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REVIEW

Upper Gastrointestinal Series after Roux-en-Y Gastric Bypass for Morbid Obesity: Effectiveness in Leakage Detection. a Systematic Review of the Literature

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Abstract The aim of this study is to evaluate the results of routine and selective postoperative upper gastrointestinal series (UGIS) after Roux-en-Y gastric bypass (RYGB) for morbid obesity in different published series to assessing its utility and cost-effectiveness. A search in PubMed's MEDLINE was performed for English-spoken articles published from January 2002 to December 2012. Keywords used were upper GI series, RYGB, and obesity. Only cases of anastomotic leaks were considered. A total of 22 studies have been evaluated, 15 recommended a selective use of postoperative UGIS. No differences in leakage detection or in clinical benefit between routine and selective approaches were found. Tachycardia and respiratory distress represent the best criteria to perform UGIS for early diagnosis of anastomotic leak after a RYGB.

Keywords Upper gastrointestinal series · Swallow contrast study · Anastomotic leak · Bariatric surgery · Obesity · Roux-en-Y gastric bypass

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Introduction

Obesity has become an epidemic condition and is recognized as a social disease. [1]. Bariatric surgery has proven to be the most effective treatment for severe obesity when conservative treatments have failed [1, 2]. It has been recognized that surgically induced weight loss results in an improved quality of life, a reduction of obesity-related comorbidities, and a reduction in the overall mortality rate [1, 3]. Roux-en-Y gastric bypass (RYGB) has been proven to be a safe and effective procedure, being one of the most widely performed procedures worldwide [2]. However, it may also be associated with some postoperative complications, affecting short-term morbidity [4, 5]. One of the most serious complications is an anastomotic leakage, which usually occurs in 2–4.4 % of procedures [2, 4, 5].

Early diagnosis of anastomotic leak after a RYGB procedure is important in order to significantly reduce postoperative morbidity and mortality [8, 9]. The use of routine upper gastrointestinal series (UGIS) has been proposed as a useful tool for prompt detection of anastomotic leakage after RYGB [10, 11]. Contrariwise, its utility is still a literature debate due to the additional costs and possible lack of sensitivity [8, 12]. The aim of this study is to evaluate and assess the results of both routine and selective postoperative UGIS after RYGB for morbid obesity in different published series evaluating UGIS's utility and cost-effectiveness. In addition, possible recommendations are also discussed.

Materials and Methods

A research in PubMed's MEDLINE was performed for English-written articles published from January 2002 to December 2012 using the keywords *upper GI series*, *RYGB*, and

obesity. Following it was performed a search using the key words *routine OR selective postoperative upper GI series*, and *swallow contrast studies*. The first selection of articles was determined by the abstracts. Then a full-text copy of each relevant publication was obtained. A manual search in the reference lists of relevant articles was performed. As for the articles reporting a series of patients being operated using different bariatric procedures, only cases of RYGB (both open and laparoscopic) were considered. Any series reporting different procedures have been excluded if the data about UGIS regarding RYGB was insufficient or unclear. When multiple articles from the same institution were identified, only the most recent one reporting the highest number of patients was considered. Case reports were also excluded. The postoperative day of performed UGIS was calculated using the mean time indicated in the studies. A UGIS was considered "*routine*" if it was a planned procedure for each patient; whereas, a UGIS was considered "*selective*" if it was done due to the presence of clinical or laboratory pathological signs. The results of a UGIS were considered "negative" if no pathological findings were detected; however, they were considered "positive" if leakage or strictures were discovered. Nonetheless, only cases of leakage were considered for the analysis and discussion of this study.

For each article, the following data were collected: study type, year of publication, number of patients (including the number of patients operated with the "open" or "laparoscopic" technique), demographic data, mortality rate, length of hospital stay, the use of intraoperative anastomotic test (when reported), type of postoperative UGIS (routine or selective on clinical signs), how long after the procedure a UGIS was performed (postoperative day of performed UGIS), number of leaks, leak rates, and leak sites, type of swallow contrast (Barium or Gastrographin®), the use of CT scans, and sensitivity of clinical signs. Variables such as the number of re-do operations or the number of days spent in the ICU were not considered because these data were not consistently reported in all the studies, therefore making it difficult to determine an accurate rate of re-do operations or days spent in ICU and difficult to correlate this data to the use of routine or selective UGIS.

Results

Twenty-two studies encompassing a total of 19,389 patients were considered. There were 19 retrospective and 3 prospective studies. The procedures reported in 14 studies were strictly laparoscopic; whereas, 7 published series of RYGB were both laparoscopic and open and 1 published series of RYGB was performed with laparotomy [2, 4, 12–17].

Overall, 15 studies reported their mortality rates: 7 studies had no deaths recorded and 8 studies had less than a 1 % mortality rate [4, 16]. From the total of 19,389 procedures, 398 leaks (2.05 %) were recorded. This data is summarized in Table 1.

The anatomical sites of leakage, when reported, are shown in Fig. 1. In 59 cases, the site of leakage was not specified. All of the studies except for six reported a routine intraoperative test (Blue-methylene or pneumatic test) to detect a possible leakage in the gastrointestinal anastomosis [5, 16–20]. Sixteen studies reported the use of routine UGIS and in three studies UGIS was performed selectively based on clinical signs [19, 21, 22]. Three papers were designed as a comparative study between two groups of routine versus selective postoperative UGIS [2, 18, 23].

In cases of scheduled UGIS, 14 of the studies collected were administered in postoperative days (POD) 1–2, while in 4 studies, UGIS was performed in POD 3–5 [2, 16, 24]. Data showing mean age, mean BMI, mean length of hospital stay, and mortality percentage are reported in Table 2.

A total of 15,022 postoperative routine UGIS were performed that resulted in 171 positive tests for leakage. In 37 cases, the positive result during UGIS was not confirmed by clinical signs, therefore were considered as "*false positive*". Similarly, in 133 cases UGIS was not able to detect signs of any leakage, which later became clinically evident and was seen on further UGIS, CTscans, or during another surgery ("*false negative*").

UGIS was performed selectively in 202 cases, of which 34 cases had an anastomotic leak. Among the selective UGIS recorded, one false positive and two false negative examinations were described.

Nineteen cases of the UGIS were performed using a water-soluble contrast; whereas, three cases used barium alone or barium mixed with Gastrographin® [12, 14, 25]. The major clinical signs that were considered suspicious or associated with anastomotic leaks were tachycardia, fever, and respiratory distress.

Discussion

For years, postoperative upper gastrointestinal swallow contrast has been recognized to be the gold standard investigation for gastrojejunal (G-J) anastomosis [26]. In bariatric surgery, a routine postoperative UGIS has generally been considered as a useful tool for the detection of anastomotic leaks, a complication that is considered as one of the prime causes of morbidity and mortality after RYGB [4, 5]. However, in the last decade, the use of UGIS has been debated due to its lack of sensitivity, low positive predictive value, and cost-effectiveness [7, 17, 19, 27].

Type of Contrast

The majority of studies found Gastrographin® to be the main contrast used for UGIS after RYGB. However, some papers have proposed the use of alternative solutions to detect anastomic leaks.

Table 1 Characteristics and data of the collected studies

Study	Patients	Number of UGIS	Leaks (%)	POD of routine UGIS performed	UGIS Sensitivity[a]	Type of UGIS
Brockmeyer (2012)	129	120 (+4 CT)	3.10	1–2	0 of 4; 4 F.N; HCR e RD 100 %	R
Csendes (2012)	1,764	1,747 (R), 17 (S) (+19 CT)	3.40	4	NR	R
Leslie (2012)	2,099	2,099	0.38	1	7 of 8; 88 % 6 F.P; HCR 25 %	R
Schiesser (2010)	804	382 (R), 16 (S)	1(R), 1.2 (S)	3–5	(R) 25 % vs (S) 80 %	RS
White (2008)	508	194 (R), 10 (S)	0	1	No leaks	RS
Madan (2007)	245	245	3	1	6 of 8; 75 %	R
Doraiswamy 2007	516	516	0.60	2	1 of 3; 33 % 8 F.P; 11 % PPV	R
Sukhyung Lee (2007)	3,828	3,828	3.90	3–4	NR	R
Carter (2007)	654	634 (+4 CT)	1.22	1	5 of 8; 43 % 2 F.P; 60 % PPV	R
Dallal (2007)	352	7 (S)	0.35	NR	0 of 1 1 F.N (had HCR)	S
Gonzalez (2007)	3,018	3,018	2.2	1	NR; HCR 72 %	R
Kolakowski (2007)	417	413	1.91	2	HCR e RD 58 %	R
Lee (2007)	418	267 (R), 26 (S)	6.7 (R), 4.0 (S)	1	(R) 7.9 % vs (S) 30.8 % HCR+drainage amilase	RS
Raman (2006)	487	487	1.23	1	6 of 6; 100 %	R
Bertucci (2006)	322	322	0	1	No leaks	R
Katasani (2005)	553	120 (S)	0.72	NR	5 of 5; 100 %	S
McCarty (2005)	2,000	NR	0.20	NR	NR	S
Lyass (2004)	368	5 (S) (+34 CT)	1.08	NR	0 of 4 pos UGI; 4 of 4 pos CT 100 %	S
Sims (2003)	201	198	4.47	1	3 of 9; 33 %	R
Hamilton (2003)	210	210	4.28	1	2 of 9; 22 % HCR e RD 89 %	R
Singh (2003)	396	242	0.75	3	3 of 3; 100 % 5 F.P; 25 % PPV	R
Serafini (2002)	100	100	4	1–2	3 of 4; 1 F.P;1 F.N.	R

POD of routine UGIS performed postoperative day of routine upper gastrointestinal series performed, *PPV* positive predictive value, *F.N* false negative, *F.P* false positive, *HCR* high cardiac rate, *RD* respiratory distress, *CT* CT-scan, *NR* not clearly reported, (*R*) routine group, (*S*) selective group

[a] 100×(leaks detected/number of leaks)

Csendes et al. describe the use of barium for postoperative UGIS as a way to improve the sensitivity of detecting anastomotic leaks. In their previous study [24], the authors showed that small localized leaks can easily be visualized using liquid barium sulphate but not with a water-soluble contrast like Gastrographin® [14]. In contrast, other studies found the risk of barium-related peritonitis to outweigh the benefits of detecting a gastrojejunal fistula with barium sulphate [28]. Furthermore, some studies describe the use of Gastrographin® mixed with barium (60/40 %) for postoperative UGIS, while Serafini et al. describes the use of double contrast performed sequentially [12, 25].

Timing for Routine UGIS

In 14 studies, postoperative UGIS was performed at POD 1–2; where as in 4 studies it was performed at POD 3–5 (see Table 2). The reasons for the use of early UGIS are that it allows a faster start for oral intake, shorter lengths of hospital stay, and earlier treatment in cases of fistulas. However, Brockmeyer et al. and Csendes et al. observed early UGIS after RYGB would only show a mechanical defect in the stapled or suture line but not show the other causes of anastomotic leaks, such as ischemia. Most of the anastomotic leaks found after RYGB are thought to be secondary to edema, ischemia, or traction on the staple line; all of which classically occur on POD 4–5 [6, 9, 14]. This could be one of the reasons Sims et al. study found UGIS to have a high sensitivity at detecting anastomotic leaks at POD >4 [9].

Therefore, Doraiswamy et al. and Brockmeyer et al. recommend to perform a UGIS at POD 4–5, extending the possibility of diagnosing delayed ischemic-related fistulas or leaks due to a "latent" mechanical defect [6, 25].

Cost-effectiveness

Postoperative UGIS is a relatively cheap radiological exam; however, if done in high volumes, it can become costly [7, 17,

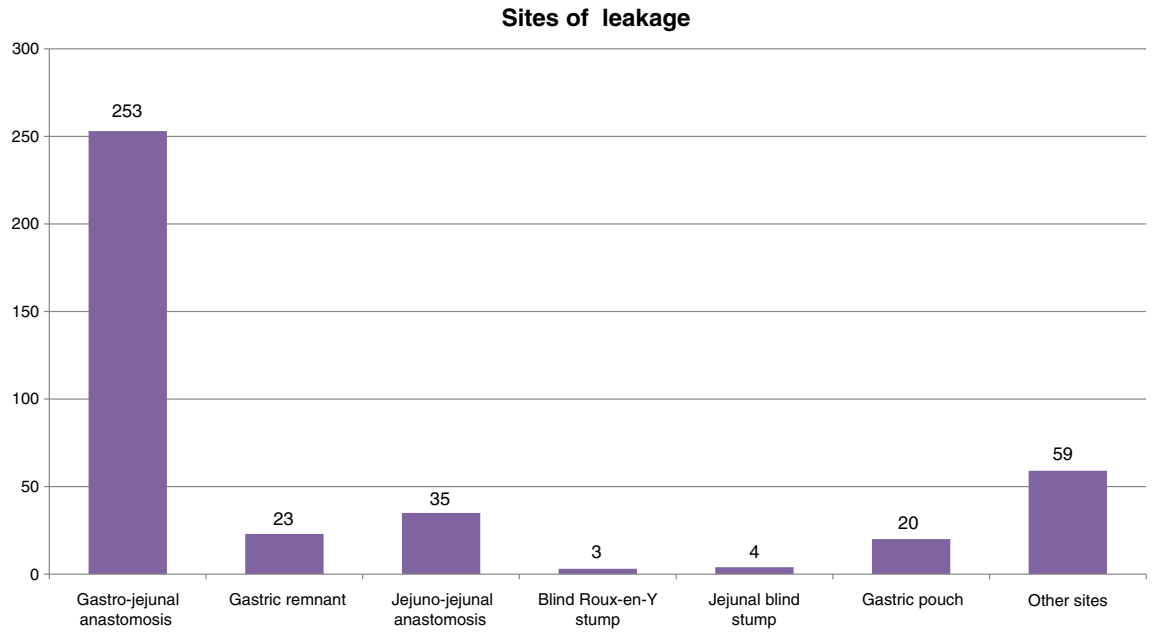

Fig. 1 Localization of leakages

Table 2 Demographics and perioperative data

Study	Age (years)	BMI (kg/m^2)	POD of routine UGIS performed	Average length of hospital stay (discharge day)	Mortality (%)	Type of UGIS
Brockmeyer (2012)	45.2	42.9	1–2	NR (DD 2)	NR	R
Csendes (2012)	43	NR	4	NR (DD 4–5)	0.34	R
Leslie (2012)	50.1	48.4	1	NR (DD 2)	NR	R
Schiesser (2010)	41	45.9	3–5	5 days (R), 4.25 days (S)	NR	RS
White (2008)	44	50.5	1	2.6 days (R), 2.55 days (S)	0	RS
Madan (2007)	39	48	1	NR	0.80	R
Doraiswamy (2007)	42	45	2	NR (DD 2)[a]	0	R
Sukhyung Lee (2007)	42.95	49.6	3–4	NR	NR	R
Carter (2007)	44	50	1	5.9 days	0.30	R
Dallal (2007)	NR	NR	NR	1.9 days	0	S
Gonzalez (2007)	46	49	1	NR (DD 3)	NR	R
Kolakowski (2007)	NR	50.6	2	5.6 days	0.70	R
Lee (2007)	42 (R), 43 (S)	50.3 (R) 48.6 (S)	1	4.3 days (R), 3.3 days (S)	1.1 (R), 0 (S)	RS
Raman (2006)	43	47	1	3.4 days	0	R
Bertucci (2006)	44	49.7	1	2.70 days	0	R
Katasani (2005)	40.4	48.6	NR	NR (DD 2–3)	0	S
McCarty (2005)	41.5	49.3	NR	1.8 days	0.1	S
Lyass (2004)	NR	NR	NR	NR	0	S
Sims (2003)	39	48.2	1	3 days	0.49	R
Hamilton (2003)	41.5	48.3	1	3 days	0.50	R
Singh (2003)	40	NR	3	NR	NR	R
Serafini (2002)	NR	51	1–2	NR	NR	R

NR not clearly reported, *DD* discharge day, *R* routine UGIS group, *S* selective UGIS group, *POD of routine UGIS performed* postoperative day of routine upper gastrointestinal series

[a] In case of false positive UGIS reported, the mean length of hospital stay is 4.4 days

19, 29]. Despite this, Leslie et al. state that the cost of an ignored fistula in morbidly obese patients is disproportionally high; thus, arguing that any investigation and procedure that can minimize morbidity and mortality is cost-effective [4, 8, 9].

Schiesser et al. estimated the cost of a routine UGIS was US$434, accounting for 1.6 % of the overall cost of a non-complicated gastric bypass procedure [2]. However, after taking into account the lack of sensitivity of a routine UGIS in detecting anastomotic leaks (<50 %) and the low rate of leakage (1.1 %), they conclude that a routine postoperative UGIS after RYGB is economically unjustified [2]. Similarly, Singh et al. estimated that the total annual expenditure for routine postoperative UGIS after RYGB was $6 million and concluded that a selective postoperative UGIS, based on clinical indicators, would reduce the total amount from 100 to 18 %; thus, giving an estimated cost-savings of %5 million [17].

Another economical aspect is the effect of routine UGIS on the length of recovery and hospital stay in particular due to the delay of oral feeding and the high percentage of false-positive exams [6, 15, 23, 25, 29].

Clinical indicators for selective UGIS. The lack of sensitivity and specificity

Clinical signs and particularly postoperative tachycardia are considered to be the earliest sign of gastrointestinal leak after RYGB suggesting the need for selective UGIS [5, 18, 21]. Other signs include respiratory distress, fever, nausea, and vomiting which seems to have a high positive predictive value for identifying complications [2, 7–9, 13, 15, 19, 21, 22, 25].

Lee et al. propose the use of selective UGIS based on the combination of clinical signs and positive amylase in drainages in order to improve the detection rate of the procedure [18].

Some authors point out that routine postoperative UGIS after RYGB should have low sensitivity and predictive value in leak detection [6, 8, 9, 27]. The main causes of lack of sensitivity of postoperative UGIS are low quality of radiological imaging, limited experience of the radiologist, the possible presence of a G-J edema during the radiological examination, and the wrong timing of UGIS (generally performed too early) [8, 9, 27].

Many authors suggest the effectiveness of CT scans with oral Gastrographin® administration when the suspect of an anastomotic leakage is high and its efficacy has been demonstrated in many studies conducted [16, 20, 26].

The low rate of false-negative results for CT scan depends on its high specificity for non-gastrojejunal anastomosis leaks, bowel perforations, and abscess as proposed by Carter et al. and Lee et al. [13, 16].

However, the disadvantages of using a CT scan as an alternative to UGIS, as a first investigative choice for leakage after RYGB in morbidly obese patients, is not to be underestimated: the high cost of the procedure, the availability of a CT scan machine, and the weight limit of the table top as well as the aperture of the machine can make the CT scan an impractical option for many bariatric surgery patients [5, 7].

The Evidence of Literature: Why *Routine*, Why *Selective* UGIS

The studies analyzed have shown certain limitations, for example, as reported in Table 2, the low leaks and mortality rates usually observed after RYGB make it difficult to assign a predictive value to all variables in particular whether the UGIS has been used routinely or selectively [5, 23].

The same applies to data demonstrating the average length of stay reported in the Table 2. Despite the fact that it could be correlated to the different approaches, the results would not be very accurate due to the following factors: both the variability in hospital stay and the timing chosen to perform a routine UGIS prior to the patients discharge is mostly based on the surgeon's decision [2, 5].

Only three of the articles reported a comparative analysis between routine and selective UGIS in their series. As shown in Table 2, the average length of stay is almost 1 day longer in the routine UGIS group for two of the three series of RYGB. However, these differences in terms of hospital stay are not substantial due to the moderate number of patients and the low complication rate reported in all of the series [2, 18, 23].

Another important aspect is that many of the series published have reported a sequential RYGB, including the procedures realized at the beginning of the experience in bariatric surgery. This could result in an evident bias for mortality rate and incidence of fistulas due to the presence of a learning curve [5, 9, 20, 23]. Finally, the presence of "non-gastrojejunal" anastomotic leaks that are not clearly visualized during UGIS can reduce the sensitivity of the diagnostic procedure in some studies [9, 20].

Arguments in favor of routine use of postoperative UGIS in RYGB patients seem to highlight the necessity of a useful "instrument" during the surgeons learning curve to evaluate both the technical aspects and the legal medical value before patient discharge or in cases of unsatisfactory weight loss [6, 7, 15, 20].

Conclusion

In our review, we have found no evident differences in leakage detection or in clinical benefit between routine and selective approaches.

Tachycardia and respiratory distress are the earliest clinical signs of an anastomotic leakage, and represent the best

criterion to perform a selective UGIS or when possible a selective CT scan.

The great differences in POD of UGIS in the different series make it difficult to analyze sensitivity and specificity of routine radiological controls after RYGB. Moreover, the lack of homogeneous data does not allow to establish the real influence of routine UGIS on the patients' length of stay.

In the analyzed series, routine UGIS does not show real benefits in terms of fistula detection, length of stay, and severity of complication. On the other hand, the mortality rates in the series reporting the selective UGIS are very low and the length of stay is equal or lower than in series reporting routine UGIS. This is why we can conclude that the selective use of postoperative UGIS could be equally safe and cost-effective. However, in order to accurately assess the real substantial value of a UGIS in bariatric patients, more studies, based on randomized series, are required.

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