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CLINICAL REPORT

Examination of the Efficacy and Safety of Intraoperative Gastroscopic Testing of the Gastrojejunal Anastomosis in Laparoscopic Roux Y Gastric Bypass Surgery

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Abstract The laparoscopic Roux Y gastric bypass (LRYGB) is one of the most often performed bariatric surgical intervention. Intraoperative gastroscopy (IOG) seems to be reliable to decrease the leakage rate of gastrojejunal anastomosis (GJA) and of gastric pouch (GP). Our aim was to test the efficacy and the safety of this method. Two hundred fifty-two LRYGB operations were performed in our institution between 1 January 2008 and 1 January 2010. IOG is routinely made to test the integrity of GJA and of GP. Patients' dates were retrospectively analysed. The intragastric pressure developed during gastroscopy in humans was measured and compared with pressure values led to destruction (positive air test) of the GJA and/or GP in animal models (hybrid pigs). Stomach and bowel wall samples from the test animals without pressure strain, with pressure strain developed at gastroscopy in humans and with pressure strains led to destruction of GJA and/or GP were histologically examined. IOG resulted in six of our cases (2.3%) positive air test. There was no anastomosis insufficiency in postoperative period. Mean pressure during IOG was 32 mmHg, mean time of examination was 3.8 min and mean maximal pressure was 43 mmHg in humans. The mean pressure leading to positive air test in pigs was 150 mmHg. We could not detect any microscopical difference between stomach and jejunum samples without pressure strain and after pressure strain developed in humans during the gastroscopy. We conclude that intraoperative gastroscopy is an effective and safe method to test the integrity of GJA and GP in LRYGB surgery.

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Introduction

As the prevalence of morbid obesity has increased rapidly all over the world and the conservative treatment has in most cases only poor and short-term results, bariatric surgery has become far more accepted and applied in the last decades. One of the most frequently performed bariatric surgical intervention is the LRYGB, with effective loss of weight and with good results in control of the co-morbidities (diabetes II, hypertension, gastroesophageal reflux), but the operative complications can be severe and life-threatening. One of the most dreaded complications is the leakage of the GJA and of the GP. This complication occurs in 0–6% of the cases, with a mortality rate ranging from 6% to 17% [1–4].

The early diagnosis of the leakage of the GJA and GP can be difficult because of the lack of explicit clinical signs in obese patients. The late recognition of anastomosis insufficiency with sepsis can be devastating, a factor which carries a high incidence of morbidity and mortality [4]. For this reason, there are different methods in trying to prevent this complication [2, 5–8]. Intraoperative gastroscopy seems to be a simple and effective way to remarkably decrease the occurrence of the leakage without substantially increasing the time and the costs of the surgical intervention, but theoretically this kind of pneumatic testing can also have a destructive mechanical impact [9]. Our aim was to try to establish the effectiveness and the safety of the IOG among our patients after LRYGB. For this reason, the dates our patients underwent procedures were reviewed, and we have compared the measured intragastric pressure values developing during gastroscopy

in humans with the pressure values which led to positive air test in the animal model.

Patients and Methods

The dates of 252 patients undergoing LRYGB surgery in our department during a 2-year period of time between 1 January 2008 and 1 January 2010 were retrospectively analysed. Two hundred nine of them were after primary gastric bypass, 28 after gastric sleeve resection, 12 after gastric banding and three were after vertical banded gastroplasty. The mean age was 39.2 years, the mean BMI was 48.2 and the female/male ratio was 84:16% (Table 1).

Surgical Technique

The procedure is performed with patient in supine position with both legs abducted. The jejunum is transected 100 cm from the duodenojejunal flexure, and then a Roux loop of 150 cm is created. A side-to-side jejunojejunal anastomosis is stapled applying triple stapler technique (Echelon-60 mm linear stapler, white cartridge). The mesenteric gap is closed using running non absorbable suture. At the proximal part of the stomach, a pouch of 50 ml is created applying Echelon-60 mm linear staplers (by primary procedures: blue and by revisional procedures a gold or green cartridge). The first stapler is fired transversely from the lesser curvature, and then the anvil of a circular stapler of 21 mm (Ethicon) is placed through a gastrotomy incision into the gastric pouch and pierced at the right side of the staple line. The pouch is completed by further cephalad firing of linear staplers to the angle of His, and the gastrotomy site will be closed. The antecolic placed Roux loop is then opened, brought up to the pouch, and the GJA is created by firing the ring stapler. The enterotomy site is resected and removed. Two stay sutures (Vicryl 3–0) at both sides of the GJA are inserted involving the distal part of the stomach, the gastric pouch and the Roux loop, in order to decrease the tension of the anastomosis and to cover the posterior line of GJA with the anterior wall of the distal part of the stomach. The GP and the GJA are routinely controlled with IOG to check for leakage and for intraluminal bleeding. The Roux limb is clamped and the upper part of the abdomen is filled with saline. The gastroscope (Olympus GIF-Q 145) is introduced through the GJA into the Roux loop, and the insufflation was set on high. If a leakage is detected, after its correction (seromuscular sutures, omental wrap), the gastroscopic test is repeated so as to make sure that it has been successfully repaired. Penrose drains for both anastomoses are routinely applied. A water soluble contrast study of the upper gastrointestinal tract is performed on the second postoperative day. If there are no anomalies (no leakage, prompt passage is documented), the patient is allowed to drink, and the day after that, the resumption of an oral diet is started. The patients are discharged when they are able to take a sufficient amount of oral fluid and soft food, and the necessary clinical requirements are fulfilled (postoperative 5–7 days).

Table 1 Clinical characteristics of our patients

Number of patients (*n*)	
Primary operation	209 (83%)
After gastric sleeve resection	28 (11%)
After gastric banding	12 (5%)
After vertical banded gastroplasty	3 (1%)
Total	252 (100%)
Mean age (SD)	39.2 years (10.49)
Mean BMI (SD)	48.2 kg/m^2 (5.72)
Female/male	212:40 (84:16%)

Estimating the Intraluminal Pressure During IOG in Patients

An inflated balloon connected with a flexible but not compressible tube to a pressure detecting and signalling device (Spiegelberg's probe) was introduced in the GP by the anaesthesiologist before the gastroscopy. The intraluminal pressure was continuously monitored during the examination and registered every 10 s. The pressure values, the reached highest pressure and the duration of the examination were registered.

Animal Experiment

Two animals (meat-type hybrid, female pigs, 85–100 kg in weight) were operated on under intratracheal narcosis (Permission Certificate No. 246/002/SOM/2006 of the Food Chain Safety and Animal Care and Protection Directorate—Veterinary University of Kaposvár). After laparotomy, the same size of gastric pouch as in our patients was performed, and it was connected with a Roux loop applying the identical surgical technique and type of staplers as used in humans. The gastroscope was placed in the GP through the mouth of the animal. The work channel of the device was connected with an insufflator and with a manometer, so as to be able to inflate air into the GP and to detect the intraluminal pressure. An elastic band was applied around the intra-abdominal part of the oesophagus, and the Roux loop was clamped under the anastomosis to prevent the escape of the insufflated air. The GP and GJA were immersed in saline. The air was insufflated in the GP through the gastroscope, and the pressure was continuously detected and registered. The intraluminal pressure was

gradually increased by 30 mmHg and kept on the same value for 3.8 min, in an attempt to try to mimic the pressure strain reached by gastroscopy in humans. The pressure value leading to positive air test was registered. The site of the leakage was repaired with seromuscular sutures, and the air test was repeated.

Histological Study

The stomach and small bowel samples from the experimental animals without pressure strain, exposed to the pressure strain reached in humans and exposed to the pressure strain leading to positive air test, were histologically examined in the search for structural disintegration. Haematoxylin–eosin, Van Gieson, Gömöri, orcein and Mallory trichrome staining methods of the connective tissue with conventional light microscopic examination were applied.

Results

Date of the Patients

In six cases (2.3%) of our 252 patients undergoing LRYGB revealed the IOG positive air test. The leakage was found in four patients on the frontal staple line of GJA and in one patient on the vertical suture line of the GP, which were repaired with laparoscopic seromuscular sutures. In the sixth case, the leakage occurred on the mesenterial side of the Roux loop. The injured part of the jejunum and the distal part of the GP were laparoscopically resected, and a new GJA was carried out, introducing into the pouch the anvil of the ring stapler with a nasogastric tube through the mouth of the patient. In one patient (0.4%), a bleeding artery in the line of the GJA was revealed by IOG, and the control of the haemorrhage was achieved by laparoscopic sutures (Table 2).

Intraluminal Pressure Values During IOG in Humans

The intraluminal pressure developing in GP during IOG was estimated in 15 of our patients. The mean value of the reached pressure was 32 mmHg, and the mean maximal pressure was 43 mmHg. The mean duration of the examination was 3.8 min (Table 3).

Pressure Values Leading to Positive Air Test in the Animal Model

Two meat-type hybrid pigs were operated on, and a GP connected with a Roux loop was completed by means of the same method applied in humans. Positive air test was observed when we reached an intraluminal pressure of 150 mmHg. In both experimental animals, the localisation of the leakage was the jejunal side of the GJA, where the seromuscular stay sutures entered the wall of the small bowel. After repairing the leaking points, the air insufflation was repeated and the anastomosis became again insufficient in both animals at the same pressure value and at the same place as at the first attempt (Table 4).

Histological Results

We could not detect any microscopical differences between the stomach and jejunum samples without pressure strain and after pressure strain of 30 mmHg for 3.8 min (pressure strain developed during the gastroscopy in our patients). After pressure strain of 150 mmHg, a remarkable histological structural disintegration of the jejunum and stomach wall could be observed. The damage of the different elements of the connective tissue was expressively demonstrated by the different staining methods: in the case of the non-striated muscle by haematoxylin–eosin and in case of collagen by the Van Gieson method.

Discussion

The intraoperative detection and repair of a technically flawed staple suture line is essential in LRYGB surgery. The late diagnosis of the leakage carries a high morbidity and mortality rate, especially in this patient population [2, 10, 11]. Intraoperative gastroscopy seems to be an

Table 2 Results of intraoperative gastroscopy in our series of 252 patients

No. of patients	Type of detected complications	No. of detected complications (leak 6, bleeding 1)	Localisation	Surgical treatment	No. of postoperative leak
252	Leakage	3	GJA—jejunal site of the stay sutures	Seromuscular sutures	0
		1	GJA—anterior wall	Seromuscular sutures	
		1	GP—vertical suture line	Seromuscular sutures	
		1	Roux loop—mesenterial side	Re-anastomosis	
	Intraluminal bleeding	1	GJA—anterior wall	Seromuscular sutures	

Table 3 Intraluminal pressure strain in the GP during IOG in humans

Mean pressure, mmHg (SD)	32 (8.26)
Mean maximal pressure, mmHg (SD)	43 (2.55)
Duration of the examination, min (SD)	3.8 (0.6)

effective method in the examined series of 252 patients undergoing gastric bypass surgery in our department, as no anastomosis insufficiency occurred in the postoperative period. Because the air delivered at a certain pressure has good compressibility, diffusion capacity and ability to penetrate through the narrowest spaces, IOG has a high sensibility. It detects the smallest dehiscence even on the posterior line of the anastomosis. After the repair, the test can be repeated [12].

Positive air test was found in six cases of 252 examined patients: Four of the six leaks were localised in the suture line of the GJA, one in the vertical suture line of the GP and the last one at the mesenterial side of the Roux loop constructing the anastomosis. The five dehiscences in the staple suture line were repaired with laparoscopic seromuscular sutures. In case of the leak on the mesenterial side of the Roux loop—which may probably have been an unrecognized jejunal diverticulum—we did not repair it in the same way because under the meso-covering the edges of the dehiscence cannot be perfectly visualized and the seromuscular sutures in this localisation can destroy the blood supply of the bowel wall. That is why we decided to resect the whole anastomosis and to prepare a new one.

IOG has an additional advantage: In that not only the flawed suture lines but the intraluminal bleedings of the GP and the GJA can also be revealed. We had one case (0.4%) where an arterial bleeding in the anterior staple line of the GJA was detected, which was solved with laparoscopic seromuscular sutures.

It can be suggested that the IOG, because of the powerful air insufflation, can lead to the mechanical destruction of the staple lines, producing a high false-positive air leak rate. That is why we compared the pressure value leading to positive air test by intact anastomosis in the animal model with the pressure values developing in humans during IOG. We found that the pressure leading to damage of the staple line and in this way to positive air test in the animal model is almost five times higher than the mean pressure and more than three times higher than the maximal pressure measured in humans during IOG. We therefore believe that IOG is a safe method of testing the integrity of the anastomosis, and if it results in a positive air test, the leaking staple line was probably not intact before the examination.

It was interesting to see that from the four positive air tests detected in the suture line of GJA, three occurred on the jejunal wall, exactly at the point, where the seromuscular stay suture entered it. We experienced the same localisation of the leakages in both experimental animals. We suggest that this is the most vulnerable point of the GP and GJA complex. If this disadvantage remains indeterminate and exceeds the acknowledged advantages of these stay sutures (covering the posterior suture line of GJA with the distal part of the stomach and decreasing the tension of the anastomosis), we argue that additional studies would be necessary to clear that question.

The experienced 2.3% of positive air test in our series of 252 patients is rather high compared to the literature. It might be the result of an "over detection" of needle or staple tracts due to the high intraluminal pressure during IOG, which is obviously a drawback of the examination. Unfortunately it cannot be estimated on the basis of our dates, which proportion of patients with positive air test is false positive and which proportion would have developed manifest leakage after the surgical procedure. But considering the outcome that any leakages did not occur in postoperative period, IOG seems to be an effective method in prevention of the staple line insufficiency of the GP and GJA after LRYGB surgery.

Our paper has some limitations: First, the number of animal models is too small to be able to determine the considerable consequences, but we found the same results in both animals: positive air test at the same pressure and at the same localisation. That is why we suppose that this result could be relevant. Second, the wall of the small bowel of the 1-year-old experimental animals is much

Table 4 Results of testing the GP and the GJA in the animal model

Pressure value (mmHg)	30	60	90	120	150
Duration of pressure strain (min)	3.8	3.8	3.8	3.8	
Animal no. 1, first air test	Negative	Negative	Negative	Negative	Positive after 2.2 min
Animal no. 1, air test after repair					Positive after 1.2 min
Animal no. 2, first air test	Negative	Negative	Negative	Negative	Positive after 3.1 min
Animal no. 2, air test after repair					Positive after 1.1 min
Animal no. 1, localisation of leakage	Site of the stay suture, jejunal side				
Animal no. 2, localisation of leakage	Site of the stay suture, jejunal side				

weaker and more fragile comparison to the jejunum of adult humans, but for this reason, the pressure limit of the destruction of the staple lines in humans is more underdetermined than overestimated. Third, the intraluminal pressure was measured in a different way in humans to that in the animal models. We determined the differences of the pressure values arrived at by the two methods. For this reason, the intraluminal pressure was estimated in three of our patients in parallel with the Spiegelberg probe and with the manometer connected to the work channel of the gastroscope. The found difference in pressure values was always under 10%. Nevertheless, we think that the measured difference between the pressure values developing in humans during gastroscopy and the pressure values leading to destruction of staple lines and positive air test in the examined animal models is high enough to be believed. In that words, IOG is a safe method of testing the GP and the GJA.

We conclude that IOG is not only safe but also an effective method of testing of the GJA and the GP in LRYGB surgery, as anastomosis insufficiency did not occur in the postoperative period in our series of 252 patients. The further advantage of the method is the intraoperative detection of intraluminal bleeding. We think that subsequent clinical studies are required to estimate the role of the intraoperative endoscopic testing (esophagogastroduodenoscopy and colonoscopy) in reduction of the rate of anastomosis insufficiency in different parts of the gastrointestinal tract.

Conflict of Interest Any commercial interest of the authors is disclosed.

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