Indian J Surg (April 2016) 78(2):130–135
DOI 10.1007/s12262-015-1437-y

REVIEW ARTICLE

Laparoscopic Sleeve Gastrectomy in Situs Inversus Totalis: a Case Report and Comprehensive Literature Review

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Received: 5 November 2015 / Accepted: 28 December 2015 / Published online: 21 January 2016

Abstract The aim of this study is to review the reliability of laparoscopic obesity operations in patients with situs inversus totalis(SIT). A new case of SIT was presented together with a literature review of published English language studies on laparoscopic gastric banding (LAGB), laparoscopic gastric bypass (LRYGB), laparoscopic sleeve gastrectomy (LSG), laparoscopic obesity surgery (LOS), and SIT, accessed via PubMed and Google Scholar databases. The case is presented of a 21-year-old female patient who underwent LSG due to SIT. A total of 12 publications in literature matched the search criteria for LAGB, LRYGB, LSG, LOS, and SIT, which reported LAGB in five cases, LRYGB in four cases, and LSG in four cases. In the rare event of SIT, LOS can be safely used following good evaluation.

Keywords Situs inversus totalis · Laparoscopy · Gastric banding · Gastric bypass · Sleeve gastrectomy · Obesity surgery

Introduction

Described for the first time by Fabricius in 1600, situs inversus totalis (SIT) is a rare autosomal recessive entity [1] with incidence varying between 1/5000 and 1/20,000. This entity can be embryologically defined as the displacement of the intra-abdominal organs 270° counterclockwise, i.e., a mirror image is formed [2, 3]. The majority of SIT patients can continue their normal lives, while some may develop severe pulmonary (bronchiectasis, the absence of one lung), cardiovascular system (interventricular and intra-atrial defects), and digestive system abnormalities such as duodenal stenosis and atresia [4]. While there is involvement of both the thoracic and the abdominal compartment in the majority of cases, occasionally only one compartment may be affected. In 25 % of cases, there may be accompanying bronchiectasis caused by immotile cilia, sinusitis, and Kartagener syndrome (KS), characterized by male infertility [5].

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With the introduction of laparoscopy into surgical routine in the 1990s, the use of laparoscopy in bariatric procedures has become increasingly widespread. Gastric banding, which used to be widely used, has been gradually replaced by gastric bypass and sleeve gastrectomy [6]. SIT is an infrequent condition, but has begun to be seen more often with an increasing number of cases reported [5, 7–17]. The presentation of these cases can be considered to provide benefit, especially in the reduction of complications in specific patients.

In this paper, a case is presented where diagnosis was made intra-operatively and is discussed in comparison with 13 cases in literature.

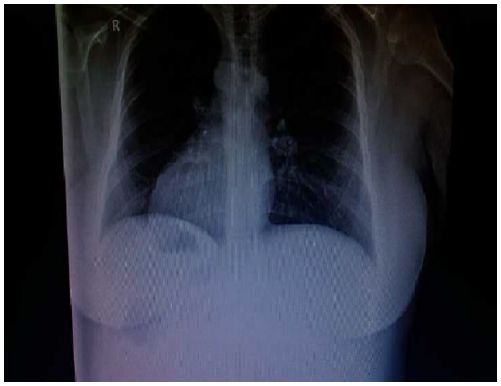

Fig. 1 Preoperative chest radiograph showing the heart located on the right side of the patient

Materials and Methods

A new case of situs inversus totalis in an obese patient was presented and discussed in the light of relevant literature. A search of the English-language medical literature using PubMed and Google Scholar was conducted for articles related to situs inversus totalis in an obese patient using the keywords of *situs inversus totalis*, *obesity surgery*, *gastric banding*, *sleeve gastrectomy*, *gastric bypass*.

The search covered all articles from 1994 to March 2015. If there were any missing data, the corresponding authors of the articles in question were contacted by e-mail. The articles included demographic and technical data, year of publication, patient's age, gender, radiological findings and preoperative diagnostic methods, primary surgical position, number of trocars used, and duration of the operation.

Results

Case Report

A 21-year-old female patient applied for elective sleeve gastrectomy. She had a history of trying various diet programs and medical treatments to lose weight over the last 3–4 years, but any weight lost in the short term was regained. The body mass index (BMI) was calculated as 41.8. No additional diseases were determined. Routine complete blood count, biochemical profile, hormone profile, electrocardiogram, chest radiograph, and upper gastrointestinal endoscopy tests were applied preoperatively. The patient was examined by the endocrinology, cardiology, pulmonary diseases, psychiatry, and anesthesia departments. The chest radiograph showed dextrocardia (Fig. 1), and the electrocardiogram revealed right axis deviation (Fig. 2). However, the image on the preoperative electrocardiogram and chest radiograph was thought to be due to a technical mistake and diagnosis of SIT could not be established in the preoperative period. The patient was hospitalized in the morning of the operation. After general anesthesia, the monitor was placed at the level of the patient's left shoulder. The patient was in the French position and the surgeon between the patient's legs. The abdomen was entered from the left lateral of the umbilicus with a 12-mm optic trocar. In the exploration carried out after insufflation of the abdomen with 14 mmHg CO_2, the liver and gall bladder were seen to be on the left and the spleen and stomach on the right side. The surgical team and the operation room were redesigned according to the mirror image. The monitor was placed at the level of the patient's right shoulder. This process lasted approximately 7 min. The patient was placed in the reverse Trendelenburg position. The other trocars were adapted to the new position (Fig. 3). Before the operation, the intra-abdominal cavity was examined generally and checked for any additional pathology accompanying SIT. As routine, the greater curvature of the stomach was freed up to 4 cm from the gastroesophageal junction and the pylorus with a Harmonic Scalpel™ (Ethicon Endo-Surgery), and the stomach was prepared. This was followed by the placement of a 34 Fr gastric calibration tube from the oral cavity to the duodenum, to give the new formation to the stomach. For the resection of the stomach, an Echelon FLEX 60 linear stapler (Ethicon Endo-Surgery) was used. As per the standard method, the first two staplers used were 4.1 mm green, and the remaining four staplers were 3.5 mm blue, and the sleeve gastrectomy was completed. The gastric calibration tube was withdrawn as far as the gastroesophageal junction, and the methylene blue dye leakage test was performed. No pathology was observed, so a latex drain was placed at the medial of the spleen and the operation was completed. The total duration of the operation was 78 min. Our center is a tertiary reference hospital in which about 450 LSG procedures have been performed since 2007. Our average time of operation is 45 min (range 25–60 min). No surgical or anesthetic complications developed during or after the operation. The patient was evaluated for leakage on postoperative day 4 with oral-contrasted abdominal tomography. As there was no pathology, the patient was discharged on postoperative day 6 (Fig. 4).

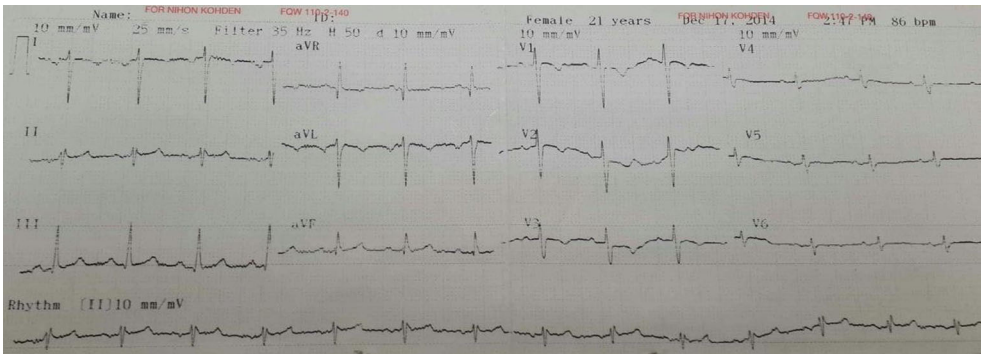

Fig. 2 Routine preoperative electrocardiogram showing right axis deviation

No problems were observed at the postoperative 1-, 3-, 6-, and 8-month follow-up examinations. The BMI value regressed from 41.8 to 29.8 kg/m^2.

Literature Review

The English-language medical literature published between 1994 and March 2015 was searched using PubMed and Google Scholar. A total of 12 reports concerning 13 cases of situs inversus totalis with obesity surgery meeting the aforementioned criteria were included in this review. The patients comprised nine (69.2 %) females and four (30.8 %) males aged from 19 to 52 years (mean 37.9 ± 11.5 years). Gastric banding was applied to five patients, gastric bypass to four, and sleeve gastrectomy to four. Mean BMI was 51.00 ± 9.22 kg/m^2 (range 42–76). In one article, two cases were presented and all the other publications were of single cases. Complications developed in two patients, with band migration in one and leakage in one. Additional trocars were needed in three patients. The clinicopathological characteristics of the 13 patients are summarized in Table 1.

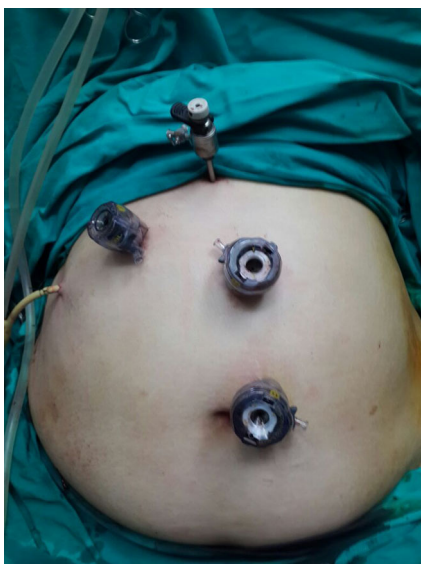

Fig. 3 Coronal computed tomographic scan of the abdomen and pelvis with oral and intravenous contrast showing the mirror image anatomy

Discussion

Obesity, which is recognized as a serious health problem worldwide, is expected to reach 700,000 in 2015, according to the data of the World Health Organization (WHO) [18].

With the increasing use of surgical modalities in the treatment, various clinical manifestations are faced by surgeons, one of which is SIT [7].

Since the first case reported in 1998, there have been 12 further publications in English of cases where laparoscopic surgery was performed [7]. These comprised four patients who underwent LRYGB [5, 7–9], four LSG [9–12] (one case of SILS+LSG [12]), and five LAGB [13–17]. One article included two patients [9], and all the other publications were each of a single case. The demographic data of the patients are summarized in Table 1.

The most important issue on which almost all the surgeons who presented their experiences focused was the preoperative establishment of the diagnosis. The diagnosis can be made through, X-rays, barium enema, and abdominal tomography.

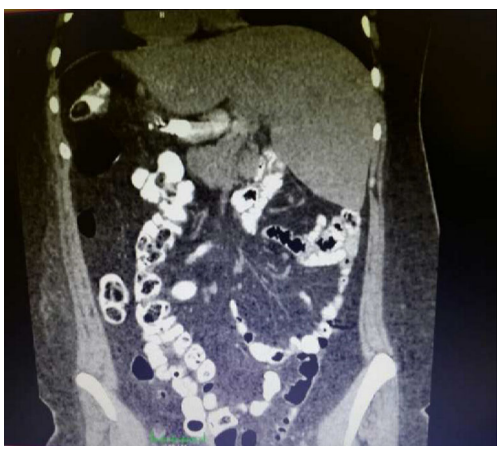

Fig. 4 Intraoperative image (camera trocar is on the left of the abdomen and the other trocars have been adapted for the mirror image)

Table 1 A brief review of the studies of laparoscopic sleeve gastrectomy with situs inversus totalis

	Age/ gender	Body mass index (BMI) before operation (kg/m^2)	Preoperative diagnostic method	The need for additional trocars	Operation time (mean operation time)	Kartagner syndrome	Previous operation	Surgical procedure	Postoperative complications
Wittgrove et al. (1998) [7], first case	38/F	47.8 kg/m^2	ECG/X- ray chest	No	300 min (159)	No	No	LRYGB	No
Ahmed et al. (2006) [5]	47/F	58.1 kg/m^2	ECG/X- ray chest/CT scan	No	160 min (105)	No	No	LRYGB	No
Tsepelidis et al. (2015) [8]	51/F	43 kg/m^2	NA	No	120 min (NA)	No	No	LRYGB	No
Stier et al. (2014) [9]	39/M	44 kg/m^2	USG/X-ray chest/gastroscopy/ ECG	No	76 min (50–93)	No	No	LRYGB	No
Stier et al. (2014) [9]	51/F	54.2 kg/m^2	USG/X-ray chest/gastroscopy/ ECG	No	61 min (16–87)	No	No	LSG	No
Catheline et al. (2006) [10]	19/M	76 kg/m^2	ECG/gastroscopy/X-ray chest/ USG	Yes	NA	No	No	LSG	No
Deutsch et al. (2012) [11]	39/F	42 kg/m^2	Abdominal CT	No	NA	No	Open gastric banding	LSG	Suture line leakage
Genser et al. (2015) [12]	52/F	49 kg/m^2	ECG/X- ray chest/CT scan	No	52 min (45–60) (it was learned via e-mail)	Yes	No	Trans-umbilical SILSG	No
Samaan et al. (2008) [14]	29/M	56 kg/m^2	ECG	No	NA	No	No	LAGB	Band erosion
Matar et al. (2008) [15]	28/M	51 kg/m^2	ECG/Barium graphy/X-ray chest/USG	No	NA	No	No	LAGB	No
Taskin et al. (2008) [16]	20/F	44.9 kg/m^2	ECG/X-ray chest/USG	Yes	90 min	No	BIB	LAGB + LC	No
Pauli et al. (2008) [17]	47/F	60 kg/m^2	X-ray chest/chest and abdominal CT scan	Yes	105 min	Yes	No	LAGB	No
Ersoy et al. (2005) [13]	33/F	53 kg/m^2	ECG/gastroscopy/X-ray chest/ USG	No	NA	No	No	LAGB	No
Current study (2015)	21/F	41.8 kg/m^2	ECG/ gastroscopy/X-ray chest/ USG	No	78 min (28–60)	No	No	LSG	No

BIB bioenteric intragastric balloon, *BMI* body mass index, *CT* computed tomography, *DM* diabetes mellitus, *ECG* electrocardiography, *HT* hypertension, *LAGB* laparoscopic adjustable gastric banding, *LC* laparoscopic cholecystectomy, *LRYGB* laparoscopic Roux-en-Y gastric bypass, *LSG* laparoscopic sleeve gastrectomy, *NA* not available, *OSAS* obstructive sleep apnea syndrome, *SILSG* single incision laparoscopic sleeve gastrectomy, *USG* abdominal ultrasonography

However, the most emphasized method is abdominal ultrasonography (USG) ordered in the preoperative period. USG is not only for the diagnosis of SIT but can also detect additional pathologies such as incidentally identified gall bladder stones in patients [9, 15, 16]. Another diagnostic method that can be used is endoscopy. Although this method has failed to be effective for definitive diagnosis, it can be useful in terms of duodenal pathologies that may be seen in these patients, even if infrequently [10]. Findings may not always be apparent on EKG and chest radiograph performed in the preoperative period, and images may be thought to be a technical error and diagnosis might not be made as in the current case. The establishment of diagnosis preoperatively may be helpful not only for the prevention of pulmonary and cardiac complications that may accompany the disease or which may develop in the postoperative period, but also for the avoidance of improper incisions and technical challenges. Taşkın et al. emphasized that awareness of the surgical terms about the anatomical variation leads to the ability to prepare preoperatively in terms of mental and physical conditions and equipment, which in turn shortens the operational time [16]. It was found in literature that the diagnosis was made in advance in all the patients and all the equipment used was redesigned, including the monitoring systems. However, although diagnosis was made on chest-graph and EKG of the patient, Wittgrove et al. started the operation with the surgeon on the right side, thinking that the anatomical variation was only in the thoracic compartment and therefore, as in the current case, adaptation to the new position was made after the exploration [7] .

When the patients were evaluated in terms of the operating times, of patients in the LRYGB group, the longest duration was seen to be in the study by Wittgrove with 300 min (mean 159 min) [7]. However, in a 2006 study by Ahmet et al., the operating time was 160 min, which was slightly higher than their own mean operating time of 105 min. This was attributed to the mirror image used in the operation [5]. In 2014, Stier reported the operating time as 76 min (mean 50–93) in one of their patients [10]. In recent publications operating times in LSG patients have been observed to be similar to those of the normal patient population without any anatomical variation [9, 10, 12]. This can be considered to be the result of the increasing laparoscopy experience of surgeons performing obesity surgeries. In the current case, the operational time was 78 min (45 (28–60)). Approximately 7 min of this duration was spent on the change of system and adaptation to the new position. However, even if this time is subtracted, the operating time was greater than our average operation time by about 50 %. This was attributed to entering the camera from the wrong location and the time spent on adaptation to the altered anatomical position. No complications directly related to the disease were experienced.

In our opinion, another personal indicator of the challenges in laparoscopic surgery is the need for an additional trocar. Evaluating the articles from this aspect, additional ports were needed in three patients. First was the patient who underwent LAGB and laparoscopic cholecystectomy as reported by Taşkın et al. [16]. However, we think that both the prolonged time of the operation (90 min) and the need for additional ports in this case were due to concomitant gall bladder stone, rather than anatomical variation. The second patient was reported by Catheline et al. [10]. We think that this patient required an additional port due to the high BMI value (76 kg/m^2). Finally, Pauli et al. used an additional port in a patient with Kartagener syndrome who underwent LAGB [17]. The need for an additional port in this patient was thought to be caused by the abdominal insufflation pressure kept low due to serious pulmonary problems.

Reports in literature have shown that surgeons have made different choices of patient position, with the most preferred method being the French position [9, 10, 12–14, 16]. The most important advantage of this position, which was also used in the current patient, is easy access to each umbilical area.

Another indicator of the difficulty of laparoscopic surgery is the high rate of complications. Of the 13 patients reviewed, only 2 were found to have developed complications. In one patient with gastric banding applied by Samaan et al., erosion developed due to the band which was removed after approximately 4 months [14]. Band erosion is a rare but potentially serious complication of LAGB. As in the case of Samaan et al., this condition may emerge as a result of the difficulties experienced during dissection of the stomach posterior. The second patient who developed complications was included in a study by Deutsch et al., as a case of adjustable gastric banding with open surgery followed by application of the band and laparoscopic sleeve gastrectomy in the same session [11]. The patient was treated with a polyflex stent inserted without any need for reoperation. As specified by Deutsch et al. [11], SIT is not a factor which increases complications when surgery is applied by experienced hands especially in laparoscopic bariatric surgery, and it is necessary to give more attention to patients who have undergone revisional surgery, in terms of complications. The current patient did not develop any complication in either the early or late periods.

In conclusion, preoperative USG can be considered to provide benefit both for the investigation of additional pathologies and the evaluation of anatomical variations such as SIT, and although this method was not helpful in the diagnosis of the current patient, preoperative endoscopic examination is necessary and awareness of the surgical team about the disease in the preoperative period would be a crucial factor in the reduction of both complications and operation time.

Although the limited number of cases does not allow clear interpretation, the addition of SIT to the event in obese patients who are already at risk under normal conditions does not seem to increase complications which may be seen in the

operation. However, if the condition is accompanied by Kartagener syndrome, the anesthesia team in particular must be more careful in terms of pulmonary complications. Furthermore, we believe that the sharing of experience of this rare type of patient is important and will be able to guide future surgical procedures.

Acknowledgments This work received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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Compliance with Ethical Standards

Disclosures Drs. Yazar, Emre, Akbulut, Urfalıoğlu, Cengiz, Sertkaya, Yıldız, and Bülbüloğlu have no conflicts of interest or financial ties to disclose.

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