Introduction

Natural orifice translumenal endoscopic surgery (NOTES) has attracted attention of physicians from various fields since its introduction in 2004 by Kaloo et al. [1]. One of the key roles of NOTES is to minimize trocar site complications by reducing the number and size of the abdominal incisions. This is emphasized when the extracting specimen is of large volume wherein it is often the case that trocar site is enlarged for extraction in traditional laparoscopic surgery.

Our routine procedures with transgastric technique are appendectomy, cholecystectomy, and laparoscopic sleeve gastrectomy with TransOral Remnant Extraction (LSG with TORE). Of these, we focus on the one with relatively large organ extraction, i.e. LSG with TORE. Conventional LSG with transabdominal specimen extraction is at higher risk of trocar site complications due to the high co-mobidity rate of patients in addition to the size of the extracting specimen. NOTES technique has quite meaningful impact on bariatric surgery from this view point.

We have successfully introduced LSG with TORE to clinical setting in August 2010. This article describes the technical details of this procedure, discusses its benefits and risks, and directly compares them with conventional LSG performed during the same period at our institute.

Methods

All patients undergoing LSG were considered candidates for TORE and were consented for this procedure if interested after detailed informed discussion.
A retrospective chart review was performed using the research plan approved by our institutional review board (IRB approval No.110438).

18 LSGs with TORE (TORE group) and 10 conventional LSGs (non-TORE group) were completed from August 2010 to March 2011. We compared these two groups for the age, sex, preoperative BMI, the number of co-mobidities, specimen volume, excess weight loss (EWL), EWL%, follow-up period, and trocar site complications. The statistical analysis was performed using unpaired t-test for each factor.

First we describe our conventional LSG. Under general anesthesia, endoscope is passed into as far as the duodenum for survey and irrigation. After the absence of endolumenal abnormality is confirmed, laparoscopic trocars are introduced on abdomen. The trocar positioning is shown in Fig. 1. The first 12mm trocar is for laparoscope which is introduced under direct view using an optical trocar, 5cm lateral to the left of the midline and 5cm craniad to the umbilical level. Number 2 and 3 are both 12mm trocar for the operator's laparoscopic maneuver, placed symmetrically with respect to the number 1 trocar. Number 2 is just medial to the right midclavicular line. Number 4 is 5mm trocar placed in the left flank for assisting retraction. A Nathanson liver retractor is introduced from at the level of the xiphoid process. All of the trocars and the retractor are placed under direct visualization. Patients are then placed in a steep reverse Trendelenberg position with split leg. The operator positions between the split legs, and the scopist/first assistant at the left of the patient. After the peritoneal cavity is explored, the mobilization of the stomach is initiated in the middle of the greater curvature. Gastroepiploic vessels and short gastric vessels are taken down using ultrasonic dissector or vessel sealing device. Progressing the dissection proximally, the left crus of the diaphragm is exposed. The stomach is then mobilized posteriorly and distally. After the mobilization, the gastrectomy is initiated 8cm proximal to the pylorus using laparoscopic stapler. We apply battress reinforcement for staplers to prevent bleeding and leak. The first stapler is introduced through number 2 trocar, and the rest are fired from number 3 trocar. Number 1 trocar is occasionally used for stapler for better stapling angle by switching the laparoscope to number 2 trocar. Progressive staple firing starts with green load, goes down to gold, and ends with blue load depending on the tissue thickness. The number of the staple firing is usually five to six for the gastrectomy. After the gastrectomy is completed, the staple line is again reinforced by running Lembert suture and the integrity of the gastrectomy line is tested. Placing the patient in flat position, underwater bubble test is performed with endoscopic insufflation of gastric sleeve to confirm absence of any air leak. A drain is placed along the gastric sleeve via number 4 trocar and the intraperitoneal maneuver is completed before specimen extraction. The specimen is extracted through the incision of number 4 trocar. The fascia or skin is incised additionally for difficult extraction. The extended fascia is approximated with absorbable suture, and the procedure is completed with closure of the skin incisions.

For LSG with TORE, the primary difference from conventional LSG is the site which the first stapling is applied for gastrectomy. With the intention of making a gastrotomy just distal to the gastrectomy line for later specimen extraction in transgastric fashion, the gastrectomy is initiated 13cm to the pylorus, i.e. 5cm proximal than that for conventional LSG [Fig. 2].

Once the gastrectomy is completed, a location 2-3cm distal to the distal most part of the staple line is prepared for a gastrotomy by making full thickness incision on the gastric wall using ultrasonic dissector or electric cautery. This opening is extended as wide as 2cm long allowing the endoscope to be guided into the peritoneal cavity under direct visualization [Fig 3]. An endoscopic snare is then passed through the scope and the snare loop was tightened around the tip of the resected stomach [Fig. 4]. The specimen is then pulled into the gastric lumen with laparoscopic assistance and removed transorally [Fig. 5, 6]. If the passage of the specimen would be difficult, then we would proceed with transabdominal extraction in a standard fashion. The defect on the stomach is closed with laparoscopic stapler with green load fired across it and this relatively small resected specimen is extracted through the number 3 trocar. The final shape of the gastric sleeve is identical to the one of conventional LSG. Underwater bubble test and irrigation was performed to confirm the absence and bleeding from the staple line. None of the fascia of the trocar site is approximated.

Results

From August in 2010 to February in 2011, 28 (5 males, 23 females) LSG was performed of which 18 (3 males, 15 females) employed TORE at our institution. 10 of the patients (1 male, 9 females) were not consented for the transgastric procedure. TORE was successfully performed in all patients in whom it was attempted.

The profile of patients and operative outcome is shown in Table 1.

The mean age, sex, preoperative BMI, and the number of co-mobidities of the patients revealed no significant difference between the TORE and non-TORE group. The specimens in TORE group were of significantly higher volume than the ones of non-TORE group (p=0.02). The width of gastrotomy estimated around 2cm was sufficient in all cases and no specimen retrieval caused tear to the gastric wall. No significant resistance was encountered on specimen extraction at potential obstacles such as gastroesophageal junction (GEJ) or upper esophageal sphincter. The duration of operation, estimated blood loss, and hospital stay showed no significant difference in two groups. There was no operative complication in all cases.

Out of 10 cases in non-TORE group, the trocar site was extended in 4 cases for specimen extraction. The extended trocar site developed panniculitis in 2 cases; 1 required panniculectomy for refractory induration. The culture was not taken for both of the panniculitis. The pathological study for the resected induration revealed non-specific fibrosis. No trocar site complication was found in TORE group. In summary regarding trocar site complications, no complication in 18 TORE cases was found wherein 2 panniculitis occurred in 10 non-TORE cases (p=0.048).

The mean follow- up period was 6.2 months in the TORE group and 6.5 months in non-TORE group with similar outcome in weight loss.

Discussion:

Sleeve gastrectomy is originally a part of the biliopancreatic-duodenal switch (BPD-DS) operation [2] and totally laparoscopic approach for sleeve gastrectomy was first reported in 2000 [3]. Recently LSG has become a relatively frequent primary procedure for management of obesity [4] because of its technical simplicity and positive outcomes [5]. The exact indication and its efficacy as a stand-alone procedure is still debated [6].

Although LSG is technically established, there is risk of perioperative complications due to the nature of patients in whom such procedures are performed, mostly related to the degree of obesity and associated co-morbidities [7]. Several of these are trocar site complications such as infection, bleeding, pain, and incisional hernia. The larger the abdominal incision, the higher rate of wound complications [8, 9]. Adaptation of NOTES technique can be of definite benefit, if it decreases the number of trocar and the size of abdominal incision. Sleeve gastrectomy with transvaginal approach is a novel technique where an abdominal incision is avoided and thus minimizes trocar site related problems [10].

Another alternative with NOTES technique for LSG is transgastric specimen retrieval, i.e. TORE.

Although the incidence of trocar site complications after laparoscopic surgery is relatively low (0.18-2.8%) [11], increasing number of bariatric surgeries [7, 12] can be translated into a considerable case volume. TORE thus may have a meaningful impact on decreasing trocar site complications. Also the fact that the transgastric route can be used regardless of sex should be listed as an advantage over transvaginal procedures.

Conventionally, trocar sites have been used for specimen extraction in laparoscopic surgery. The idea of TORE could potentially be applied to other laparoscopic surgeries accompanying specimen retrieval. The benefit of TORE is emphasized when the extracting specimen is of large volume. Also an additional advantage with infected specimen may be the avoidance of its contact with the incised fascia and skin.

In this study, two out of ten conventional LSG cases developed trocar site inflamation, wherein no such complication was found in the group which LSG with TORE was applied. Considering the small case volume and higher trocar site complication rate

(20%) in this case series comparing with previous studies published in the past [11], statistical analysis was not performed for this factor. However, our study demonstrated advantage of TORE over conventional abdominal specimen extraction regarding trocar site complications while no significant difference was seen between the two groups for the profiles of patients: age, sex, the number of co-mobidities, preoperative BMI.

To performing TORE, an endoscopic survey from pharynx to duodenum should be done right before the procedure to rule out any conditions to potentially prevent safe retrieval. It may still be difficult to predict whether the specimen could be extracted safely or not. Our suggestion is not to extend the gastrotomy wider than 2cm. Our experience demonstrates that, as far as the specimen passes the gastrotomy of 2cm wide without any injury to the gastric wall, natural lubrication and elasticity of retrieval route should help the specimen being extracted safely. In the event of difficulty with pulling the specimen anywhere within the extraction route, conversion to a standard transabdominal extraction should be done or esophageal or pharyngeal tear may result. Even though the mean specimen volume in TORE group was significantly larger than the one in non-TORE group, all the retrieval was completed safely without any injury to the extraction route or the specimen.

The fact that the average operation time and blood loss of LSG with TORE revealed no significant difference from the conventional LSG supports TORE’s feasibility and safety.

We assume TORE can be performed at any institution where LSG has being done routinely. The technique should be stated as quite simple and straight forward, and could be performed safely by surgeons familiar to LSG or endoscopists with average experience. Also the TORE is feasible from the view point of medical economy regarding the instruments used for the TORE which are readily available in market at low price: an upper endoscope, an ordinary endoscopic snare, and one or two loads of regular stapler for gastrotomy closure.

We have experienced no serious perioperative complications and the mean length of the hospital stay was similar in both groups. The EWL and EWL% in both TORE and non-TORE group revealed no significant difference. TORE does not causes significant additional risk for stricture of the gastric sleeve, nor does it interferes the effect of sleeve gastrectomy as the total resected specimen would be similar in both techniques, leaving the final shape of the gastric sleeve comparable.

A potential risk of transgastric specimen extraction is the spillage of gastric contents through the gastrotomy into the peritoneal cavity. This may causes localized inflammatory response and results in adhesion or abscess formation [13]. The measures are taken to deal with this issue, i.e. the patients are starved preoperatively, stomach is irrigated carefully before gastrotomy, and the operative site is irrigated after the gastrotomy is closed. We have experienced no abscess formation or adhesion related event as short term outcome. Considering the relatively clean environment inside the stomach and short duration of the exposure of gastric lumen to the peritoneal cavity, the risk for these complications might be noted as insignificant.

Conclusion

We conclude that TORE is a technique with potential benefits that could be successfully introduced into LSG with minimal added risk, additional resources or economical impact. Although the limited number of case volume, our initial experience demonstrated an advantage of LSG with TORE over conventional LSG in that minimizes trocar site complications. This technique and concept may have application in other laparoscopic surgery, especially for them with large organ extraction. This procedure will provide an intermediate platform for development of NOTES.

References

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Fig. 1 Summary of procedure

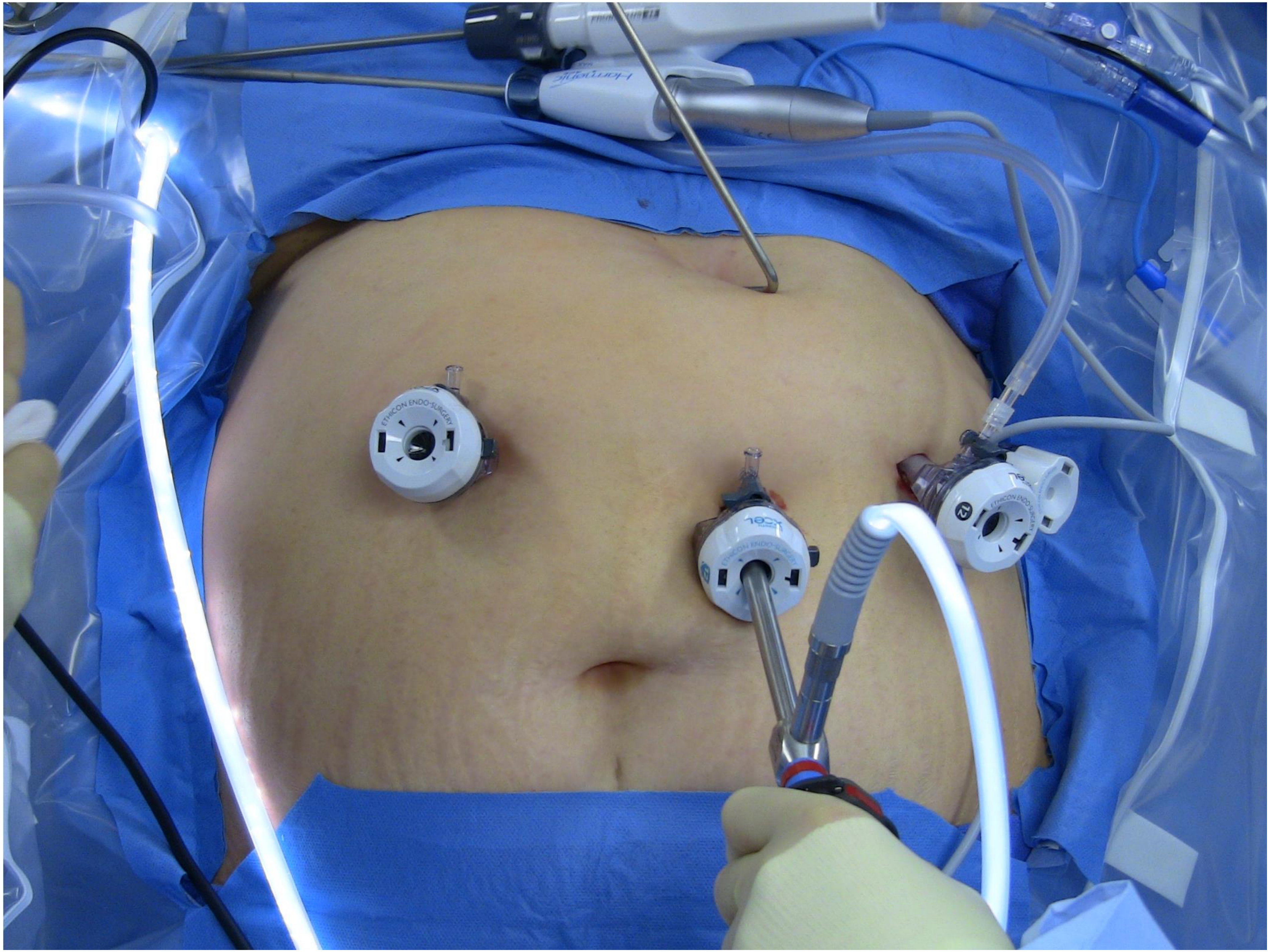

Image 1 Trocar positioning

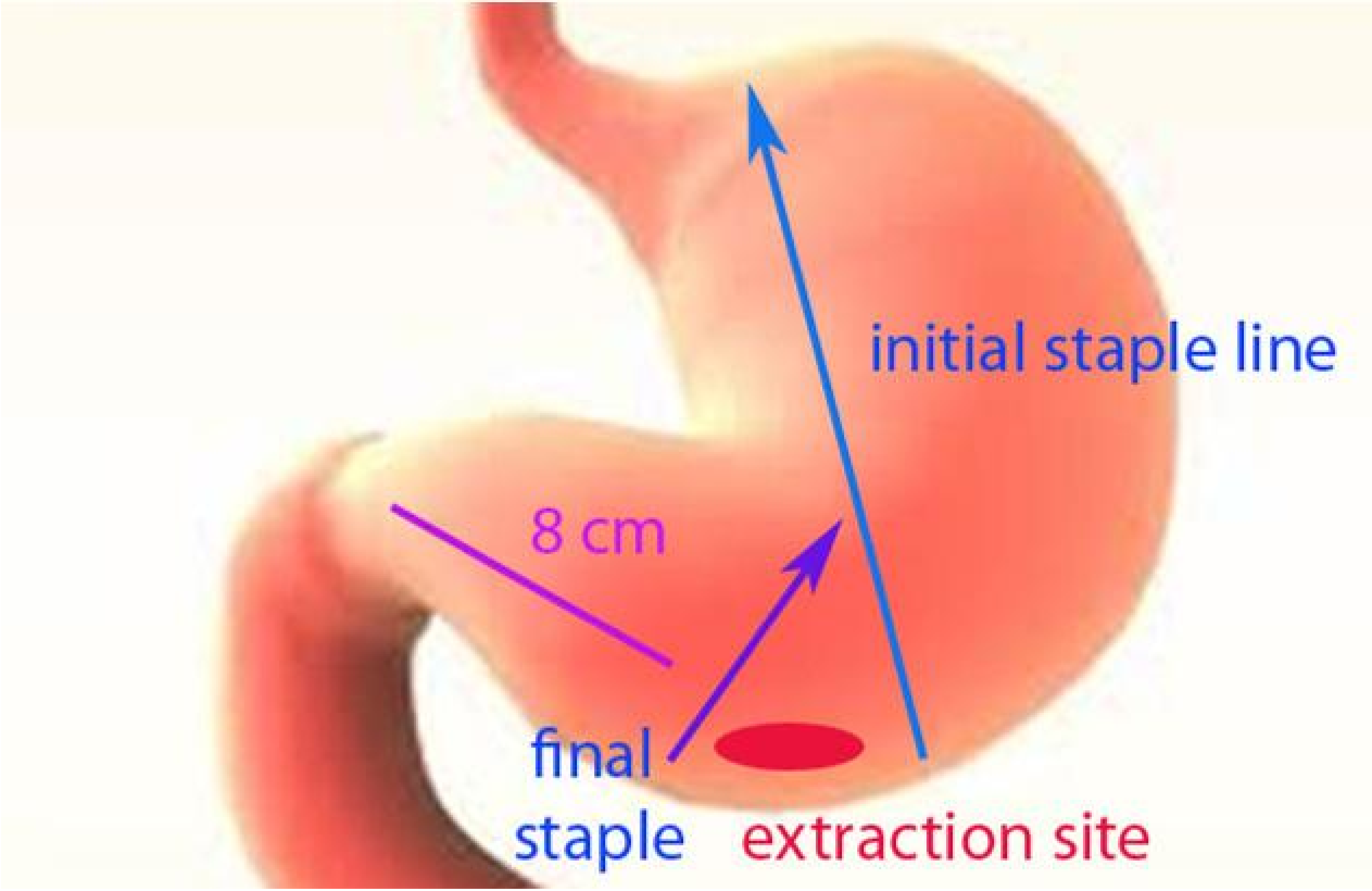

Image 2 2-cm Gastrotomy is created for specimen extraction

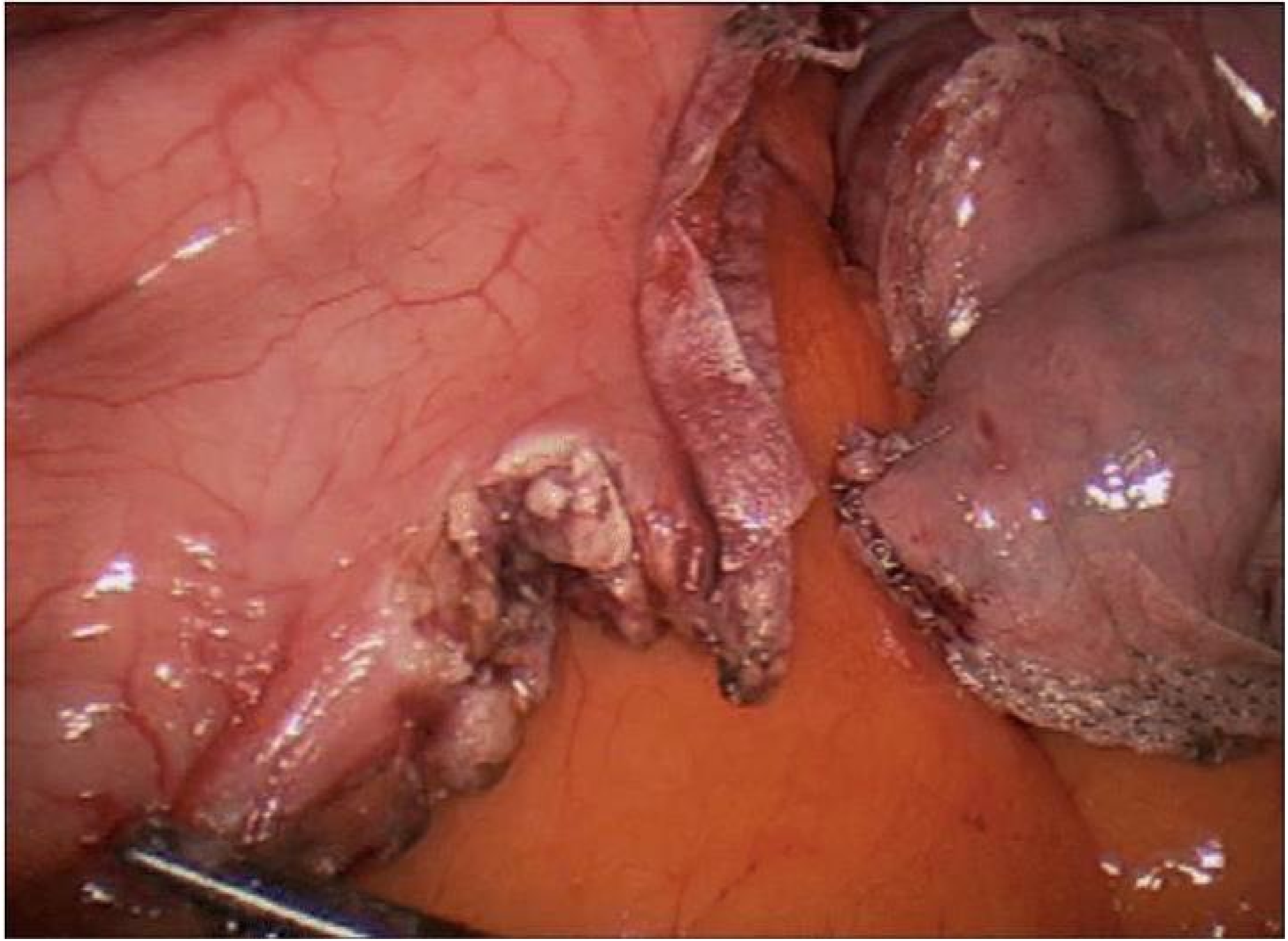

Image 3 Specimen is grasped with endoscopic snare

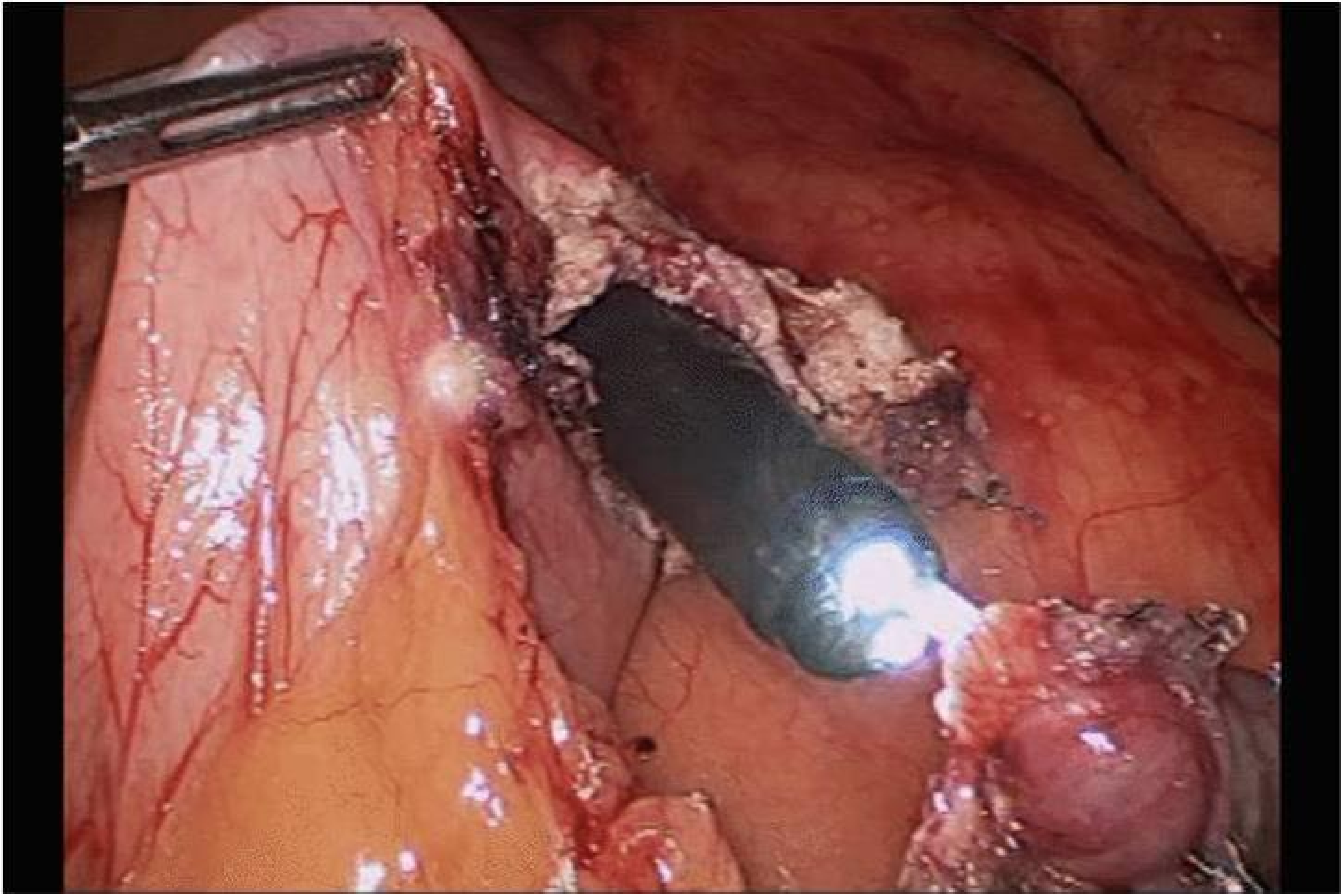

Image 4 Specimen retrieved into the stomach

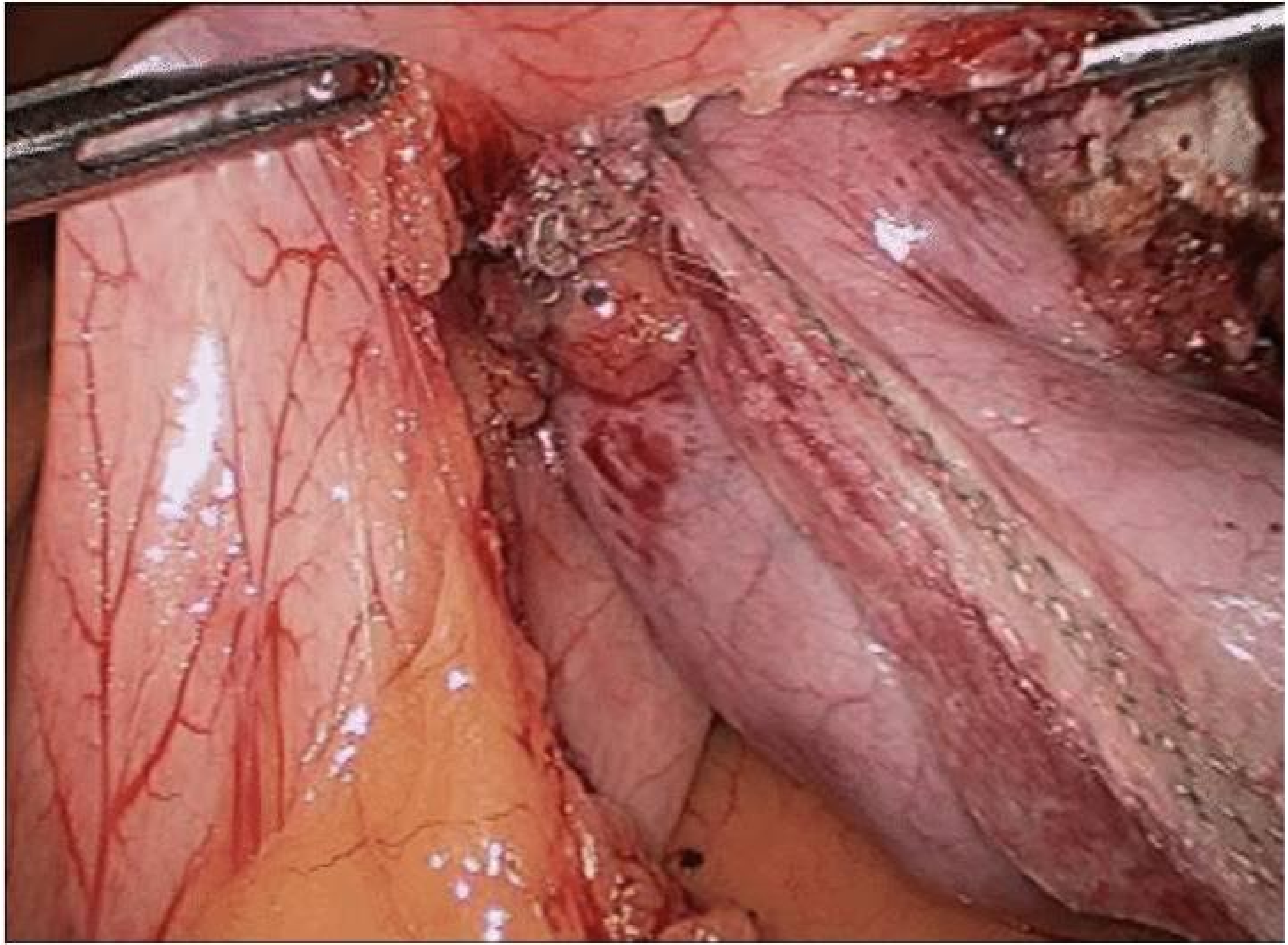

Image 5 Specimen was extracted intact

Table 1 Results

	TORE	non-TORE	p value
number of cases	18	10	N.S
sex	male = 3, female = 15	male = 1, female= 9	N.S
age	48.2 (29-63)	52.7 (27-61)	N.S
BMI	44.8 (33-60)	48.6 (40-62.3)	N.S
number of comobidities	3.6 (1-7)	3.2 (1-4)	N.S
speimen volume (cc)	291.5 (112-520)	173.8 (100-262.5)	0.02
OR time (minutes)	87.3 (20-150)	95.2 (60-180)	N.S
estimated bllod loss (cc)	21.2 (5-50)	22.5 (5-50)	N.S
hospital stay (days)	2.6 (2-7)	2.4 (2-5)	N.S
EWL (Ib)	60 (18.5-152.1)	61.3 (27.1-119.9)	N.S
EWL%	42.9 (14-87)	36.7 (18-66)	N.S
follow-up period (months)	6.2 (0.25-12)	6.5 (1-12)	N.S
wound extension	0	4	
wound infection	0	2	