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Transgastric laparoendoscopic approach to tumours of the stomach

Short title: Laparoendoscopic resection of gastric tumour

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Abstract

Background

There is currently limited data to reassure the technical efficacy, particularly in attaining clear margins, through a transgastric laparo-endoscopic approach to resecting tumours located near the gastroesophageal junction (GOJ) or the pylorus.

Methods

Single institution retrospective analysis of all cases from April 1, 2008 to Dec 31, 2019.

Results

Overall, 34 patients (38 tumours) underwent transgastric laparo-endoscopic resection. Of these, 27 (71.1%) and 5 (14.7%) cases were located close to the GOJ and pylorus respectively. Three (8.0%) cases were converted to conventional laparoscopic excision. No anatomical gastric resection was required. The mean (SD) operative time was 167.5 (64.2) minutes and reduced with increasing experience. The median (IQR) length-of-stay was 3.0 (3.0-4.5) days. Major post-operative complication (Clavian-Dindo ≥3) occurred in 1 (2.9%) patient, which required surgical control of staple line bleeding. The most common pathology was gastrointestinal stromal tumour (71.1%), followed by leiomyoma (10.5%), schwannoma (5.2%), dysplastic polyp (5.2%), and neuroendocrine tumour (2.6%). The mean (SD) tumour diameter was 3.9 (2.1) cm (largest 10.1 cm, 10 cases >5 cm). Resection margins were clear in all cases. We found no evidence of tumour recurrence or gastric stenosis at a median follow-up of 88 months.

Conclusion

Transgastric laparo-endoscopic resection of junctional and pyloric tumours with low metastatic potential is technically feasible. This approach achieved clear resection margins in all our cases, with acceptable perioperative and longer-term outcomes.

Introduction

Submucosal lesions of the stomach constitute less than 2% of tumours,(1) and are identified by their projection into the gastric lumen with normal overlying gastric epithelium. The majority of these lesions are gastrointestinal stromal tumours (GIST). Whilst mostly benign, some have malignant potential, the risk stratified by tumour size and mitotic rate.(2)

GIST can present at any location throughout the gastrointestinal tract with 40-60% occurring in the stomach.(1) Gastric GIST rarely metastasize to lymph nodes and are potentially curable by local excision making them readily amenable to laparoscopic resection. GIST may present to the serosal surface where standard laparoscopic resection is generally straight forward.(3, 4) However, when presenting intraluminally, particularly in close proximity to the gastro-oesophageal junction (GOJ) or pylorus, they can present a technical challenge (**Figure 1**). In these cases, the lesion may be difficult to excise by traditional laparoscopic techniques as there is a risk of compromising the GOJ or pylorus. Traditionally such lesions were subjected to laparotomy and potentially anatomical gastric resection to ensure adequate tumour excision, preservation of the GOJ or pyloric channel, and satisfactory patient outcomes. Techniques such as laparoscopy with gastrotomy and lesion eversion suit lesions located on the main anterior or posterior gastric walls but are cumbersome and potentially morbid around the GOJ and pylorus.(5, 6)

The technique of transgastric laparoendoscopic resection offers a precise method of managing such awkwardly located tumours, allowing minimal resection and protection of major oesophago-gastric anatomy. However, publications are limited to case reports and small (under 10) case series.(6-10) There is minimal data to reassure the short and longer-term safety of this approach especially with respect to completeness of resection and risk of recurrence.

This paper reports the experience of a specialist upper gastro-intestinal surgical unit using this technique for intraluminally presenting gastric tumours, particularly of the proximal stomach. To date, this is the largest consecutive case series in the literature. The technique, clinical and pathological outcomes as well as post-operative follow up are reported here.

Materials and Methods

Study design

Retrospective analysis of patients undergoing transgastric laparoendoscopic resection of submucosal lesions of the stomach from April 1, 2008 to Dec 31, 2019. This study was approved by the Austin Health Human Research Ethics Committee.

Surgical technique

The patient is placed in a modified Lloyd-Davies position under general anaesthesia. The operation involves an endoscopist, laparoscopist and surgical assistant. The surgeon stands between the patient's legs with the assistant on the patient's left. The laparoscopic and endoscopic screens are situated on the patient's right side at the head of the bed (**Figure 2**). The stomach is inflated using CO_2 delivered via the gastroscope. Gastric transillumination through the anterior abdominal wall is ensured, which facilitates positioning using needle localization into the lumen of the stomach. The gastroscope is withdrawn back to the level of the tumour so a position on the greater curve that allows direct access to the tumour can be identified. An open cut down through the anterior abdominal wall is made. The stomach is then grasped with atraumatic graspers and secured with two anchoring sutures. A gastrotomy is created to allow placement of a 12 mm balloon port (**Figure 3A**). The inflated balloon holds the stomach against the abdominal wall. Two flanged 5 mm ports or one 5 mm and one 12 mm port are then inserted trans-gastrically under gastroscopic vision, triangulating towards the tumour. With the gastroscope withdrawn into the oesophagus, gastric insufflation to 15 mmHg is delivered via the 12 mm balloon port. Operative vision is provided by a 30-degree, 10 mm laparoscope. Standard laparoscopic instruments are used for tissue manipulation and dissection (**Figure 3B**). Tumour resection is performed in most cases with a laparoscopic stapler. Traction sutures placed at the proximal or distal margins of the tumour are used to elevate and aid passage of the stapler beneath the tumour to ensure an adequate resection margin. Once resected, the lesion is placed in an Endocatch (Medtronic, Covidien, USA) bag and delivered trans-orally with the gastroscope or via an extended gastrotomy if deemed too large to pass through the oesophagus. The gastrotomy is sutured closed and leak tested using gas insufflation from the gastroscope before returning back into the abdomen. The transgastric ports are then converted to laparoscopic ports and the remaining gastrotomies sutured or stapled closed. The resection line, and gastric closure sites were inspected endoscopically and laparoscopically to ensure haemostasis upon completion of each case.

Data collection and analysis

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Data was extracted from patient records into a standardised electronic proforma. Patient demographics, operative details,

histopathology and clinical outcomes were collected. Quantitative analysis was performed in Microsoft Excel.

Results

In total, 34 patients with 38 submucosal lesions of the stomach underwent resection using the described technique. There were 13 men and 21 women with a median age of 72 years (range 41 to 85 years). The method of removal, size, location and histopathology of the resected specimens are detailed in **Table 1**. All resections achieved R0 margins.

All operations apart from three (92%) were completed successfully via the transgastric technique. In the remaining three patients, it was deemed intraoperatively unsuitable for transgastric resection due to poor transgastric access and thus converted to laparoscopic resection. The overall mean (standard deviation) surgical duration was 167.5 (64.2) minutes. This reduced with increasing operative experience (first 10 cases: 219.3 (58.7), second 10 cases: 170.4 (79.5), third 10 cases: 184.4 (46.3), last 8 cases: 125.4 (44.3) minutes). The overall median (interquartile range) length of stay post-surgery was 3 (3.0-4.5) days.

There were five complications in the 34 patients (14.7%). As per the Clavian-Dindo classification, these are categorised into three: 1 (2.9%), two: 3 (8.8%), one: 1 (2.9%). Four patients had complications associated with post-operative bleeding while one had a minor leak and post-operative collection. There was no operative or 30-day mortality. Of the bleeding complications, one patient required return to theatre day one post-surgery for bleeding from the intragastric staple line. This was controlled with a sutured repair. One patient had haematemesis post-operatively requiring two units of transfused packed red blood cells without the need for operative intervention. Two cases of extragastric sites of bleeding were recorded. One had a minor splenic laceration during laparoscopic closure of the port sites at the conclusion of the case. Haemostasis was achieved with topical haemostatic agents including Floseal (Baxter, USA) and Surgicell (Johnson and Johnson Medical Devices, USA). Another patient suffered a self-limiting rectus sheath haematoma from passage of a transperitoneal decompression needle to relieve intraperitoneal gas accumulation during surgery. A localized leak from a transgastric ports that resulted in a post-operative collection was found in one patient. This was managed nonoperatively with antibiotics. Of note, this case was converted to a conventional laparoscopic wedge resection due to the tumour location at the distal antrum.

For the 27 GIST lesions the average tumour size was 42.0 mm (range 10 – 101 mm). Eleven were removed transorally (40.7%), and sixteen transabdominally (59.3%). Seventeen tumours were low grade (63.0%), five moderate grade (18.5%)

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and five high grade (18.5%). All margins on resection were clear. Clinical, endoscopic and radiological (CT) follow-up data was available for 18 patients (75%), including the 10 patients with moderate and high grade tumours. Follow-up duration was at a median of 88 months (range 12-149 months). We found no evidence of local or distant tumour recurrence. No luminal stenosis was identified. One patient with high-grade GIST had concurrent diffuse Large B-cell lymphoma and passed away 15 months post GIST resection from lymphoma.

Discussion

This is the largest reported series of transgastric laparoendoscopic tumoral resection, including 27 GISTs. Tagaya et al reported a similar technique in six consecutive patients and Privette et al in four patients.(8, 9) Our experience extends these findings, demonstrating that even for large lesions (up to 10 cm), and those with high grade histopathology, a transgastric laparoendoscopic approach is technically feasible, achieves clear resection margins, with acceptable perioperative and longer-term outcomes.

Laparoscopic local resection is widely accepted for resection of gastric submucosal tumours.(5, 7, 10) Laparoscopic surgery has the benefit over open surgery of shorter hospital stay, early return of bowel function, faster return to activities of daily living and reduced analgesic requirements.(5) Intraluminal lesions however, particularly those close to the GOJ, pose an operative challenge. Being intraluminal, the lesion is not visible and may not be easily palpable laparoscopically. Accurate localisation and complete resection of these tumours can be problematic. Pre-operative marking with clips or dye may act as a guide to the tumour location but still does not facilitate precise local resection and often a wide margin for error is required. This has the potential to compromise important anatomical structures such as the GOJ and pylorus, particularly when the lesion is closely adjacent. Some authors advocate avoiding laparoscopic surgery within 1 cm of these regions.(5) Open surgery is feasible but requires a major abdominal incision to access the hiatus and GOJ. It also demands an anatomical resection to avoid narrowing the GOJ and pylorus.

The transgastric technique avoids such problems and is ideal for these proximally and distally based lesions. Gastrotomies are made on the greater curve with ample room for closure without compromising either the pylorus or GOJ. The procedure is entirely self-contained, thus minimising the risk of tumour cell spillage into the abdominal cavity compared to other approaches. Furthermore, intragastric insufflation flattens the rugal folds, and allows precise localization and resection of the target site. Importantly, the view is magnified and the squamo-columnar junction is clearly visible. This facilitates local resection of even the most abutting of lesions.

In our series, the transgastric approach was successfully employed in the majority of cases (92% intention to treat) indicating excellent utility in selected patients. It finds its greatest application in peri GOJ, high lesser curve and pre pyloric regions. This experience is shared by Privette et al, who proposed an anatomical classification to guide selection of different

approaches for resecting gastric GISTs.(8) It is not well suited or necessary for mid body, greater curve or proximal antral lesions where a standard laparoscopy and gastrotomy eversion technique is likely to be easier. Lesion selection based on site is important but assessment intraoperatively of stomach shape and access to the lesion via transgastric ports is also vital. Whilst described by some authors, we did not require routine laparoscopy to facilitate gastric port placement in our series, with needle localization through the insufflated stomach proving sufficient. Patients with likely gastric adhesions from prior upper abdominal or gastric surgery may not be suitable candidates.

Preoperative endoscopy and cross-sectional imaging are important in planning. Apparent intraluminal lesions on endoscopy may be dumbbell shaped with a significant exophytic component. In these cases, a transgastric approach is not ideal nor usually necessary. PET scanning may be used in some cases for staging of GIST lesions to exclude distant metastases particularly for larger lesions.

Tumour dissection technique depends on the nature of the lesion. A narrow pedicle lesion can be dealt with easily using a laparoscopic stapler. An articulating type stapler is useful when negotiating various angles depending on tumour and port locations as well as stomach shape. A broad-based lesion may require initial lifting to create a narrower pedicle prior to stapling. Importantly, adequate distance between port site and tumour location, as assessed on endoscopy, is required to facilitate stapler manoeuvrability. A short (e.g. 45mm) stapler cartridge is usually ideal in our hands.

Bleeding appears to be the most frequent complication of the laparoscopic transgastric approach. Bleeding from the internal gastric staple line occurred in two of our patients, one requiring return to theatre for open repair and one managed conservatively. Meticulous care and inspection should be performed intraoperatively and haemostasis achieved at the end of every procedure. Standard laparoscopic techniques can be used intraluminally and recently the authors have routinely underrun the staple line with sutures.

Our reported series is limited by its retrospective nature and incomplete follow-up data in 25%. However, all patients with moderate to high grade tumours were followed up. Overall, based on our experience, the transgastric approach is technically feasible, surgically safe, and consistently achieves clear margins with minimal risk of recurrence. We conclude that this is a

valid technique for treating gastric GIST and other gastric lesions, where nodal dissection is not required, and when these lesions are placed at or near the GOJ and pylorus.

Statement of ethics

This study was approved by the Austin Health Human Research Ethic Committee. Individual patient consent was waived for this study

Conflict of interest statement

The authors have no conflicts of interest to declare

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None

Author contributions

Zarif Yahya: study design, data collection and analysis, drafting of article, final approval

David S Liu: study design, data analysis and interpretation, drafting of article, final approval

Gary Foo: study design, data interpretation, drafting of article, final approval

Ahmad Aly: study conception and design, data interpretation, drafting of article, final approval

References

1.   Cheng HL, Lee WJ, Lai IR, Yuan RH, Yu SC. Laparoscopic wedge resection of benign gastric tumor. Hepatogastroenterology. 1999;46(27):2100-4.

2.   Parab TM, DeRogatis MJ, Boaz AM, Grasso SA, Issack PS, Duarte DA, et al. Gastrointestinal stromal tumors: a comprehensive review. J Gastrointest Oncol. 2019;10(1):144-54.

3.   De Vogelaere K, Van Loo I, Peters O, Hoorens A, Haentjens P, Delvaux G. Laparoscopic resection of gastric gastrointestinal stromal tumors (GIST) is safe and effective, irrespective of tumor size. Surg Endosc. 2012;26(8):2339-45.

4.   Aogi K, Hirai T, Mukaida H, Toge T, Haruma K, Kajiyama G. Laparoscopic resection of submucosal gastric tumors. Surg Today. 1999;29(2):102-6.

5.   Ma JJ, Hu WG, Zang L, Yan XW, Lu AG, Wang ML, et al. Laparoscopic gastric resection approaches for gastrointestinal stromal tumors of stomach. Surg Laparosc Endosc Percutan Tech. 2011;21(2):101-5.

6.   Sekimoto M, Tamura S, Hasuike Y, Yano M, Murata A, Inoue M, et al. A new technique for laparoscopic resection of a submucosal tumor on the posterior wall of the gastric fundus. Surg Endosc. 1999;13(1):71-4.

7.   Ludwig K, Wilhelm L, Scharlau U, Amtsberg G, Bernhardt J. Laparoscopic-endoscopic rendezvous resection of gastric tumors. Surg Endosc. 2002;16(11):1561-5.

8.   Privette A, McCahill L, Borrazzo E, Single RM, Zubarik R. Laparoscopic approaches to resection of suspected gastric gastrointestinal stromal tumors based on tumor location. Surg Endosc. 2008;22(2):487-94.

9.   Tagaya N, Mikami H, Kogure H, Kubota K, Hosoya Y, Nagai H. Laparoscopic intragastric stapled resection of gastric submucosal tumors located near the esophagogastric junction. Surg Endosc. 2002;16(1):177-9.

10.   Walsh RM, Ponsky J, Brody F, Matthews BD, Heniford BT. Combined endoscopic/laparoscopic intragastric resection of gastric stromal tumors. J Gastrointest Surg. 2003;7(3):386-92.

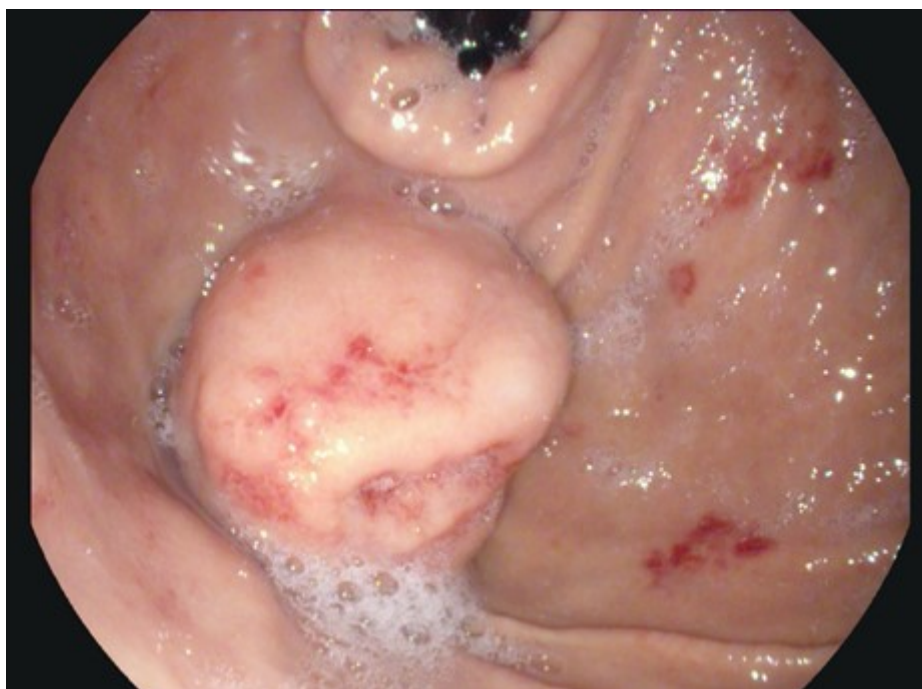**Table 1. General Data for Patient Series**

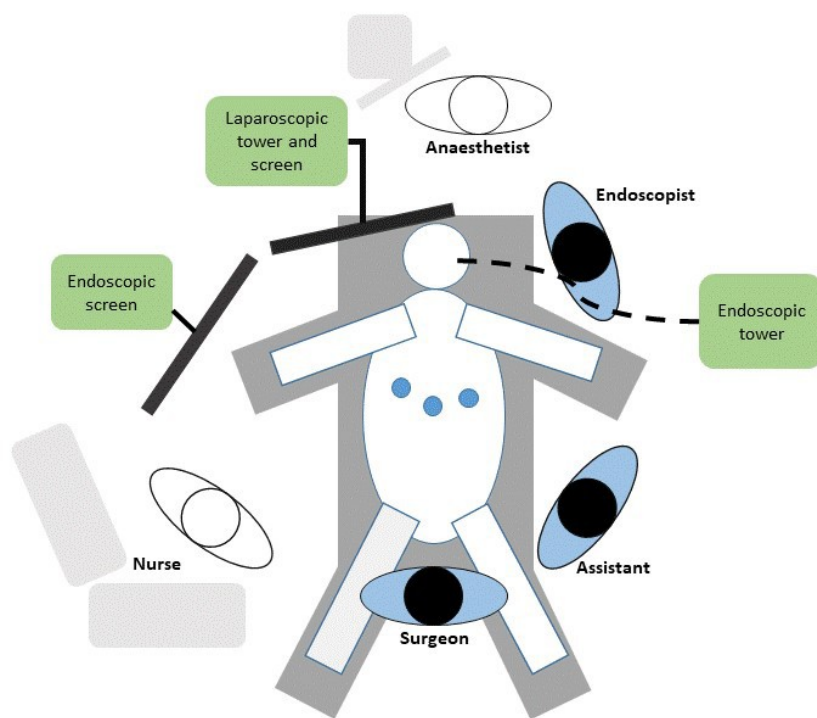|	
Age, years	
Range	41 - 85
Median	72
Mean	70
Gender, n (%)	
Female	21 (61.8)
Male	13 (38.2)
Size, cm, (%)	
< 2	6 (15.8)
>2 to <5	22 (57.9
>5 to <10	9 (23.7)
>10	1 (2.6)
Location of Lesion, n (%)	
Cardia	13 (34.2)
Fundus	6 (15.8)
Lesser Curvature	8 (21.1)
Greater Curvature	2 (5.2)
Antrum & Pylorus	5 (13.2)
Anterior wall	1 (2.6)
Posterior wall	3 (7.9)
Method of removal, n (%)	
Transoral	16 (42.1)
Transabdominal	18 (47.4)
Not recorded	4 (10.5)
Pathology, n (%)	
Leiomyoma	4 (10.5)
Schwannoma	2 (5.2)
Dysplastic polyp	2 (5.2)
Carcinoid tumour	1 (2.6)
Gallstone	1 (2.6)
Heterotopic pancreatic tissue	1 (2.6)
GIST lesion	27 (71.1)
GIST Lesions Mitotic count (Grade), n (%)	
< 5 /50 HPF (Low-grade)	17 (62.9)
>5 to < 10 /50 HPF (Mod-grade)	5 (18.5)
>10 /50 HPF (High-grade)	5 (18.5)
Surgical margins (R0), n (%)	38 (100.0)

Figures

Figure 1. Difficult submucosal lesion at the gastric cardia

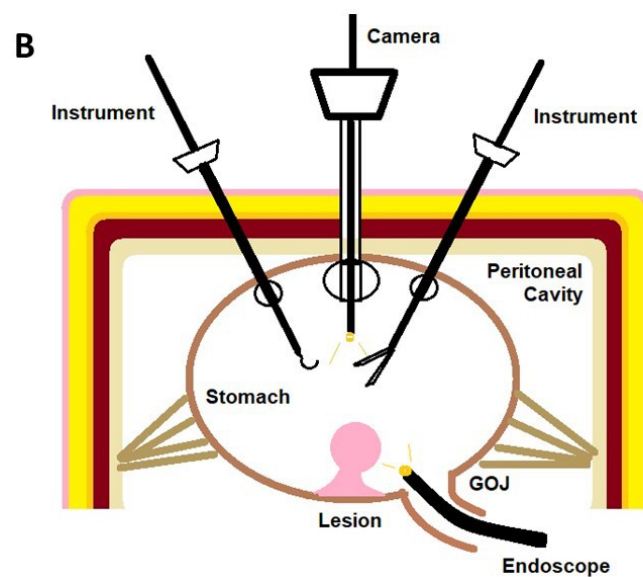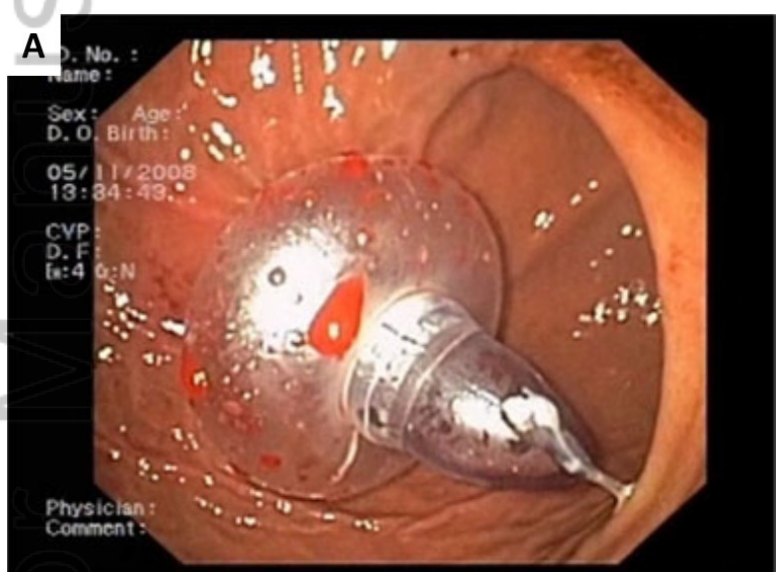**Figure 2.** Laparoendoscopic transgastric approach in theatre set up

Figure 3. **A.** Endoscopic view of the 12 mm transgastric balloon port. **B.** Cross-sectional diagram of transgastric access

ANS_17314_Figure 1.jpg

ANS_17314_Figure 2.jpg

A

B

Camera

Instrument

Instrument

Peritoneal
Cavity

Stomach

GOJ

Lesion

Endoscope

ANS_17314_Figure 3.jpg