World J Surg (2008) 32:1021–1028
DOI 10.1007/s00268-008-9492-1

World Journal of Surgery

# Simultaneous Use of Laparoscopy and Endoscopy for Minimally Invasive Resection of Gastric Subepithelial Masses — Analysis of 93 Interventions

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Published online: 14 March 2008


**Abstract**
*Background* Subepithelial gastric tumors are common findings during upper gastrointestinal endoscopy. Tumor resection is mostly done laparoscopically, but there is still discussion concerning the size of lesion for which the treatment may be minimally invasive; additionally there is very little data available concerning patient outcome after minor access surgery.
*Methods* Clinicopathologic features and survival data of 93 consecutive patients undergoing a combined laparoscopic-endoscopic approach for gastric submucosal tumors were prospectively analyzed. Analysis included preoperative diagnostic work-up, perioperative data, and postoperative complications. Follow-up was carried out for patients with GIST to check for tumor recurrence.
*Results* It was possible to resect 88 of 93 lesions by the laparoscopic-endoscopic approach, with tumor-free margins in all patients. Intraoperative endoscopy facilitated exact tumor localization in 92 patients. Most lesions were removed by endoscopic-laparoscopic wedge resection or, less frequently, by a combined transgastric approach. Mean operative time was 90.7 min; the postoperative hospitalization was 7.3 days. Adverse events appeared in 7.5%, and conversion to open surgery was required in 6.5%. For patients suffering from gastrointestinal stromal tumors, there was no tumor recurrence at a mean follow-up of 40 months.
*Conclusions* Combined laparoscopic-endoscopic "rendez-vous" procedures are easy to perform and offer a curative approach for almost all gastric submucosal lesions. The technique is associated with low morbidity and short hospitalization. Though even patients with large GISTs of intermediate and high risk were treated, no tumor recurrence has been observed to date.

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## Introduction

Gastric subepithelial masses are common findings during routine upper endoscopy, normally appearing as a mass, bulge, or impression covered by normal epithelium; the actual incidence rate of these lesions is difficult to estimate, but it may be as high as 0.4% [1].

Subepithelial tumors display a wide spectrum from benign to highly malignant, with gastrointestinal stromal tumors (GIST) the most common type [2, 3]. Unfortunately, only endoscopic ultrasonography with fine-needle aspiration allows exact preoperative assessment of the diagnosis in some cases [4, 5], as these lesions are located in deep layers of the stomach.

Accordingly, local excision with negative surgical margins is indicated in the majority of cases. In order to avoid the invasivity of a conventional open surgical resection, however, laparoscopic wedge resection was established as a less invasive option without compromising curability [6–9]. Some methodological limits to this

approach, however, are immanent: localization of intraluminal tumors during laparoscopy is only promising when approaching large lesions that protrude into the abdominal cavity. Intraoperative tumor localization therefore is mostly realized by preoperative endoscopic marking of the lesion via clip application or injection of dye [10–12]. Unfortunately, some problems are described for most of these techniques [13, 14]. In addition, wedge resection cannot be considered when a tumor is located near the cardia or pylorus, where the esophagocardiac junction or pyloric ring could be involved in the resection line [15], The procedure would also be difficult if the tumor is located at the posterior wall; in such cases, various types of transgastric or intragastric laparoscopic resections have been published [16]. In some recently reported series, intraoperative gastroscopy is considered to be a promising technique for successful intraoperative tumor localization, and it is seen as essential for laparoscopic local excision of subepthelial masses [3, 15, 17, 18]. In rare cases, it is even possible to remove the lesion solely by means of the flexible endoscope and the diathermy snare if the tumor is adequately presented by the laparoscopist [19].

In a consecutive series of 93 patients, we set out to assess whether the armamentarium of three minimally invasive procedures (laparoscopic wedge resection, laparoscopic transgastric resection, and endoscopic resection), together with routine intraoperative endoscopy, is suitable for the treatment of all types of subepthelial masses with a diameter of <5 cm irrespective of location within the stomach.

## Patients and methods

Between March 1994 and December 2006 a total of 93 patients underwent combined laparoscopic-endoscopic resection for gastric subepithelial masses at our institution (Klinikum rechts der Isar, Technical University of Munich). Preoperative work-up for all patients included medical history, standard blood tests, upper gastrointestinal (GI) endoscopy with endoscopic ultrasound examination, chest x-ray, and abdominal ultrasonography/computed tomography (CT) scan. If patients were referred by an external gastroenterologist, the endoscopic examination was repeated to verify the diagnosis and to exclude alternative options of treatment. In some patients additional infomation was gained by taking biopsies of the lesion by means of conventional endoscopic tissue probing or by ultrasound-guided fine needle aspiration.

According to the preoperative work-up, all tumors were diagnosed as subepithelial tumors irresectable by endoluminal endoscopy.

All patient data were included into a prospective database containing name, gender, age, and the date of the operation. Additionally, the preoperative assumed diagnosis was included, as was the exact location of each lesion. The ability to provide intraoperative tumor localization by laparoscopy alone or by endoscopy, the duration of the intervention, intraoperative and postoperative complications, and the length of hospital stay were registered. The exact histopathological diagnosis, the lesion's diameter, and, for gastrointestinal stromal tumors, the grade of potential malignancy were included in the database. All patients suffering from a gastrointestinal stromal tumor received a tumor follow-up according to particular guidelines (Scottish GIST guidelines [20, 21]). This follow-up included the medical history, blood tests, chest x-ray, abdominal ultrasound examination and, depending on the malignant potential of the resected tumor, initial and repetitive CT scans. An additional upper GI endoscopy was perfomed to exclude endoluminal tumor recurrence. For patients with gastrointestinal stromal tumors, the follow-up was carried out either by the family physician or by our outpatient department.

### Surgical procedures

All interventions were performed under general anesthesia with the patients in a supine and reverse-Trendelenburg position. The laparoscopist stood on the patient's right side, with the monitors face-to-face on the opposite side.

After pneumoperitoneum was established with a Verres needle, at least three trocars were inserted intra-abdominally: the optical trocar in a supraumbilical position and two trocars for the manipulating instruments in the left and right upper quadrants, corresponding to the tumor site. For patients with an expanding left liver lobe, a fourth (5 mm) trocar was inserted in the right epigastrium close to the costal arch for better exposition of the stomach.

The abdominal cavity was exposed and identification of the gastric lesion was attempted. Upper endoscopy was then performed, with the endoscopist standing close to the anesthesiologist. Endoscopy was done after establishing the pneumoperitoneum to avoid injury to inflated organs. The endoscope (Olympus Q 160, Olympus Deutschland GmbH, Hamburg, Germany) was inserted perorally and advanced into the stomach, and the lesion, which usually protruded into the gastric lumen, was precisely localized. By the use of diaphanoscopy and manipulation along the gastric wall close to the lesion, the exact location of the subepithelial tumor was demonstrated to the laparoscopist, who observed the gastric wall from the outside. With this team approach, tumor targeting was accomplished and the decision was made for the best means of tumor resection.

To optimize the interaction between the participating actors, the laparoscopist needs direct view onto the endoscopic situs, so a second screen displaying the endoscopic

view to the laparoscopist is mandatory. Likewise, the endoscopist has an additional screen providing the laparoscopic view. Thus, four monitors are necessary in total (laparoscopist: laparoscopic and endoscopic view; endoscopist: endoscopic and laparoscopic view). This normally leads to a crowded OR; by the use of an integrated OR system (SIOS Siemens/Erlangen/Germany), and by establishing an OR environment dedicated to combined interventions, the routine was significantly facilitated in our institution. In our combined procedure intervention room all monitors are flat panel plasma screens mounted pairwise onto a monitor arm fixed to the ceiling. The mobility of these monitor arms allows for optimal positioning of the screens face-to-face to the actors. Thus, an effective interaction between both members of the rendez-vous team is guaranteed.

Depending on the localization of the tumor and according to the assessment of both actors, any of three possible approaches to resection can be chosen: laparoscopically assisted endoscopic resection (LAER), endoscopically assisted wedge resection (EAWR), or endoscopically assisted transgastric resection (EATR).

*Laparoscopically assisted endoscopic resection (LAER)*

For early cases with only small lesions found during endoscopic ultrasound examination, the resection can be done endoscopically with a snare. In some cases the resection can only be performed when supported from the outside by the laparoscopist—for example, by pushing the lesion into the stomach for increased exposition or by stretching the gastric wall with graspers. As this procedure is combined with a higher perforation rate, we recommend simultaneous laparoscopic assistance in any case. If a leak develops at the site of perforation, it can be closed by stapler application or by suturing (Fig. 1a).

*Endoscopically assisted wedge resection (EAWR)*

The procedure most commonly used is endoscopically assisted laparoscopic wedge resection (EAWR) which can be applied to tumors in the anterior wall of the stomach or lesions located at the greater or lesser curvature. After localization of the tumor with the rendez-vous technique, the surgeon elevates the part of the gastric wall that carries the lesion; this can be done by grasping the gastric wall with atraumatic forceps or by the use of one of more sutures inserted into the anterior wall, next to the lesion; the sutures then can be elevated like braces, "towing" the tumor site (so-called lesion lift method). As soon as the tumor is exposed that way, a linear stapler device is inserted intra-abdominally and positioned just beyond the lesion; after verifying the correct position of the stapler,

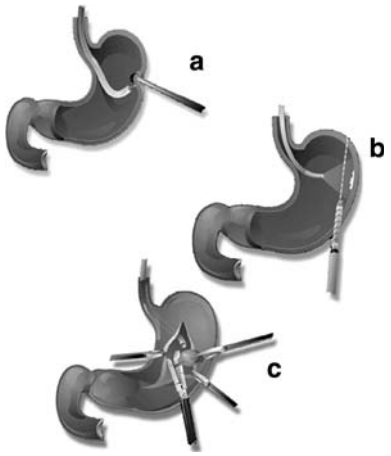


**Fig. 1** For laparoscopic-endoscopic "rendez-vous" resection, three different methods are available. In case of laparoscopic assisted endoscopic resection, the lesion is resected with diathermy (**1a**); larger lesions demand resection to be performed as wedge resection for tumors located in the anterior aspect of the stomach (**1b**) and as transgastric resection for posterior wall lesions (**1c**)

with the tumor completely captured, the device is fired. After wedge resection of the tumor site, the specimen is recovered into a retrieval bag and extracted. Though the suture line is controlled from both sides, from endoluminal side by the endoscopist and externally by the laparoscopist, we recommend oversuturing the stapler line to avoid bleeding and insufficiency later on. This recommendation is the result of experience gained at the beginning of "combined interventions," when reoperation sometimes became necessary because of postoperative bleeding. To assure a safe and leak-proof suture line, the endoscopist finally can insufflate air into the stomach or apply blue dye.

The EAWR procedure can be applied to lesions of the anterior wall and is limited to the central parts of the stomach; it may be difficult in the cardia region and close to the pylorus, because in these areas it might lead to stenosis (Fig. 1b).

*Endoscopically assisted transgastric resection (EATR)*

Lesions of the posterior gastric wall were approached transgastrically after incision of the anterior wall. In the first step, the endoscopist demonstrates the site of the tumor, and with endoscopic assistance the laparoscopist chooses the optimal entry point into the gastric cavity. Diaphanoscopy is used so that injury to major vessels during this step of the procedure can be avoided.

As soon as the anterior wall is incised with diathermy and scissors, the tumor is elevated by stay sutures and resected by application of one or more linear stapler devices capturing the surrounding posterior wall.

After revision of the posterior wall stapler line, the entry point on the anterior aspect of the stomach is closed by

suturing or by linear stapler application. To prevent the development of stenosis, the stapler should be applied at right angles to the gastric axis. Finally, the suture lines are checked for bleeding and leak-proofness (endoscopically and laparoscopically) (Fig. 1c).

## Results

Since 1994, combined laparoscopic-endoscopic resections for subepithelial masses of the stomach were performed in 93 consecutive patients in our institution. Demographic analysis revealed an almost equal male to female ratio (43 males and 50 females); mean patient age was 58 years at time of operation, with an age range of 18 to 83 years. Tumors resected ranged from 0.3 cm to 6.5 cm in diameter, with a mean size of 2.6 cm (Table 1) .

The lesions were located in the upper third of the stomach in 36 cases, in the middle third in 38 patients, and distally, in the lower third of the stomach, in 19 patients. Most often, tumors were situated in the anterior wall or along the lesser or greater curvature (55 patients), whereas tumors of the posterior wall were seen less frequently (38 patients). According to this distribution, endoscopically assisted laparoscopic wedge resection (EAWR) was the therapy of choice for most patients.

Tumor resection was done as a wedge resection under endoscopic assistance (EAWR) in 55 patients, via a transgastric approach after anterior gastrotomy (EATR) in 34 patients, and as laparoscopically assisted endoscopic snare resection (LAER) in 1 case only. In three converted cases alternative methods of treatment were chosen (like distal gastrectomy); accordingly, these interventions could not be assigned to any of the three methods.

For the single patient who underwent LAER, laparoscopic assistance was confined to adequate exposition of the tumor during resection and external control for leak-proofness afterwards. The endoscopic resection was completed the fastest in only 25 min and the patient could be discharged 2 days postoperatively. Mean operative time for wedge resections was 81 min with a range of 35 to 202 min, whereas the duration of the EATR operation was 114 min with a range of 40 to 275 min. The length of postoperative hospital stay for patients who underwent a laparoscopic resection averaged 7.5 days, both in the case of a wedge resection and a a transgastric procedure.

Tumor identification and localization by single visual exploration and palpation of the abdominal cavity during initial laparoscopy was successful in 21 of 93 patients (22.6%), but in only three patients was it so exact that the resection could have been performed without additional targeting. This was due to the inability to define whether a lesion was located in the anterior or posterior aspect of the stomach, though the lesion itself appeared as protruding mass. Interestingly, tumor sizes exceeded 2 cm in diameter in the majority of cases where tumors were laparoscopically localized. However endoscopic tumor localization was applied in every case, and with the endoluminal view, 92 tumors were exactly located. In one patient localization of the lesion was impossible by either endoscopy or laparoscopy (Table 2); therefore an open resection proved to be necessary. As endoscopic visualization could also be applied during resection, it allowed maintenance of clear resection margins in all cases of combined tumor resection.

Supplementary procedures were performed in five patients: additional cholecystectomy was done in three cases; in one patient, the treatment for gastric submucosal tumor was combined with a laparoscopic sigmoidectomy, and a laparoscopic fundoplication was performed in the fifth patient. These five patients were entered into the database despite the longer operative times and the major trauma.

Conversion from laparoscopic to open surgery was required in 6.5% of all cases (6/93). In one case, bleeding

**Table 1** Demographic data of the collective

| | LAER | EAWR | EATR |
|---|---|---|---|
| Age (years) | 69 (69) | 59.6 (18–80) | 55.7 (27–83) |
| Sex (m/f) | 0/1 | 28/27 | 15/19 |
| Mean tumor size (cm) | 0.5 | 2.54 (0.3–6.5) | 2.61 (0.5–5.5) |
| Median tumor size (cm) | 0.5 | 2,50 | 2,85 |
| Number[a] | 1 | 55 | 34 |
| OR time (min) | 25 | 81.2 (35–202) | 114.0 (40–275) |
| Hospitalisation (days) | 2 (2) | 7.68 (4–19) | 7.48 (2–14) |
| Location | | | |
| Upper Third | 1 | 18 | 18 |
| Ant wall | 0 | 17 | 1 |
| Post wall | 1 | 1 | 17 |
| Middle third | 0 | 29 | 8 |
| Ant wall | 0 | 27 | 0 |
| Post wall | 0 | 2 | 8 |
| Lower third | 0 | 11 | 8 |
| Ant wall | 0 | 11 | 0 |
| Post wall | 0 | 0 | 8 |

[a] Three converted cases could not be assigned to any method

**Table 2** Methods of intraoperative tumor localization

| | Frequency | Percent |
|---|---|---|
| Laparoscopic targeting | 21 | 22.6% |
| Endoscopic targeting | 92 | 98.9% |
| None | 1 | 1.1% |
| Total | 93 | 100% |

occurred and could not be handled in a minimally invasive setting; in a second patient, tumor targeting was unsuccessful even though intraoperative endoscopy was performed. After conversion, a subepithelial tumor 0.7 cm in diameter could be palpated and was locally resected. Three conversions were necessary because wedge-resection or transgastric resection for lesions located in the antrum region of the stomach would have caused stenosis of the lumen. After conversion to an open procedure a distal gastrectomy was performed. The last conversion was necessary because of excessive intra-abdominal adhesions from prior surgery for cholecystitis.

Adverse events occurred in seven cases (7.5%, 7/93). Nearly all complications (6/7) were due to bleeding of the stapler line postoperatively. Bleeding was handled via endoscopic epinephrine and fibrin-glue instillation in two patients. In another patient bleeding stopped after substitution of fresh frozen plasma under conservative treatment, but in three cases a reoperation was necessary (Table 3).

All bleeding occurred during the performance of the first cases of laparoscopic-endoscopic rendez-vous resection. Because the linear stapler lines are regularly oversewn, bleeding did not occur in any further case.

Insufficiency of the stapler line was identified in one patient and required an open reoperation. As already mentioned, three additional reoperations were necessary because of postoperative bleeding. In this series, however, there were no wound infections and no perioperative deaths.

All patients received nasogastric tube drainage for 3 to 4 days. Oral nutrition started the day after the nasogastric tube was removed. Bowel function resumed between postoperative days 2 and 3 for all patients.

Histopathologic processing of the retrieved specimen showed malignant and potentially malignant findings in 65 patients (62 gastrointestinal stromal tumors, 3 neuroendocrine tumors) and benign findings in 28 patients (9 leiomyomas, 8 pancreatic rests, 5 neurinomas, 3 lipomas, 3 hyperplastic polyps). According to the classification for GISTs published by Fletcher et al. in 2002 [22], and according to the lesions size and mitotic activity index, 49 GISTs proved to be of low risk, and 5 were of very low risk, whereas 7 GISTs were of intermediate risk and one of high risk. All lesions were resected with tumor-free margins as shown by histopathologic post processing (Table 4).

Though preoperative work-up included endoscopic ultrasound examination by an experienced endoscopist, the correct diagnosis could be predicted in only 68% of cases (63/93). Even for cases with preoperative tissue sampling (deep submucosal biopsies, fine needle aspiration), positive prediction of the underlying pathology was possible in only 83% (19/23).

The median follow-up period for the patients with GISTs in this series was 39.5 months (range: 2–99 months). One patient died from cardiac arrest, and all other patients were alive at the end of the study. There were no local or distant recurrences. Three patients describe mild upper gastrointestinal symptoms like postprandial disorders and pyrosis.

**Table 3** Perioperative complications

| | | | | |
|---|---|---|---|---|
| Bleeding | 6/93 | (6.4%) | Endoscopic treatment | 2 |
| | | | Conservative treatment | 1 |
| | | | Operative treatment | 3 |
| Leakage | 1/93 | (1,1%) | Operative treatment | 1 |
| | | | Reason | |
| | | | Bleeding | 1 |
| | | | Stenosis of lumen | 3 |
| | | | Localization | 1 |

## Discussion

The adequate management of submucosal lesions of the stomach, particularly gastric gastrointestinal stromal tumors, is still a matter of debate. Whereas small lesions (< 2 cm) are considered a clear indication for a minimally invasive approach, tumors larger than 3–5 cm in size are assigned to an increased risk for malignant behavior, and therefore some authors recommend open surgery, for oncologic principles [20].

Another point of discussion is the tumor localization. Whereas tumors in the middle third of the stomach can be treated easily in a laparoscopic way, tumors in the upper and lower thirds of the stomach, in proximity to the cardia

**Table 4** Postoperative histopathogical findings of the collective

| Diagnosis | Number ($n$ = ) | GIST risk group[a] | Number ($n$ =) |
|---|---|---|---|
| GIST | 62 | Very low risk | 5 |
| | | Low risk | 49 |
| | | Intermediate risk | 7 |
| | | High risk | 1 |
| Leiomyoma | 9 | | |
| Pancreatic rest | 8 | | |
| Neurinoma | 5 | | |
| Lipoma | 3 | | |
| NET | 3 | | |
| Hyperplastic Polyp | 3 | | |

[a] Risk groups according to Fletcher et al., Hum Pathol 2002 [22]

and pylorus, display an increased risk for stenosis after resection. Therefore some authors recommend open surgery for proximal and distal gastric submucosal lesions [15]. Laparoscopic resection for benign gastric lesions and GISTs had been proven to be feasible and safe, with moderate complication rates; in fact, the short-term results were superior, compared to open surgery [8]. However, little information is available concerning the long-term outcome of the patients; additionally, the impact of consequent intraoperative endoluminal endoscopy and the technique of combined laparoscopic-endoscopic surgery have not yet been evaluated.

This article summarizes a single-center experience of more than 10 years of combined laparoscopic-endoscopic rendez-vous resection for gastric submucosal lesions, based on the largest such series published to date.

The majority of subepithelial masses and most of the lesions in our series were gastrointestinal stromal tumors. As reported by DeMatteo et al. in 2000 and Fletcher et al. in 2001, these tumors rarely develop lymph node metastases [22, 23]; therefore local resection with gross negative margins is considered as curative approach as also described by other investigators [2, 6, 9, 24]. In this regard, safety margins of 1–2 cm, as required in older studies [8], do not appear to be absolutely necessary, especially as the long-term results and the overall outcome appear to depend much more on the mitotic index, than on widely resected margins [21]. This has to be regarded as a relevant precondition when working in the region of the gastroesophageal junction and close to the pylorus, where resection cannot be performed extensively to avoid stenosis later on.

In our series we found no local or distant recurrences after local resection of submucosal lesions. However, almost 70% (65/93) of the tumors proved to be malignant or potentially malignant, 5 of 62 resected GISTs measured more than 5 cm in size, and 8 of 62 gastroinestinal stromal tumors were assigned as intermediate or high risk according to the classification of Fletcher et al. [22]. As we did not preserve a safety margin of 1–2 cm in all cases, our results confirm the data of Novitsky et al. [21], which demonstrated that laparoscopically local resection offers a curative approach to all GISTs, even if they are of higher risk and measure more than 3–5 cm in diameter. In a multivariate analysis of potential risk factors for tumor reccurence they also could show that tumor reccurence is correlated only with the mitotic index of the lesion. Similar results were reported by Otani et al. in 2006 [20], with an excellent outcome after laparoscopic wedge resection of gastric stromal tumors. Additionally, tumor recurrence commonly occurs distant from the resection site, mainly in the liver. Therefore local resection remains the standard treatment for unmetastasized GISTs, although alternative therapeutic methods are available [24–26]. The indication for minimally invasive tumor resection should be set irrespective of the tumor size, focusing only if the lesion can be removed with safety margins and without a resulting stenosis.

With GISTs being the most common diagnosis for submucosal tumors and lacking the tools necessary to predict the underlying pathology prior to operation [2, 9, 25], the indication for surgical resection should, be set generously.

In the present series, of the tumors resected, 53 (60%) were located in the proximal and distal third of the stomach, more or less close to the cardia or the pylorus; however, in only three patients (3.2%), with lesions growing just beside the pylorus, the resection could not be performed laparoscopically because of the risk of stenosis. In consideration of this risk, tumor localization seems to have little influence on the feasibility of a laparoscopic resection. The consequent use of intraoperative endoscopy (combined laparoscopic-endoscopic rendez-vous resection) is therefore considered an indispensible precondition. It makes it possible to prevent stenosis by splinting the gastric lumen from inside. Additionally, it is probably the best method available for tumor localization in a minimally invasive setting [2, 3, 13, 18, 27–30]; once again this fact could be proved in our series, as only 23% of all lesions were identifiable by laparoscopic examination, but almost 99% of the tumors were exactly localized by intraoperative endoscopy. A further advantage of intraoperative endoscopy is the assistance it provides during resection, allowing the laparoscopist to decide upon the best technique to be applied, to simultaneously verify a complete excision of the tumor, and to check for a leak-proof suture line. Sometimes the scope can also be used for improved exposition of the tumor, and the endoscopic view offers an additional angle of vision, which might be helpful for the step of tumor excision or the placement of the linear stapler device. As we encountered no complications associated with the additional use of intraoperative endoscopy, we recommend its use.

There are different constellations for the interaction of laparoscopy and endoscopy. We focused on three different techniques, the first of which was laparoscopically assisted endoscopic resection, which actually turned out to play no major role in the treatment of submucosal gastric lesions as it was applied in one case only. However, in the future it may gain in importance, as endoscopic suturing techniques for closure of excision sites will become available within the framework of natural orifice transluminal endoscopic surgery [31, 32]. As we could demonstrate, the two alternative techniques of endoscopically assisted laparoscopic wedge and transluminal resection, make minimally invasive treatment possible for almost all gastric submucosal lesions. The lesion-lifting technique, first described by Ohgami et al. in 1996 [33], for laparoscopic wedge

**Table 5** Recent studies for combined laparoscopic-endoscopic resection of submucosal lesions of the stomach

| Author | Year | Number of patients | Mean age (years) | Operating time (min) | Hospitalization (days) | Conversion (%) | Complications (%) |
|---|---|---|---|---|---|---|---|
| Aogi et al. [38] | 1999 | 7 | 63.1 | 269 | 11.4 | 28 | 0 |
| Basso et al. [35] | 2000 | 9 | 52.5 | 75–120 | 4 | 0 | 11.1 |
| Hepworth et al. [16] | 2000 | 9 | 73 | | 3[z] | 22 | 0 |
| Choi and Oh [17] | 2000 | 32 | 51.4 | 80–180 | 6 | 3.1 | 6.2 |
| Shimizu et al. [15] | 2002 | 11 | 64.2 | 145 | 13.2 | 0 | 0 |
| Ludwig et al. [36]* | 2003 | 44 | 65.3 | 58.4 | 6.6[z] | 4.5 | 13.6 |
| Bouillot et al. [9]* | 2003 | 65 | 56.7 | 104 | 6.5 | 16.9 | 3.7 |
| Hindmarsh et al. [37] | 2005 | 30 | 64.2 | 73.8 | 5 | 23.3 | 3.3 |
| Schubert et al. [2] | 2005 | 26 | 67.2 | 53–83 | 5.6 | 11.5 | 7.7 |
| Mochizuki et al. [3] | 2006 | 12 | 60 | 100 | 7 | 0 | 16.7 |
| Novitsky et al. [21] | 2006 | 50 | 60 | 135 | 3.8 | 0 | (8) |
| Present series | 2007 | 93 | 58 | 90 | 7,4 | 6,5 | 7,5 |

resection is the method of choice for anterior wall lesions and the transluminal approach, according to the procedure of Ohashi [34], is our method of choice for posterior wall lesions. Furthermore combined procedures are convincing by its low complication rate as well in our own series as in literature [2, 3, 9, 15–17, 21, 35–38]. Tables 3 and 5 summarize our own results in single and in comparison to previously published studies.

In addition, laparoscopic-endoscopic rendez-vous resection is comparatively easy to perform, as demonstrated by relatively short operating times early in our series and by the fact that the intervention is increasingly performed by residents at our institution. By analyzing the perioperative data over the period of this study, we did not encounter a typical learning curve for the operating time, but we did note continuously decreasing complication rates and an improved interaction between laparoscopist and endoscopist. These factors might also be an expression of the low complexity of this technique and its high potential for minimally invasive tumor treatment.

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