Surg Endosc (2003) 17: 798–802
DOI: 10.1007/s00464-002-9117-y

SURGICAL ENDOSCOPY
and Other Interventional Techniques

Minimal invasive approach of gastric and esophageal mobilization in total pharyngolaryngoesophagectomy

Total laparoscopic and hand-assisted laparoscopic technique

S. K. H. Wong, A. C. W. Chan, D. W. H. Lee, E. W. H. To, E. K. W. Ng, S. C. S. Chung

Departments of Surgery, The Chinese University of Hong Kong, Prince of Wales Hospital, Shatin, Hong Kong SAR, China

Received: 10 June 2002/Accepted: 12 September 2002/Online publication: 17 February 2003

Abstract
Background: To evaluate early results in total pharyngolaryngoesophagectomy (PLE) by minimally invasive approaches for patients suffered from pharyngoesophageal tumor.
Methods: Between April 1998 and September 2001, 12 consecutive patients underwent either total laparoscopic ($n = 9$) or hand-assisted laparoscopic ($n = 3$) gastric mobilization plus transhiatal esophageal resection in total PLE. The operative data and postoperative outcomes were evaluated.
Results: Total PLE by minimally invasive approach was successfully performed in 11 patients, and 1 patient required conversion due to uncontrolled bleeding. The median total operative time was 8.5 h (range, 5–11 h) and the abdominal laparoscopic stage usually took less than 4 h. The median time for extubation was 2 days (range, 1–4 days) and the median ICU stay was 2 days (range, 1–20 days). There was no 30-day mortality, and major complications occurred in 5 patients (42%).
Conclusion: Minimally invasive PLE is a feasible and safe alternative to conventional open surgery for patients with pharyngoesophageal carcinoma.

Key words: Esophagectomy — Laparoscopy — Pharyngolaryngoesophagectomy

Pharyngoesophageal cancer poses a challenge to surgical management, and there is always controversy as to the best procedure to be used. The surgical choices include pharyngolaryngoesophagectomy with gastric transposition and pharyngolaryngectomy with free jejunal graft. As the incidence of multicentric tumors can be up to 30% [12] in pharyngoesophageal cancer, total pharyngolaryngoesophagectomy (PLE) and gastric transposition offers a complete eradication of all the condemned squamous mucosa, and it is also technically more reliable than free jejunal graft. Conventional total PLE requires gastric mobilization via laparotomy either with thoracotomy or by blind transhiatal dissection of the mediastinal esophagus. However, the operation itself carries a significant pulmonary morbidity attributed to the access trauma through major laparotomy and thoracotomy. Indeed, many attempts have been made to reduce the postoperative wound pain, and hence the respiratory complications. Esophageal mobilization and resection without thoracotomy by the transhiatal technique was first popularized by Orringer and colleagues [7] and subsequently adopted as a treatment of choice in pharyngoesophageal cancer [6]. Although thoracotomy was avoided in the transhiatal approach, midline laparotomy was still required for gastric mobilization. A less traumatic approach in performing this operation will be advantageous to the patient. With technological advances in laparoscopic surgery, total laparoscopic transhiatal esophagectomy is now possible [3, 5]. We herein present our experience in total PLE with minimally invasive approach and evaluated its clinical outcome.

Materials and methods

From April 1998 to September 2001, 12 consecutive patients were evaluated for total PLE with minimally invasive approach at a university teaching hospital. All patients suffered from pharyngoesophageal carcinoma that involved the postcricoid region and required resection of larynx, pharynx, and esophagus. The operation requires two teams working synchronously (Fig. 1). One team performs laparoscopic gastric mobilization and transhiatal esophageal dissection, while the other team dissects and resects the pharyngoesophageal tumor through conventional cervical incision. Five of our patients required unilateral radical neck lymphadenectomy, and one patient required carotid artery resection plus pectoris major myocutaneous flap as part of the cervical procedure. Gastric and esophageal mobilization was performed totally laparoscopically in nine patients, and three other recent patients underwent hand-assisted laparoscopic sur-

Correspondence to: S. C. S. Chung

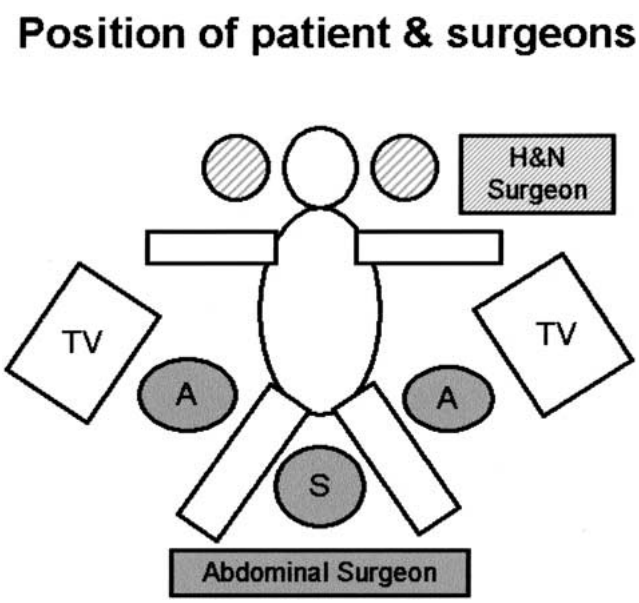

Fig. 1. Position of patient and surgeons.

gery (HALS) with stomach and esophagus mobilization through the pneumatic HandPort System (Smith & Nephew Inc., Andover, USA).

Surgical technique

Total laparoscopic (TL) abdominal approach. The patient was positioned in supine position with neck extended and both legs abducted. The head and neck surgeons were standing at both sides of the neck, while the laparoscopic surgeon was standing between the legs and assistants were standing at both sides of the abdomen (Fig. 1). Five access ports (10–12 mm) were placed at the upper abdomen with supraumbilical port for video camera and subxiphoidal port for liver and hiatal retraction (Fig. 2).

Gastric mobilization began at the greater curvature of stomach. With the stomach retracted and elevated, the gastroepiploic arcade was identified and the omental and short gastric vessels were divided using an ultrasonic-activated scalpel. The right gastroepiploic pedicle vessel was carefully preserved. The duodenum was then retracted medially, and kockerization of duodenum was facilitated by sharp dissection lateral to the second part of duodenum using the endoscopic scissors (Roticulator Endo-shear, Ethicon, USA). The lesser curve was mobilized and the lesser omentum was incised up to the esophageal hiatus, preserving the right gastric artery. With ventral retraction of the stomach, the left gastric artery pedicle was identified and divided with an endoscopic linear stapler with a vascular cartridge. Pyloroplasty was not performed.

The esophageal hiatus was mobilized by upward dissection from the lesser curve and fundus onto the hiatus. The diaphragmatic hiatus was further widened by partial division of the left and right cura muscle using an ultrasonic-activated scalpel. The esophagus was slung up by nylon tape and pulled caudally. Mobilization of the mediastinal esophagus was continued through the hiatus under direct vision. A zero degree laparoscope was used for mediastinal dissection. The esophageal blood supply was divided with an ultrasonic-activated scalpel and the esophagus was separated from the parietal pleura and pericardium. A chest drain would be inserted if the mediastinal pleura was opened during esophageal mobilization. The dissection of the mediastinal esophagus was then continued cranially until becoming confluent with the dissection from above.

Hand-assisted laparoscopic (HAL) approach. The patient and surgeon's position's were similar to the total laparoscopic approach. A 10-mm supraumbilical port was first inserted for the video camera and a 30-degree laparoscope was used for diagnostic laparoscopy. A transverse incision was then made over the right side of the abdominal wall

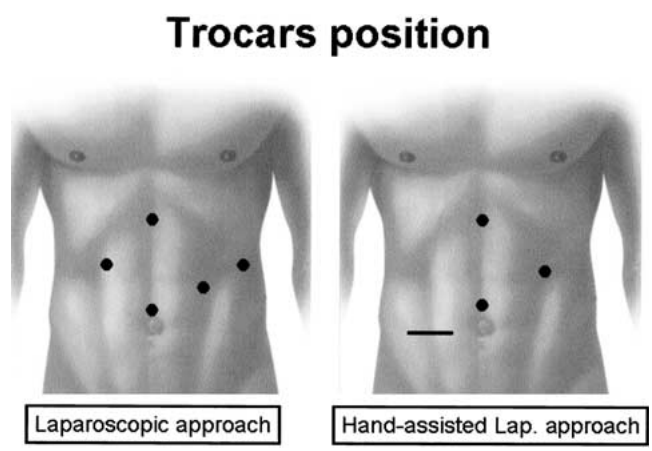

Fig. 2. Trocar and HandPort position.

for insertion of the surgeon's left hand (Fig. 2). The incision should only be long enough for comfortable hand insertion. Care was taken not to make the incision too close to the costal margin or the pelvic brim so as to avoid unbalanced siting of the HandPort base retractor and air leakage. Two additional ports were then put at subxiphoidal and left upper quadrant for liver retraction and gastric dissection, respectively (Fig. 2).

Gastric mobilization and transhiatal esophageal mobilization was performed in a manner similar to the total laparoscopic approach. The surgeon's left hand was primarily for gastric retraction and the left abdominal port was mainly for access of laparoscopic instruments for dissection and hemostasis. The right gastroepiploic vessel pedicle was carefully preserved and full kockerization of the duodenum was achieved. The stomach was lifted up ventrally with the dorsum of the left hand, and the left gastric artery pedicle was tensed up and transected between the endoscopic linear stapler and the cutter. Upon transhiatal dissection, the stomach was pulled caudally by the left hand and the mediastinal esophagus was mobilized under video camera control. Visualization of posterior mediastinum was facilitated by hiatal retraction through the subxiphoid port and utilizing a zero-degree laparoscope during mediastinal dissection.

Cervical stage

The abdominal stage and cervical stage of the operation were carried out simultaneously. A standard Gluck Sorensen incision was made and pharyngolaryngeal resection was performed. Upon cervical esophageal mobilization, dissection was performed under mediastinoscopic guidance. A zero-degree laparoscope was inserted through cervical wound as mediastinoscope. The esophagus was retracted cranially by the left hand and a laparoscopic ultrasonic-activated scalpel was inserted through cervical wound. The esophageal blood supply was divided and mobilization was completed until dissection confluent with transhiatal dissection. Under laparoscopic guidance, the gastroesophageal segment was drawn into the neck by traction from above and laparoscopic manipulation from below. The whole stomach was used as the esophageal conduit. Finally, the pharyngolaryngoesophageal segment was excised and a pharyngogastric anastomosis was performed between the gastric fundus and the base of the tongue.

Results

The minimally invasive approach of PLE was been performed in 12 patients (8 men, 4 women) from April 1998 to September 2001. During the earlier period (before 2001), gastric mobilization was performed by the total laparoscopic approach ($n = 9$). However, after the introduction of the HandPort system, we started to

Table 1. Summary of patients receiving minimally invasive approaches to pharyngolaryngoesophagectomy

Case	Age/sex	Operation	HAL/TL	Operation time (h)	Conversion	Extubation (days)	ICU stay	Complication
1	F/75	PLE + RND	TL	9	No	3	3	CVA + pneumonia
2	M/53	PLE	TL	10	Yes	2	2	No
3	M/69	PLE	TL	11	No	2	2	Anastomotic leakage
4	F/29	PLE	TL	6	No	1	2	No
5	M/50	PLE	TL	9	No	2	2	No
6	M/63	PLE + RND	TL	9	No	2	2	Pneumonia
7	M/57	PLE + RND	TL	7	No	1	1	No
8	M/53	PLE + RND	TL	8	No	2	3	No
9	F/72	PLE	HAL	5	No	2	20	Myocardial infarct
10	M/43	PLE	TL	8	No	1	1	Delayed gastric emptying
11	F/52	PLE + RND + carotid artery resection	HAL	9	No	4	4	No
12	M/63	PLE	HAL	6	No	1	1	No

HAL, hand-assisted laparoscopic; TL, total iaparoscopic; ICU, Intensive care unit; PL, pharyngolaryngoesophagectomy; RND, radical neck dissection; CVA, cerebral vascular accident

perform HAL gastric and esophageal mobilization ($n = 3$). Direct comparison of these two approaches had not been performed since the types of surgery were not uniform (Table 1).

Operative data

The minimally invasive approach of PLE was performed successfully in all but one patient, who received total laparoscopic gastric mobilization due to bleeding occurring during dissection of the origin of the right gastroepiploic pedicle. As the laparoscopic view was obscured by blood and safe hemostasis could not be achieved, the abdominal laparoscopic stage was converted to midline laparotomy and bleeding was finally controlled without damaging the blood supply of the stomach.

For the remaining 11 patients (92%), TL or HAL gastric and esophageal mobilization was successfully performed without operative mortality. The median total operative time was 8.5 h (range, 5–11 h) and the abdominal laparoscopic stage usually took less than 4 h. The median total estimated operative blood loss was 500 mL (range, 250–2500 mL) and intraoperative transfusion was required in 6 patients. The median time for extubation was 2 days (range, 1–4 days) and the median ICU stay was also 2 days (range, 1–20 days).

Morbidity

Major postoperative complications are shown in Table 1. One anastomotic leakage occurred (8%), and he was treated with cervical drainage. Feeding jejunostomy was performed and the fistula healed in 2 months. However, this gentleman suffered from intestinal obstruction secondary to a small bowel volulus at the jejunostomy site 5 months after surgery and requiring laparotomy and small bowel resection. Respiratory complication occurred in another two patients (17%), and one of them suffered from ischemic stroke (8%) at postoperative day 3. One patient (8%) suffered from postoperative myocardial infarction on day 4 and required readmission to the intensive care unit afterwards. Delayed gastric emptying was noticed in one patient (8%) who had persistent high nasogastric output for more than 2 weeks. He was treated with nasogastric decompression and finally received endoscopic pyloric balloon dilatation 4 weeks after initial operation. There was no 30-day operative mortality and the median hospital stay was 41 days (range, 18 to 75 days).

Discussion

Traditional methods of gastric and esophageal mobilization, either through a combined thoracic and abdominal access or transhiatally, are among the most physiologically stressful procedures performed in gastrointestinal tract surgery. The total in-hospital stay is over 30 days in 50% of patients [13] and it is associated with high rates of morbidity (60–84%) and mortality (1–4%) [16, 19]. Much of the morbidity of the procedure, including cardiopulmonary failure, complications from prolonged immobilization, and wound complications, is due to the method of access. Minimally invasive approaches to gastrointestinal tract surgery have been shown to protect the patient to some degree from the physiological impact of the procedure.

Various minimally invasive methods had been reported on gastric and esophageal mobilization for PLE. Law et al. [10] compared the thoracoscopic approach of esophageal mobilization to the traditional open transhiatal technique and could not demonstrate any significant reduction in mortality and morbidity. The potential benefit of the thoracoscopic approach could have been offset by prolonged one-lung ventilation, and an upper midline incision was still required for gastric mobilization. Montgomery et al. [14] reported the feasibility of total laparoscopic mobilization of the stomach

and transhiatal pharyngolaryngoesophagectomy. As the pleural cavity is not breached, the potential pulmonary insult is minimized, and the absence of an upper midline incision further reduces postoperative wound pain. Furthermore, conventional transhiatal dissection is a blind procedure and it carries its own risks of aortic bleeding, tracheal injury, pneumothorax, or cardiac impairment [8]. The advantage of the laparoscopic transhiatal approach is that all mediastinal dissection is carried out under magnified laparoscopic vision and injury to these vital structures can be avoided.

We applied this technique in patients with postcricoid cancer, but one of them required open conversion during the early series. However, with the gain in experience, the procedure was successfully performed in the rest of our series. We utilized the whole stomach without pyloroplasty in our series, as there was less size discrepancy when performing the pharyngogastric anastomosis. While some authors recommended routine drainage procedure after gastric transposition [4], some other authors suggested that pyloroplasty was associated with higher incidence of bile regurgitation, aspiration pneumonia, and dumping syndrome [20], and there is no significant benefit noted in postoperative symptoms and dietary status [11]. We believe that without laparoscopic pyloroplasty or pyloromyotomy, the length of stomach can be maintained for high pharyngogastric anastomosis at the base of the tongue.

Some authors [2] have reported the use of an operative mediastinoscope through cervical access for endodissection of the mediastinal esophagus. However, this procedure requires appropriate instruments, which allows only a single piece of equipment at a time and provides a narrow operative view during dissection. We have modified this technique so that no special equipment is necessary. Different instruments (ultrasonic dissector, malleable retractor, and sucker) are inserted through the cervical wound after division of the trachea. With appropriate retraction, the operative view is significantly improved and the dissection can be easily carried out under mediastinoscopic guidance.

The main drawback of all complex laparoscopic procedures is the technical challenge of working in a three-dimensional field through a two-dimensional view. The loss of depth perception, difficulty of organ retraction, and lack of tactile feedback slow down the speed of dissection and prolong the operative time. Since the first hand-assisted laparoscopic nephrectomy reported by Tierney et al. in 1994 [18], hand-assisted laparoscopic (HAL) surgery has gained momentum, and it seems to bridge the gap between open surgery and advanced laparoscopic surgery. The ability to insert a hand into the laparoscopic field allows for invaluable tactile feedback, gentle traction and countertraction, blunt finger dissection, and a much better depth perception in the two-dimensional visualization. Gerhart [5] first reported the use of the HAL method in esophagectomy. Its potential benefits of decreased operation times and retention of the recovery advantages of completely laparoscopic techniques was further stated in a multicenter trial [17]. As the HandPort system became available in our country in 1999, we started to apply this hand-assisted laparoscopic technique and found that it overcame much of the difficulty that we encountered during total laparoscopic dissection. We found that the organ retraction and tissue handling during gastric mobilization is much more effective and precise. This advantage is most apparent when performing transhiatal esophageal mobilization. The surgeon's right hand provides a much more effective retraction of the stomach than laparoscopic instruments and the esophagus can be pulled down easily. The extent of mediastinal dissection can also be easily assessed by the surgeon's finger, inserted transhiatally. Moreover, bleeding during gastric dissection can be quickly controlled by the surgeon's finger and more precise hemostasis can be achieved without jeopardizing the gastric vessel arcade, which indeed may prevent the open conversion from initial total laparoscopic dissection in our early series. Another advantage of the hand-assisted technique is that if the surgeon wants to perform a gastric drainage procedure, such as pyloroplasty or pyloromyotomy, it can be performed through the HandPort Base incision at the right side of the abdomen. In our series, although there is no difference in total operative time between the TL approach and the HAL approach, we found that HAL approach is superior to the total laparoscopic technique and relatively shortens laparoscopic operation time. We believe that the HAL technique is a more appropriate technique in laparoscopic gastric and esophageal mobilization during PLE.

Apart from the operative time, the main concern of laparoscopic surgery is safety. There is no report on direct comparison of the laparoscopic transhiatal approach to open transhiatal surgery in PLO, but other authors had reported the role of minimally invasive approach in esophagectomy [9, 15]. When compared with conventional open surgery, Nguyen et al. [15] had concluded that minimal invasive esophagectomy was safe and provided clinical advantages in less blood loss, fewer blood transfusions and shortened intensive care unit and hospital course. As the limitation in this retrospective review, direct comparison with the open technique is not possible and the potential benefits of decreased wound pain and improve postoperative recovery are not apparent in this current report. When we compare our results to previous reports [1, 6, 10] on the open transhiatal approach and thoracoscopic approach to PLE, our overall complication rate of 45% is compatible to the morbidity reported in these series (27–47%). We believe that the minimally invasive approach offers a safe alternative in PLE without excessive mortality and morbidity.

In conclusion, the experiences reported have shown that a minimally invasive approach in pharyngolaryngoesophagectomy is technically possible with good results. The recent development of hand-assisted laparoscopic surgery bridge the gap of traditional open surgery and advance laparoscopic surgery and its use in gastric and esophageal mobilization has improved the efficiency of this laparoscopic procedure without much jeopardizing the advantage of the use of the total laparoscopic approach in PLE.

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