



# Anastomotic Strictures After Roux-en-Y Gastric Bypass: a Cohort Study from the Scandinavian Obesity Surgery Registry

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## Abstract

**Background** Roux-en-Y gastric bypass (RYGB) is the most common bariatric procedure worldwide. Anastomotic stricture is a known complication of RYGB. The aim was to explore the incidence and outcomes of strictures within the Scandinavian Obesity Surgery Registry (SOReg).

**Method** SOReg included prospective data from 36,362 patients undergoing bariatric surgery in the years 2007–2013. Outcomes were recorded at 30-day and at 1-year follow-up according to the standard SOReg routine. The medical charts of patients suffering from stricture after RYGB were requested and assessed.

**Setting** National bariatric surgery registry

**Results** Anastomotic stricture within 1 year of surgery was confirmed in 101 patients representing an incidence of 0.3%. Risk factors for stricture were patient age above 60 years (odds ratio (OR), 6.2 95% confidence interval (CI) 2.7–14.3), circular stapled gastrojejunostomy (OR 2.7, 95% CI 1.4–5.5), postoperative anastomotic leak (OR 8.9 95%, CI 4.7–17.0), and marginal ulcer (OR 30.0, 95% CI 19.2–47.0). Seventy-five percent of the strictures were diagnosed within 70 days of surgery. Two dilatations or less was sufficient to successfully treat 50% of patients. Ten percent of patients developed perforation during dilatation, and the risk of perforating at each dilatation was 3.8%. Perforation required surgery in six cases but there was no mortality. Strictures in SOReg may be underreported, which could explain the low incidence in the study.

**Conclusion** Most strictures present within 2 months and are successfully treated with two dilatations or less. Dilating a strictured gastrojejunostomy entails a risk of perforation (3.8%).

**Keywords** Morbid obesity · Bariatric surgery · Endoscopy · Stenosis · Endoscopic dilation

## Background

The number of bariatric procedures have been increasing worldwide and although laparoscopic sleeve gastrectomies (LSG) have been increasing, laparoscopic Roux-en-Y gastric bypass (LRYGB) was the most common procedure in 2015 [1]. Bariatric surgery is the only effective treatment for morbidly obese individuals and bariatric surgery is associated with

decreased mortality and improved quality of life compared to non-operative management of obesity [2, 3].

Stricture of the gastrojejunostomy is a well-described complication of RYGB. The incidence of strictures has in previous cohorts ranged from 3 to 27% [4]. The etiology of strictures is unclear but strictures are more common when circular staplers are used to create the gastrojejunostomy, particularly when a 21-mm diameter circular stapler is used [5, 6]. Strictures have also been associated with marginal ulcers which are amenable to proton pump inhibitor treatment (PPI) [7]. Non-steroidal anti-inflammatory drugs have been associated with the development of marginal ulcers which may lead to stricture [8]. No association between *Helicobacter pylori* and the formation of strictures has been shown [9]. Using the antecolic route for the Roux limb has been noted as a risk factor for anastomotic stricture [10]. It has been hypothesized that late-presenting strictures are less amenable to dilatation than early presenting strictures [4, 11].

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The aim was to assess the incidence of anastomotic strictures in SOReg, investigate risk factors associated with stricture, and evaluate the treatment and outcome of anastomotic strictures.

## Method

SOReg was assessed for patients suffering from anastomotic stricture. During the years 2007–2013, 36,362 RYGB patients were registered in SOReg, 134 of which were registered as suffering from stricture. The charts of patients with stricture were requested through mail. If no charts were sent, centers were contacted over the phone. The charts were assessed and the treatment and outcome of the strictures were evaluated.

SOReg is a nationwide Swedish quality registry for bariatric surgery and the registry is financially supported by the Swedish National Board of Health and Welfare. The registry covers 99% of all bariatric surgery in Sweden and has been validated: 98% of data is correctly entered [12]. Data is collected preoperatively, at the time of surgery, 30 days after surgery, and after 1 year [12]. Complications and the severity of complications according to the Clavien-Dindo classification are registered [13]. Anastomotic stricture is defined as a resistance or inability to pass a standard endoscope through the gastrojejunal anastomosis, suggesting a luminal size of < 10 mm, or through radiology suggestive of stricture. Only strictures causing symptoms are registered in SOReg. Strictures diagnosed within 45 days from RYGB were defined as early, and strictures diagnosed after that were defined as late. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments. Informed consent has been obtained from all participants included in SOReg. The study was approved by the regional ethical review board in Uppsala (Dnr 2015/481).

## Surgical Technique

In the standardized LRYGB technique in Sweden, the pouch is created by one horizontal 45-mm stapler followed by vertical stapling toward the angle of His, until the pouch is completely separated from the rest of the stomach [14]. The Roux limb is then brought up the antecolic, antegastric route to the gastric pouch. The gastrojejunostomy is then created with a linear stapler and the remaining defect is then handsewn. This technique was used in 97% of patients. A circular stapler was used in 3% of patients. The anastomotic technique with circular stapler has been previously described [6]. Briefly, using a circular stapler technique, the anvil of

the stapler was placed in the distal staple line on the pouch. The stapler was then inserted in an enterotomy done on the Roux limb. The diameter used in the circular stapled approach was 25 mm in 84% of patients and 28 mm in 15%, and in the remaining 1%, a 21-mm diameter stapler was used. The antecolic route was used in 97% of the circular stapled anastomoses.

## Statistics

Numeric data were expressed as the mean  $\pm$  standard deviation, unless otherwise stated. Student's *t* test was used to compare parametric data and chi-square test was used to compare proportions. The Wilcoxon rank sum was used to compare non parametric data. Fisher's exact test was used to compare proportions with less than five cases in one cell. Risk factors with a  $p < 0.10$  were entered into a multivariate logistic regression analysis. For odds ratios (ORs), the 95% confidence interval (CI) was reported.  $p < 0.05$  was considered statistically significant. All data were analyzed using Stata® version 14.2 (Statacorp LP, Texas, USA).

## Results

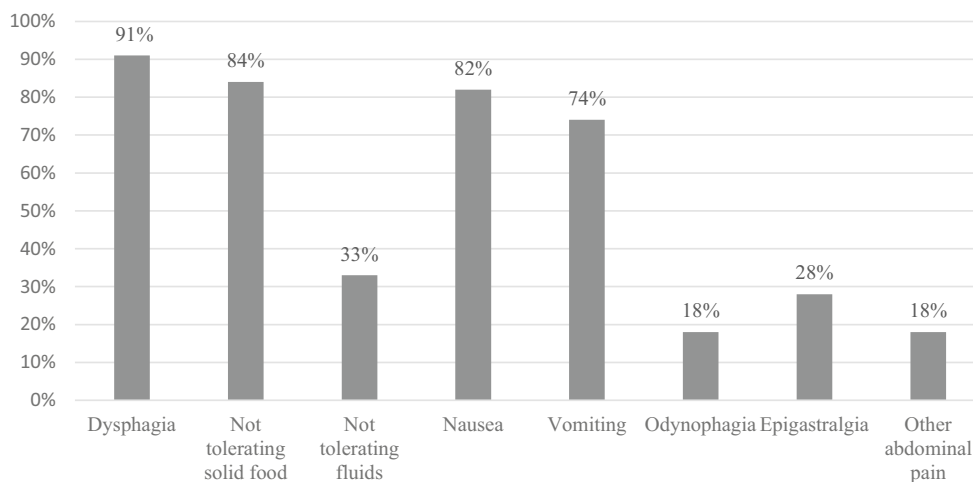
In all, 36,362 patients were included in SOReg between 2007 and 2013. Out of these, 146 patients were registered as suffering from an anastomotic stricture within the first postoperative year. The charts were located and sent to us for 111 of those patients. In 20 cases, a kinking of the entero-anastomosis was described in the charts; thus, they were erroneously categorized as suffering from anastomotic strictures. In 25 cases, other conditions were described but no stricture. In 66 cases, an anastomotic stricture was described in the charts. In the 35 cases in which we were not able to locate the patient chart, we assumed that the register data was correct. In all, 101 strictures were found, giving an incidence of 0.3% within the first postoperative year.

The most common symptom from anastomotic stricture was dysphagia; 93% of stricture patients complained of this. Other common symptoms reported by patients diagnosed with anastomotic stricture were not tolerating solid food (84%), nausea (82%), and vomiting (75%) (Fig. 1).

Upper endoscopy was used to confirm stricture in 99% of cases.

The median time from RYGB to diagnosis of stricture was  $50.5 \pm 65$  days (Fig. 2). Seventy-five percent of the strictures were diagnosed within 70 days after surgery. Early strictures (diagnosed within 45 days from RYGB) represented 45% of the strictures and required fewer dilatations than later diagnosed strictures, with a mean of 2.8 dilatations versus 5.6 dilatations for later diagnosed strictures ( $p = 0.02$ ). The

**Fig. 1** Symptoms reported by patients suffering from anastomotic stricture



remaining 55% of strictures were considered late diagnosed, which were diagnosed after 45 days from surgery.

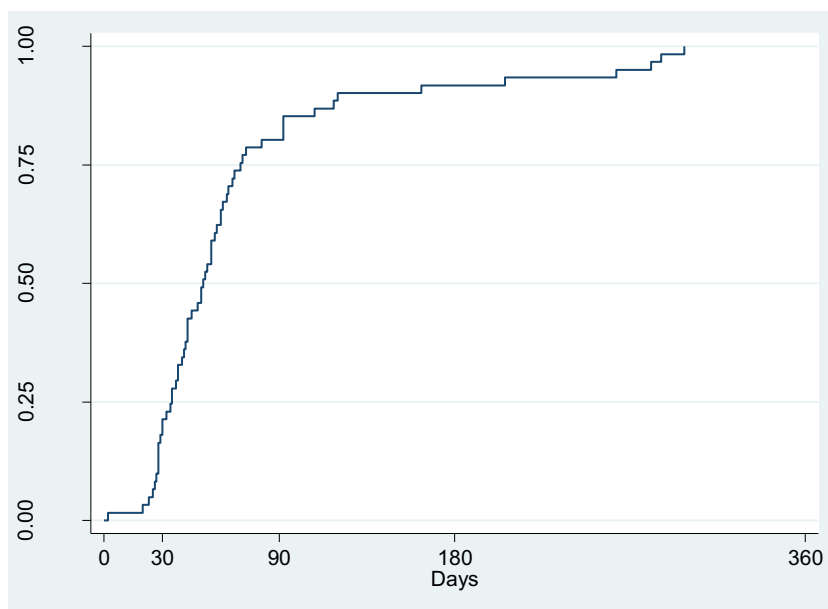
Patients who developed stricture were older than those who did not, 46.4 years versus 40.9 years ( $p < 0.001$ , Table 1). Converting to open surgery and using a circular stapler was more common in patients suffering from stricture than in those without stricture. Anastomotic leak was more common in patients who developed stricture compared with those who did not, 13% versus 1%. Marginal ulcer was also seen more often in patients with stricture, 35% versus 1% ( $p = 0.0001$ ). Male gender, BMI, smoking, diabetes, and hypertension were not associated with anastomotic stricture.

In the multivariate analysis age above 60 years (OR 6.2, 95% CI 2.7–14.3), circular stapled gastrojejunostomy (OR 2.7, 95% CI 1.4–5.5), postoperative anastomotic leak (OR 8.9, 95% CI 4.7–17.0), and marginal ulcer (OR 30.0, 95% CI 19.2–47.0) were

associated with anastomotic stricture (Table 2). BMI, diabetes, hypertension, male gender, smoking, and antecolic Roux limb were not.

Dilatation was done in 97% of the patients. All dilatations were performed with balloons. Most required only one dilatation (33%); two dilatations or less was sufficient to successfully treat 50% of the strictures. In ten patients (10%), the dilatation resulted in perforation of the gastrojejunostomy; the median diameter of the balloon in the cases that perforated was 15 mm. In total, 266 dilatations were performed and the risk of perforating at each dilatation was 3.8%. The perforations were surgically treated in six patients (laparoscopy or laparotomy, drainage, and gastrostomy). Endoscopic treatment with stent was sufficient in two perforations. Non-operative and non-endoscopic management of the perforation was done in three patients.

**Fig. 2** Time from surgery to diagnosis of stricture. Seventy-five percent of strictures were diagnosed within 70 days of surgery



**Table 1** Non-stricture and stricture patients, baseline data, operative data and complications

	Patients with no stricture (n = 36,261)	Patients with stricture (n = 101)	p value
Age (years)	40.9 ± 11.0	46.4 ± 12.4	< 0.0001 $\alpha$
Male gender	24%	30%	0.19*
Body mass index (kg/m <sup>2</sup> )	42.5 ± 5.4	41.7 ± 4.8	0.12 $\alpha$
History of smoking	32%	31%	0.88*
Comorbidities			
- Hypertension	25%	33%	0.08*
- Diabetes	14%	17%	0.49*
Operative data			
- Planned as laparoscopic/open	97%/3%	92%/8%	0.003*
- Laparoscopic/converted	99%/1%	94%/6%	< 0.0001*
- Stapler linear/circular	97%/3%	87%/13%	< 0.0001*
- Antecolic/retrocolic	99%/1%	97%/3%	0.13*
Complications			
Leak	1%	13%	< 0.0001*
Marginal ulcer	1%	35%	< 0.0001*

\*Chi-squared test.  $\alpha$ Student’s *t* test

Linear stapled gastrojejunostomies constituted 87% of strictures and 80% of the perforations. Circular stapled anastomoses constituted 13% of strictures and 20% of the perforations. Consequently, the stapler technique used to construct the gastrojejunostomy did not affect the risk of perforation during dilatation (*p* = 0.61, Fisher’s exact test). Perforation occurred in two patients during their first dilatation; each dilatation seemed to have similar risk of perforation regardless if the dilatation was the first or the tenth in that patient. No patient in this cohort required conversion to esophagojejunostomy and no patient died from the stricture or perforation.

**Table 2** Risk factors for anastomotic stricture after Roux-en-Y gastric bypass

Risk factors	N (%)	Odds ratio	95% CI
Age (years)			
< 30	6248 (18%)	Ref	
30–40	10,501 (29%)	1.1	0.5–2.3
40–50	11,225 (32%)	1.2	0.6–2.6
50–60	6406 (18%)	1.9	0.9–4.1
> 60	1248 (3.5%)	6.2	2.7–14.3
Gastrojejunostomy			
- Linear stapled	34,735 (96%)	Ref	
- Circular stapled	1260 (3%)	3.1	1.6–5.9
- Handsewn	230 (1%)	1.6	0.2–12.4
No leak	35,511 (99%)	Ref	
Leak	426 (1%)	8.9	4.6–17.0
No marginal ulcer	32,672 (99%)	Ref	
Marginal ulcer	499 (1%)	30.0	19.2–47.0

## Discussion

Previous studies have indicated an incidence of stricture after RYGB of 3–27% [4], indicating that the figure in the present study may be a considerable underestimation. Only symptomatic strictures are diagnosed in SOReg and in addition strictures may go unreported if they are treated at other hospitals outside the bariatric centers and information about the complication is not passed on to the bariatric surgeon. The strong dominance of linear stapled anastomoses in SOReg, which seem less prone to stricture, may contribute additionally to the low incidence.

Dysphagia was the most common symptom among patients suffering from stricture. This is in line with what has been published [15]. It is worth noting that dysphagia is not a normal symptom after RYGB; in contrast, a degree of dysphagia is common after gastric banding [16], emphasizing the importance of distinguishing between different bariatric procedures also for non-bariatric doctors treating bariatric patients. It also underlines the importance of bariatric surgeons to follow up bariatric patients.

Endoscopy was used to diagnose the stricture in practically all cases (99%). Endoscopy is advantageous to barium swallow because it gives the opportunity to dilate the stricture. In addition, being able to biopsy pathology has contributed to the switch from barium swallow to endoscopy for diagnosis of esophagogastric pathology.

Most anastomotic strictures appeared early in the postoperative period. Goitein et al. found a median time to stricture of 32 days compared to 50 days in the present study [17]. As shown in Fig. 2, strictures were rare in the first two postoperative weeks. Other causes than anastomotic stricture should be

sought if the patient is vomiting and nauseous in the first week postoperatively, for example, kinking of the entero-anastomosis [18].

Patients developing a stricture were older than those who did not develop stricture, 46.4 years versus 40.9 years ( $p < .0001$ ). This has not been noted previously but few previous cohorts have sufficient patients above the age of 60 to investigate this. Comorbidities such as diabetes and hypertension were as common in both groups.

Circular stapled anastomoses have been associated with a higher incidence of strictures than anastomoses performed with a linear stapler [6, 19]. Considering how strongly associated marginal ulcer was with stricture, taking every measure to prevent ulcers from forming is warranted. This includes giving PPI postoperatively as well as creating a small pouch which decreases the risk of developing a marginal ulcer [20].

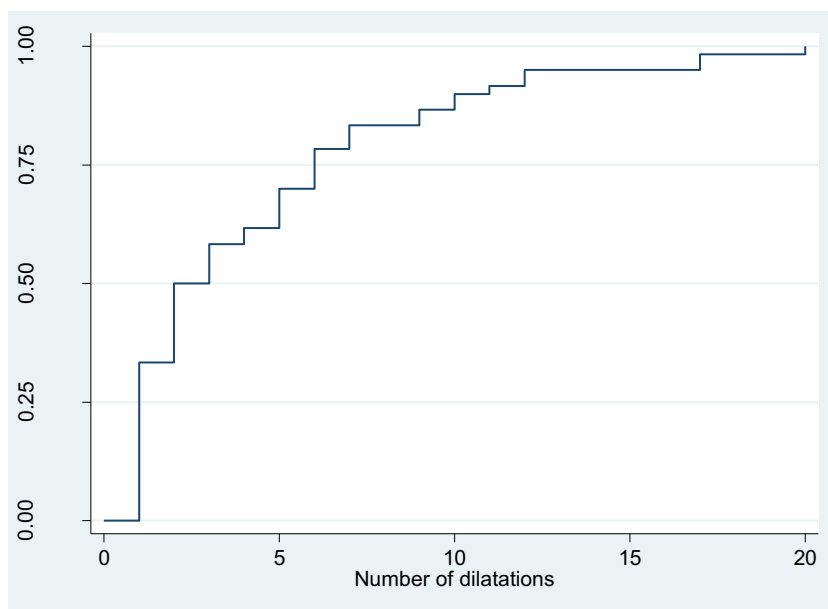
Two dilatations were sufficient to treat 50% of stricture patients (Fig. 3). In Nguyen's paper, five out of 29 patients (17%) required more than one dilatation [5], compared to our study in which 64% of patients required more than one dilatation implying that the strictures in our series were more resilient. Our study supports previous studies implying that strictures presenting late require more dilatations than strictures presenting early [4, 11].

Perforation was a common complication from dilatation; 3.8% of dilations resulted in perforation and 10% of patients with stricture perforated. Previous studies have noted a perforation incidence of 1.6–3.2% [17, 21, 22]. The rate of perforations was higher in SOReg compared to previous studies which may reflect a reporting bias; dilatations resulting in perforation are more likely to be reported in SOReg than uneventful dilatations. Another possibility is that an anastomosis created with a linear stapler, which is the predominant

technique in Sweden, could be more susceptible to perforate when dilated than an anastomosis done with a circular stapler. There is little data published comparing the risk of perforation during dilatation between stapler techniques. We did however not see that linear stapled anastomoses were overrepresented in the group that perforated; thus, we did not find support that linear stapled anastomoses are more prone to perforate. A perforation risk of 2–4% is serious and dilating a gastrojejunostomy after RYGB should be done only after the patient has been thoroughly informed of the risks. Referring the most resilient strictures to tertiary centers with more experience of dilating anastomoses could be considered given the high risk of perforation. One could also argue that strictures that do not respond to two or three dilatations should be considered for surgical management as they are likely to require several additional dilatations which will increase the risk of perforation. De Moura et al. found that the number of dilatations needed predicted which patient might perforate during the dilatation [23] and it seems logical that the more dilatations that are done, the higher the probability that a perforation would occur. Stents have also been used to treat strictures and could be of benefit in treating resilient strictures [24].

There are several limitations to the present study. The incidence of strictures in this study compared to the literature is lower than expected. It is probable that there is an underreporting to SOReg in this aspect in spite of SOReg having 98% of data correctly entered. Dysphagia in RYGB patients might erroneously be dismissed as normal symptoms after RYGB by doctors with limited experience of bariatric patients. Bariatric nurses may be entering data into the register at follow-up and sometimes, the classification of complications may be challenging when rare complications arise. In addition, in some centers, the responsibility to follow up is

**Fig. 3** Number of dilatations needed before resolution of stricture. The maximum number of dilatations needed was 20. Fifty percent of strictures resolved with 2 dilatations or less



passed on to the general practitioner after the 6-week follow-up. This may lead to erroneous data being entered into SOReg. Education on definitions of complications during register meetings could improve quality of the data. With register studies, it is crucial that correct data is entered. In case of erroneous data being entered, such errors will have a bigger impact on rare complications than on common complications as the erroneous data will make up a greater proportion of the reported complications. We suggest that when rare complications are studied in any large register that charts are used to verify, the register data is correct.

## Conclusion

Most anastomotic strictures are diagnosed within 70 days of surgery and can be successfully treated with two dilations or less. Dilating a strictured gastrojejunostomy after RYGB entails a risk of perforation (3.8%). Late-presenting strictures are more resistant to dilation than early presenting.

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## Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments. Informed consent has been obtained from all participants included in SOReg. The study was approved by the regional ethical review board in Uppsala (Dnr 2015/481).

**Conflict of Interest** Kristina Almby has nothing to disclose. David Edholm received funding from Swedish medical council.

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