International Journal of Surgery 12 (2014) 1151–1156

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Review

An analysis of surgical anatomy of the gastric fundus in bariatric surgery: Why the gastric pouch expands? A point of technique

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HIGHLIGHTS

- It is essential to completely release the Fundus in bariatric surgery in order to create a narrow gastric pouch.
- Dissection during bypass prevents any "rocking" movement from above downwards and from lateral to medial.
- This minimal dissection is compensated by further dissection at the level of the left pillar.
- The greater tuberosity has no electrical activity and therefore no mechanical activity.
- This would appear logical as this area does not contain food but generally air.

ARTICLE INFO

Article history:
Received 7 August 2014
Received in revised form
21 August 2014
Accepted 31 August 2014
Available online 16 September 2014

Keywords:
Gastric fundus
Surgical anatomy
Bariatric surgery
Hiatus hernia
Diaphragmatic pillar

ABSTRACT

In bariatric surgery, it is essential to completely release the Fundus in order to create a narrow gastric pouch. The upper part of the fundus is located above the omental bursa and is therefore retro-peritoneal. In order to release this completely, not only does the arterial supply to the fundus need to be divided to visualise the left diaphragmatic pillar, but the right attachment beginning at the left diaphragmatic pillar and running towards the fundus needs to be divided. This minimal dissection is compensated by further dissection at the level of the left diaphragmatic pillar and traction on the stomach from right to left during the final division stapling division process. The surgeon still has the impression of having released the posterior aspect of the Fundus, exposing the pillar of the diaphragm, although in fact part of the Fundus still remains adherent to the diaphragm and is therefore not released.

1. Introduction

In principle, the anatomy of the stomach is not complicated. Although knowledge of the anatomy of the gastric Fundus is extremely useful in bariatric surgery, this is only very rarely clearly described. The aim of this article is to describe the anatomical features of the gastric Fundus which may explain some operation difficulties, some "disappointing" postoperative radiological appearances and finally, which allow to discuss the surgical strategy for the treatment of severe obesity.

2. Technical point

It is essential to completely release the Fundus in bariatric surgery in order to create a narrow gastric pouch both in sleeve gastrectomy and in gastric bypass. Dissection may be incomplete in gastric bypass if the posterior gastric dissection which is minimal does not pass to the right of the posterior gastric vessels (Fig. 1). This minimal dissection is generally compensated by

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http://dx.doi.org/10.1016/j.ijsu.2014.08.409
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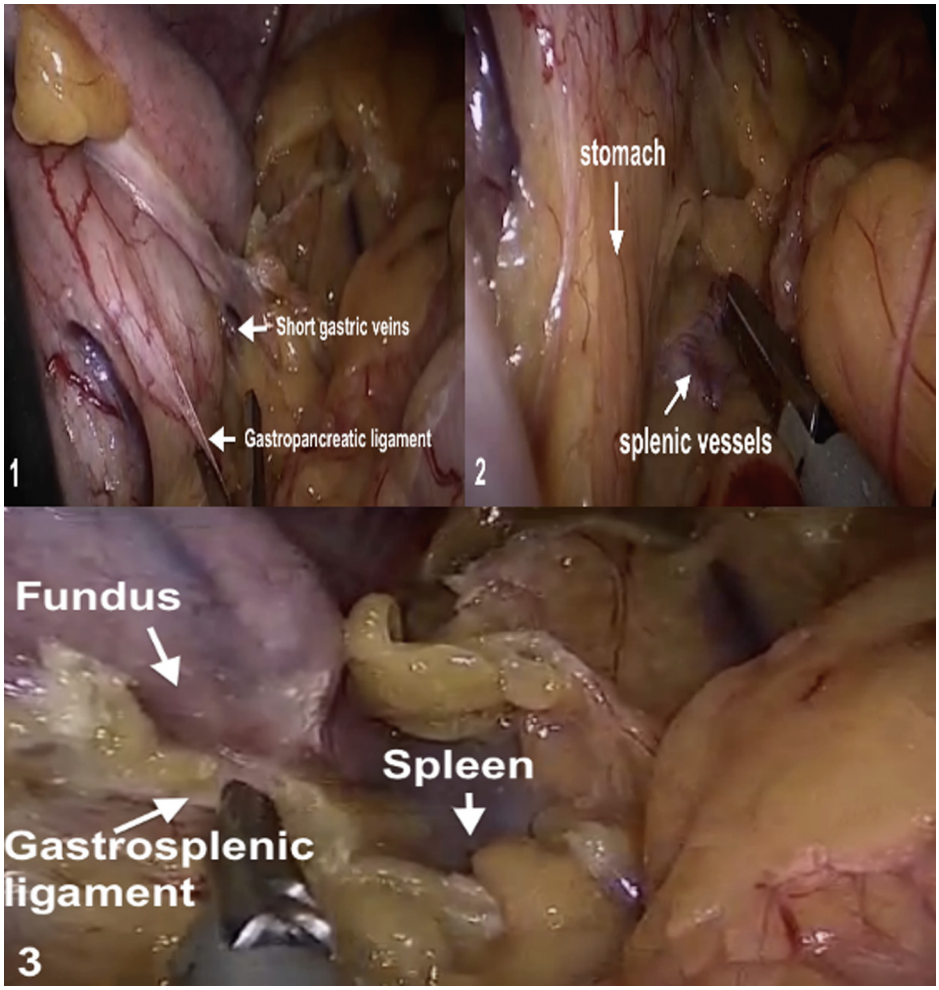

Fig. 1. Technical point. Laparoscopic view.

further dissection at the level of the left pillar and traction on the stomach from right to left during the final division stapling division process (Fig. 2). In revision surgery (after a ring or anti-reflux surgery) this release is impossible. The surgeon still has the impression of having released the posterior aspect of the Fundus, exposing the pillar of the diaphragm, although in fact part of the Fundus still remains adherent to the diaphragm and is therefore not released. This is due to the inflammation (created by the foreign body or creation of a valve) passing above the omental bursa and abolishing the avascular dissection plane. This explains why gastric pouches may be too wide (incomplete dissection) and the increased complication rate after revision bariatric surgery (when the tissues are more fragile) (Figs. 3 and 4) [1]. A too wide gastric pouch may explain insufficient weight loss as this part of the stomach may dilate over time because of the lack of electrical and mechanical activity at this level. There is always a risk after an initial procedure of having to perform a second one in the long term, as bariatric surgery is "counter to nature" and nature always seeks to rectify itself. It is therefore a form of surgery which changes over time and the anatomy explains why surgical management of obesity should begin with correct dissection of the fundus, either with a sleeve gastrectomy or gastric bypass and not routinely with a ring as a first line choice, particularly in massive obesity when the risk of failure is greater as more kilograms need to be lost [2–3].

Malrotation abnormalities are extremely rare, although these must be looked for on opacified preoperative gastrointestinal imaging [4]. This is also used to investigate for abnormalities at the gastro-esophageal junction (hiatus hernia). The upper part of the fundus is located above the omental bursa and is therefore retroperitoneal (Fig. 5). In order to release this completely, not only does the arterial supply to the Fundus need to be divided to visualise the left pillar but the right attachment beginning at the left diaphragmatic pillar and running towards the fundus needs to be divided. If the fundus is divided and stapled, the staple lengths must not be too long at this point. The consensus conference statement recommends 2.5 mm staples for the first surgery and at least 4.8 mm staples for revision surgery (when the tissues are thicker). Four to six 60 mm cartridges should be available in the operating theatre for a sleeve gastrectomy [5]. Longer staples may be required for the antrum (green cartridges). The staples may be shorter for gastric bypass when two to four 60 mm cartridges should be available in the operating theatre (horizontal division 6 cm from the cardia) [6].

3. Discussion

The stomach is visible from the 4th week of pregnancy. The dorsal part (the future greater curvature) develops more quickly during growth than the ventral part (the future lesser curvature). It

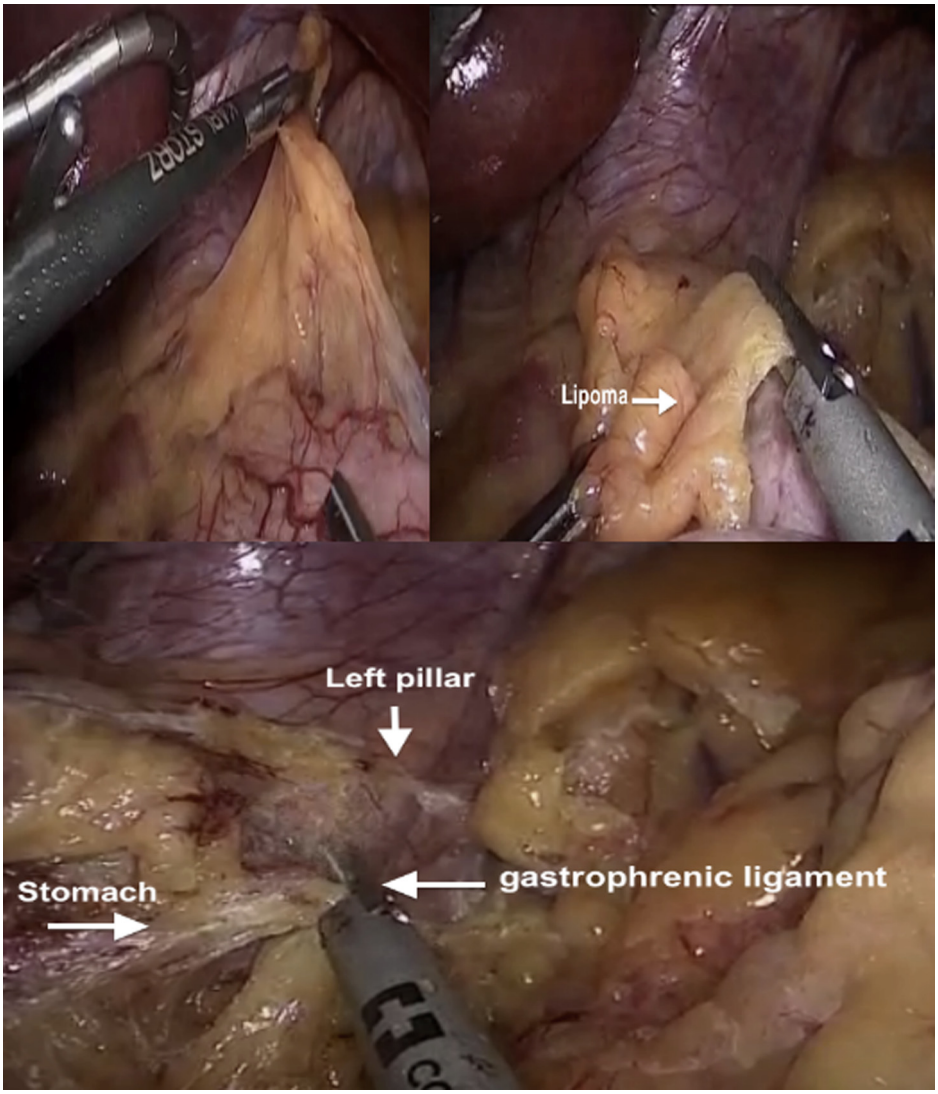

Fig. 2. Technical point. Laparoscopic view.

initially develops sagittally and then rotates 90° around a sagittal axis directing the posterior surface to the left (greater curvature) and the anterior surface to the right (lesser curvature). This rotation creates a diverticulum on the posterior aspect of the stomach which extends the main peritoneal cavity. It is located entirely in the supra-mesocolic region. This creates the omental bursa (formerly called the posterior omental cavity) which stops cranially a few centimetres from the cardia. The fundus is the upper part of the stomach which is involved in acid secretion. The stomach has 3 essential roles: 1) receiving food in order to store it temporarily and mix it 2) begin protein digestion and 3) empty the food into the small bowel at a controlled rate promoting digestion and absorption. Conversely, the stomach is not significantly involved in nutrient absorption. The greater tuberosity has no electrical activity and therefore no mechanical activity. This would appear logical as this area does not contain food but generally air. When this region is full of air promoted by swallowing (opening of the lower esophageal sphincter) or by compression of the abdomen, the air leaves through by burping. Gastric innervation is from the vagus nerve (afferent and efferent fibres).

The stomach is covered by peritoneum except at the junction of the oesophagus and cardia and on the posterior aspect of the upper part of the fundus. The peritoneal relationships of the fundus are the gastro-splenic ligament on the left, the omental bursa inferiorly and posteriorly, and the gastro-phrenic ligament superiorly (Fig. 5). Its muscle relationships are the left pillar of the diaphragm medially and the diaphragm superiorly and posteriorly. It lies in contact with the left lobe of the liver anteriorly, the hilum of the spleen laterally and the diaphragm posteriorly. The arterial system for the fundus varies and is made up of direct or indirect vascular supply which may arise from 9 arteries: the left inferior diaphragmatic, accessory left hepatic, left gastric, left adrenal, splenic, posterior gastric, superior polar, left gastro-epiploic and the gastro-splenic arteries (Figs. 6 and 7) [7]. The gastric wall is formed from 3 muscle layers: longitudinal, circular (responsible for its constricting motor activity) and internal oblique. The circular muscle layer in the fundus is less developed and the stomach is thinner at this point. It is also accepted that the wall of the antrum is thicker than that of the rest of the stomach and increases in thickness with increasing BMI [8–10].

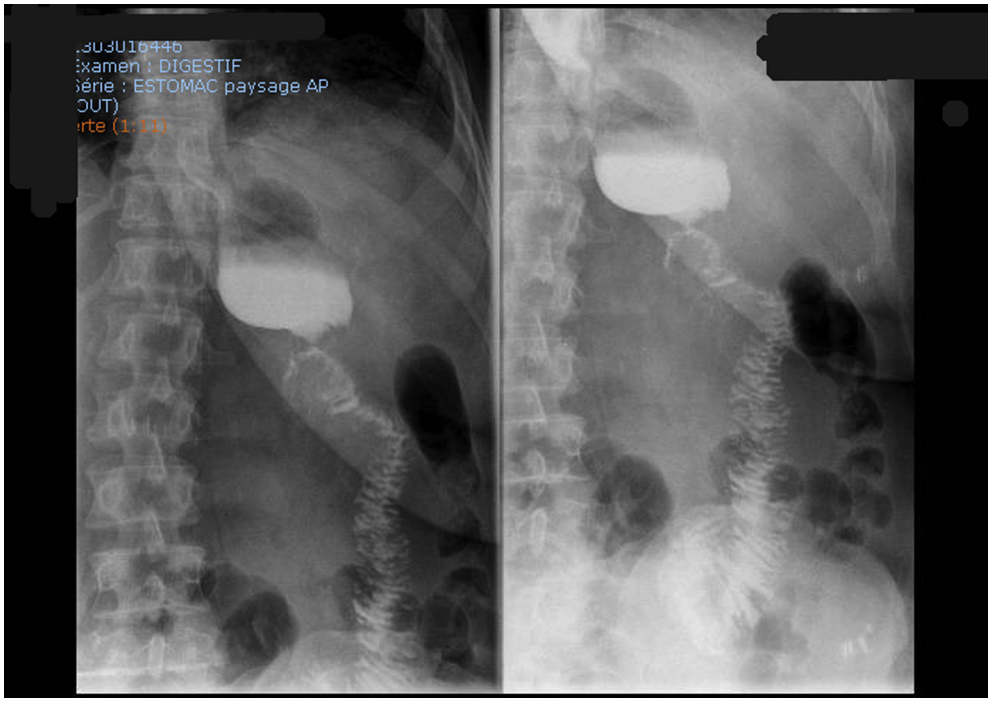

Fig. 3. Sleeve gastrectomy after ring: fundus left in place.

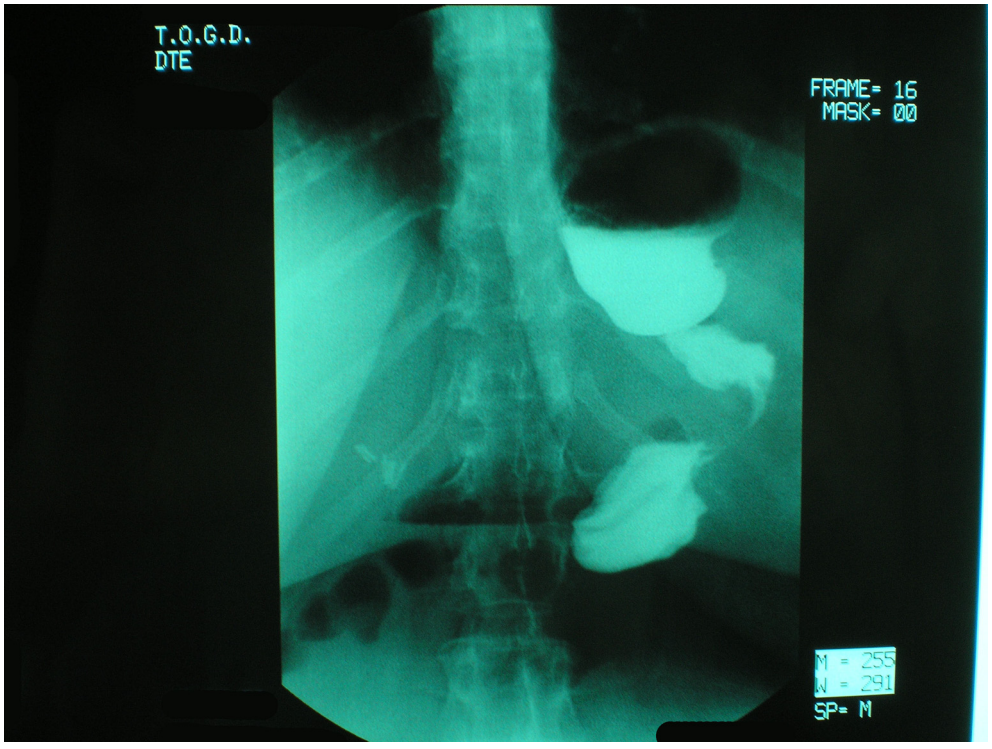

Fig. 4. Bypass after Nissen: small stomach pouch too wide.

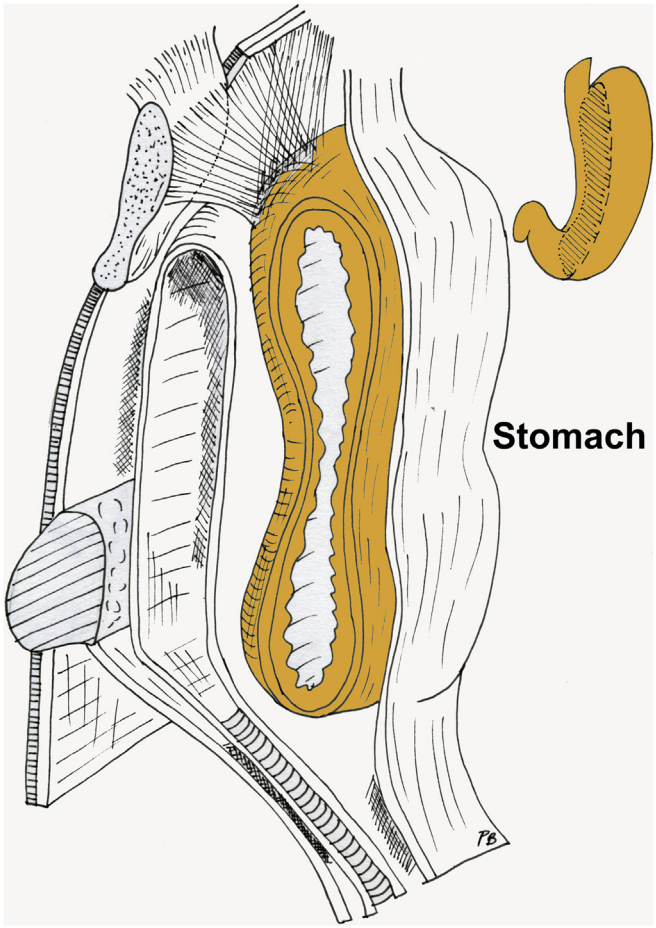

Fig. 5. Sagittal section: gastro-phrenic ligament.

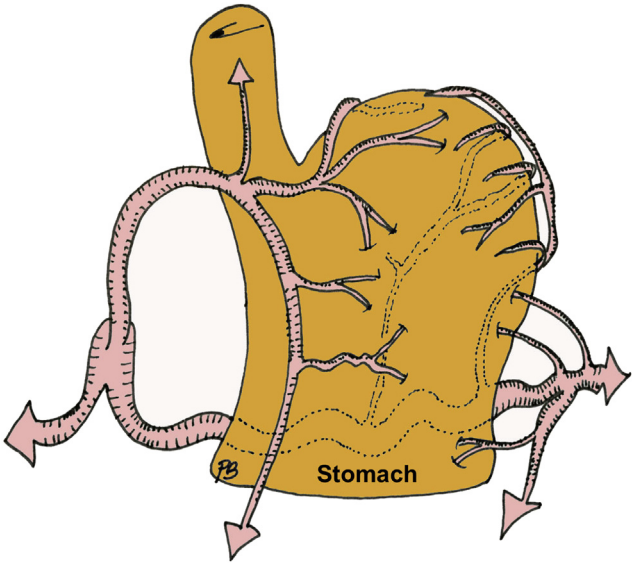

Fig. 6. Anterior view of the blood supply to the stomach.

4. Conclusion

The anatomy of the Fundus wasn't adequately described. Knowledge of this anatomy explains certain operative difficulties and some “disappointing” postoperative radiological appearances. It raises questions about the suitability of the use of a ring as the first stage of a two stage bariatric surgery to treat severe obesity.

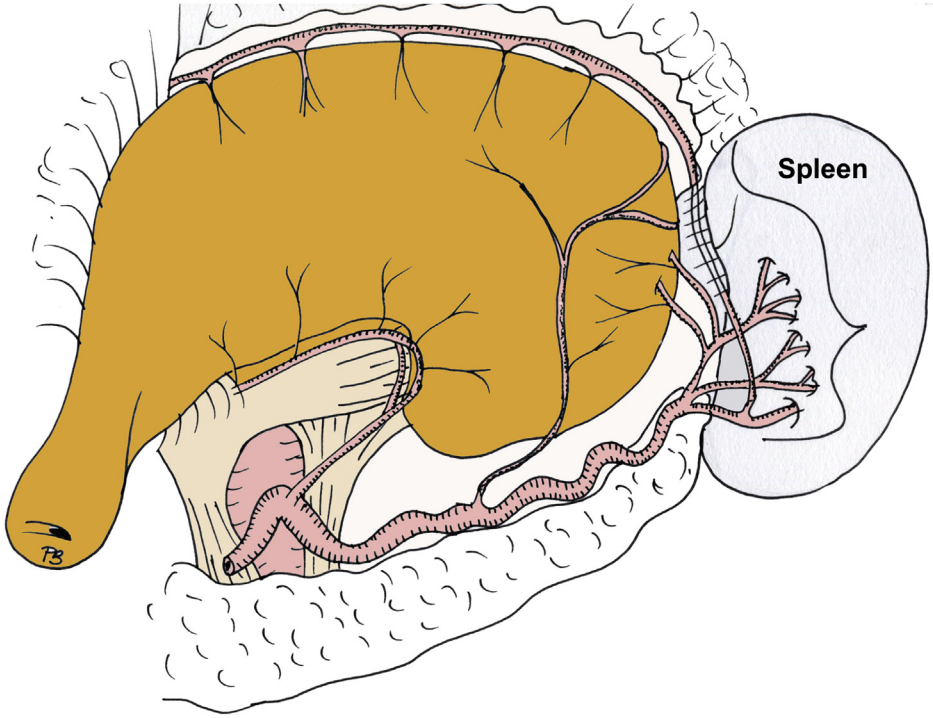

Fig. 7. Posterior view of the blood supply to the fundus.

Ethical approval

"Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request".

Funding

No source of funding for our research.

Author contribution

Radwan KASSIR: writing.
Pierre Blanc: conceptualized and designed the paper.
Patrice Loitier: data collections.
Chirstophe Breton: reviewed the paper.
Antonio Iannelli: reviewed the paper.
Olivier Tiffet: reviewed and revised the paper.

Conflict of interest

The authors declare no conflict of interest.

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