tests were used to compare differences between study groups, as appropriate, and significance was considered at $P < 0.05$.

Table 1 Demographic details of patients undergoing linear-stapled (LS) *vs* hand-sewn (HS) gastrojejunal anastomosis in laparoscopic Roux en-Y gastric bypass

	LS group	HS group	*P* Value
Number of patients	144	222	
Age, (mean ± SD, years)	45.4 ± 9.6	46.9 ± 10.4	0.227
Body mass index, (mean ± SD, kg/m^2)	48.3 ± 5.0	53.8 ± 7.1	<0.001
Female, (%)	110 (76 %)	157 (71 %)	0.278
Hypertension, (%)	77 (54 %)	97 (44 %)	0.070
Diabetes mellitus, (%)	72 (50 %)	80 (36 %)	0.009
Sleep apnea, (%)	55 (38 %)	55 (25 %)	0.007
Gastroesophageal reflux disease, (%)	39 (27 %)	62 (28 %)	0.905
Previous thromboembolic disease, (%)	3 (2 %)	8 (4 %)	0.538
Obesity Surgery Mortality Risk Score (OSMRS, %)			
• Class A	68 (47 %)	62 (28 %)	<0.001
• Class B	69 (48 %)	131 (59 %)	0.042
• Class C	7 (5 %)	29 (13 %)	0.011
Operative approach			
• Retrocolic-antegastric	101	221	
• Antecolic-antegastric	43	1	
Operative time, mean ± SD, min	172 ± 30	127 ± 30	<0.001
Length of hospital stay, mean ± SD, days	2.4 ± 0.9	2.3 ± 1.5	0.294

Results

During the study period, 366 consecutive primary LRYGB (LS = 144 and HS = 222) were performed and included in the analyses. Baseline demographic details are shown in Table 1. Compared to the HS group, the LS cohort had lower body mass index (BMI, $P < 0.001$) and more patients with type II diabetes ($P = 0.009$) and sleep apnea ($P = 0.007$). There were greater numbers of patients in OSMRS groups B ($P = 0.04$) and C ($P = 0.01$) in the HS cohort. Mean operative time was shorter in the HS group ($P < 0.001$). Details of complications and reoperations are given in Table 2. There were no anastomotic leaks or mortality in this series, and all procedures were successfully completed laparoscopically. There were no significant differences in the total number of complications during the index admission (LS 2.1 % vs HS 5.4 %, $P = 0.21$) or overall reoperations (LS 4.9 % vs HS 3.6 %, $P = 0.77$) on follow-up. However, significantly more patients in the HS group developed a GJA stricture that required endoscopic dilatation (HS 7.7 % vs LS 0 %, $P < 0.001$). Median (IQR) follow-up was 13.5 (9.0–20.8) and 12.0 (7.0–14.0) months for LS and HS groups, respectively. Data for EWL are shown in Fig. 1. EWL data were available for 139 (96.5 %) and 213 (96.0 %) patients in the LS and HS groups, respectively. Compared to the HS group, the LS group had a higher EWL in the first 3 postoperative months (40.7 % vs 31.0 %, $P < 0.001$), but there was equivalent EWL at the other follow-up time points (LS vs HS at 9–12 months: 71.0 % vs 66.5 %, $P = 0.09$; >12-months: 71.1 % vs 69.1 %, $P = 0.63$).

Discussion

This study was the first to compare operative and clinical outcomes following LS and HS LRYGB performed by 'technique-specific' fellowship-trained surgeons who were beyond the learning curve. A survey of 215 practicing surgeons (average 423 RYGB performed per surgeon) of the American Society for Bariatric and Metabolic Surgery (ASMBS) demonstrated 43, 41, and 21 % to utilize, respectively, the CS, LS, and HS GJA in LRYGB [17]. Three previous studies [4, 5, 18], all of which had major limitations, examined outcomes following CS *vs* LS *vs* HS GJA in LRYGB. Abdel-Galil et al. [18] studied 90 consecutive patients over a 2-year period who underwent CS (first 30 patients), then HS (next 30 patients), and then LS (final 30 patients) GJA. This retrospective small series employed 3 different procedures early in the learning curve and had relatively high anastomotic leak (6.6 %) and stenosis rates (up to 36.6 %). Gonzalez et al. studied 108 consecutive patients over a 2-year period with the first 87 patients undergoing HS, the subsequent 13 CS, and the final 8 patients undergoing LS GJA [5]. Patients were followed up for 3 months to determine complications related to the GJA, and clinical outcomes (EWL) were not described. There were small numbers in each group, and 3 different procedures were employed early in the learning curve. Bendewald et al. published the largest series to date, describing outcomes of 835 consecutive patients over a 5-year period [4]. There were 181 (21.6 %) HS, 514 (61.5 %) LS, and 140 (16.8 %) CS GJA performed with mean overall follow-up of 14.8 months. In this large series, comparative GJA leak rates were HS 1.1 % versus LS 1 % versus CS 0 %, stenosis rates were HS 6.1 % versus LS 6 % versus CS 4.3 %, and marginal ulcer rates were HS 7.7 % versus LS 8 % versus CS 3.6 % [4]. It was unclear if the 3 techniques performed were 'surgeon-specific' and whether procedures were performed early or late in the learning curve of respective surgeons. The study was also confounded by a postoperative 30-day course of PPI being prescribed only in LS and CS groups. Finally, the methodology of the multivariate analysis and EWL was not described.

Table 2 Morbidity following linear-stapled (LS) and hand-sewn (HS) gastrojejunal anastomosis (GJA) in laparoscopic Roux en-Y gastric bypass

	LS group ($N = 144$)	HS group ($N = 222$)	P value
Index admission complications	3 (2.1 %)	12 (5.4 %)	0.18
• Anastomotic leak	0	0	
• Bleeding (Hemoglobin drop, treated by transfusion only)	2	5	
• Deep venous thrombosis/pulmonary embolus	0	0	
• Radiologically confirmed intraabdominal collection	0	2	
• Chest infection	1	5	
Reoperations	7 (4.9 %)	8 (3.6 %)	0.60
Index admission	1 re-laparoscopy for bleeding 1 (negative laparoscopy for abdominal pain)*	1 re-laparoscopy for bleeding	
Post-discharge			
• Laparoscopic repair of internal hernia	3	2	
• Laparoscopic adhesiolysis	2	1	
• Re-laparoscopy (other causes)		1 repair gastro-gastric fistula, 1 washout abdominal collection, 1 excision excess hockey-stick at GJA, 1 laparoscopy for perforated ulcer**	
GJA stenosis	0	17 (7.7 %)	<0.001
Mortality	0	0	

* Patient had abdominal pain postoperatively who underwent laparoscopy to exclude an abdominal cause and was treated for chest infection. ** Perforated ulcer presented 3-months postoperatively and was located distal to GJA

There have been no published randomized studies comparing LS and HS LRYGB. Two previous case series have compared outcomes of LS versus HS LRYGB [6, 13]. Kravetz et al. described a single-surgeon series of 222 consecutive patients over a 3-year period [6]. Ninety-nine patients had LS GJA with the subsequent 123 undergoing HS GJA, and all patients were followed up for at least 8 months. There were comparable GJA leak rates (LS 1 % vs HS 0.8 %), but a higher stenosis rate was noted in the LS cohort (10.2 % vs 4.1 %). The early reoperation rate for both groups was 5 %. Finally, the HS group had a shorter operating time (128 min vs 160 min, $P < 0.001$) which suggests a 'learning curve' effect, as the HS procedures were undertaken subsequent to the LS cohort. This retrospective series did not describe the learning curve of the surgeons or EWL. The final study was a single-surgeon series of 104 consecutive patients over a 27-month period. LS GJA was performed in the first 51 patients, and the following 53 patients underwent HS GJA [13]. Revisional surgery constituted 27 % of the series. Both groups had

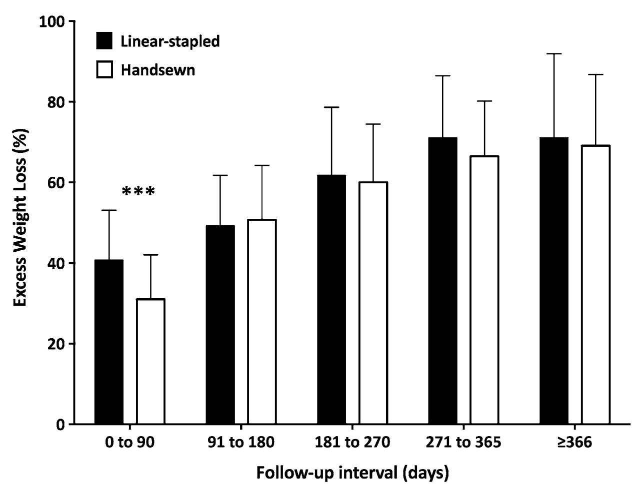

Fig. 1 Excess weight loss (EWL, %) for patients undergoing linear-stapled vs hand-sewn gastrojejunal anastomosis in laparoscopic Roux en-Y gastric bypass. EWL data were available for 139 (96.5 %) and 213 (96.0 %) patients in the LS and HS groups, respectively. For 0–90 days $P < 0.001$, for 91–180 days $P = 0.44$, for 181–270 days $P = 0.51$, for 271–365 days $P = 0.09$, and for $\geq$ 366 days $P = 0.63$

equivalent GJA leak (LS 2 % vs HS 1.9 %), stenosis (LS 2 % vs HS 1.9 %), 30-day reoperation rates (LS 7.8 % vs HS 5.6 %), and 12-month EWL (LS 66 % vs HS 70 %). The HS group had a shorter operating time (160 min vs 190 min, $P = 0.029$).

Our study differs from the aforementioned series in being the first to report both operative and clinical outcomes of LS *vs* HS GJA performed by 'technique-specific' surgeons who were beyond the learning curve. This permitted comparison of the two techniques without data being confounded by the learning-curve effect [19]. In our study, 0 % anastomotic leak, 2.1–5.4 % complication, and 3.6–4.9 % overall reoperation rates compared favorably with data from previous series [4, 6, 13]. Both techniques may therefore be utilized with equivalent effect as long as surgeons were appropriately trained in performing their respective technique. Although there was a significantly higher GJA stricture rate in our HS cohort (7.7 %), this was still in keeping with rates (6.1 %) reported by Bendewald et al. who described a similar technique and bougie size to perform the HS GJA [4]. The present study design did not allow detailed study of factors that may have been associated with increased GJA stenosis in the HS group. However, there were no differences in demographics, co-morbidities, or operative factors between patients who developed stenoses and those who did not. We have since adapted our HS technique to fashion a wider (18–20 mm) GJA to reduce the incidence of stenosis. Finally, both groups demonstrated similar EWL at 12 months, and this was in keeping with two other series who described this outcome [13, 18].

As the present study was a non-matched case series, there were differences in baseline demographics and co-morbidities between the two study groups. These have resulted from differences in UK regional bariatric surgery commissioning criteria which differed between the two centers. One center was permitted to undertake surgery only for patients with BMI $\geq$35 kg/m^2 in the presence of obesity-related co-morbidities (e.g., hypertension, diabetes, sleep apnea, or polycystic ovaries), while the other center was permitted to undertake surgery for patients with BMI $\geq$45 kg/m^2 in the presence of co-morbidities or $\geq$50 kg/m^2 without co-morbidities. These criteria resulted in the LS cohort having lower BMI and a greater proportion of patients with type II diabetes mellitus and sleep apnea. However, as all procedures were successfully completed laparoscopically, and the aim of the study was to examine differences in the technique of performing the GJA, it is unlikely that differences between the groups would have confounded study outcomes.

In conclusion, when performed by 'technique-specific' surgeons, both LS and HS GJA may be performed safely with no significant differences in morbidity, reoperations, or EWL in LRYGB. However, the HS technique was associated with significantly more GJA stenosis that required endoscopic dilatation.

Disclosures Awad undertook a national clinical bariatric fellowship (supported by an unrestricted educational grant from Ethicon Endo-Surgery to the host hospital) and has received educational support and travel grants from Ethicon EndoSurgery and Fisher & Paykel Healthcare. The other authors have no conflicts of interest to declare.

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