International Cancer Conference Journal (2018) 7:117–120
https://doi.org/10.1007/s13691-018-0329-y

VIDEO ARTICLE

Mesenteric excision for esophageal cancer surgery: based on the concept of mesotracheoesophagus

Shin Akagawa[1] · Hisahiro Hosogi[1,2] · Fumihiro Yoshimura[1,3] · Hironori Kawada[1,4] · Seiichiro Kanaya[1]

Received: 27 April 2018 / Accepted: 7 May 2018 / Published online: 14 May 2018

Abstract

The fundamental principle of surgery for intestinal cancer is mesenteric excision. It has been widely accepted as radical surgery for colorectal cancer, and it comprises procedures such as complete mesocolic excision for colon cancer and total mesorectal excision for rectal cancer. So far, the concept of mesenteric excision of the esophagus has not been well documented, but our surgical experience with a magnified view using a thoracoscope and understanding of the surgical anatomy based on embryologic foregut development has led us to introduce the concept of mesotracheoesophagus. Using this concept, our technique is reproducible, effective, and safe for lymph node dissection along the left recurrent laryngeal nerve. Here we report our concept, procedure, and results of thoracoscopic esophageal cancer surgery.

Keywords Mesenteric excision · Mesotracheoesophagus · Thoracoscopic esophagectomy · Upper mediastinum

Introduction

The fundamental principle of surgery for intestinal cancer is mesenteric excision, and it has been widely accepted as radical surgery for colorectal cancer. Mesenteric excision encompasses well-known procedures, such as complete mesocolic excision for colon cancer and total mesorectal excision (TME) for rectal cancer [1, 2]. The same principle has also been accepted for gastric cancer surgery after studying the embryologic foregut development [3, 4]. Conversely, the principle of mesenteric excision as radical surgery for esophageal cancer has not been widely accepted, possibly because of an incomplete understanding of embryologic foregut development and the mesentery around the esophagus, which may be because of the complex surgical anatomy in the mediastinum.

Thoracoscopic esophagectomy is a widely accepted minimally invasive surgical treatment for esophageal cancer. With magnified observation using the thoracoscope, the precise surgical anatomy of the upper mediastinum can be identified [5, 6]. Our surgical experience with this magnified view, along with the application of the accepted surgical anatomy based on embryologic foregut development, has led us to understand the concept of mesotracheoesophagus. Our technique is reproducible, effective, and safe for lymph node (LN) dissection along the left recurrent laryngeal nerve (RLN). In this video article, we report our concept, procedure, and results of thoracoscopic esophageal cancer surgery.

Technique

Concept

Figure 1 shows the surgical anatomy of the upper mediastinum, which we have now come to understand. The esophagus, trachea, RLNs, and surrounding LNs are contained in a common compartment. It is the mesenterium of

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s13691-018-0329-y) contains supplementary material, which is available to authorized users.

✉ Shin Akagawa
akagawa@surg1.med.kyushu-u.ac.jp

1 Department of Surgery, Osaka Red Cross Hospital, Osaka, Japan

2 Department of Surgery, Kyoto City Hospital, Kyoto, Japan

3 Department of Gastroenterological Surgery, Fukuoka University School of Medicine, Fukuoka, Japan

4 Department of Gastroenterological Surgery, Hyogo Prefectural Amagasaki General Medical Center, Hyogo, Japan

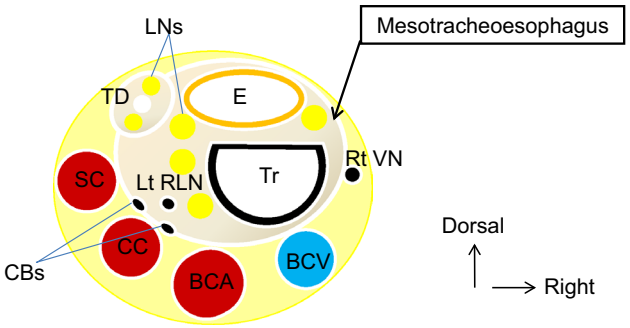

Fig. 1 A schematic drawing of the anatomy of the upper mediastinum in the prone position. The esophagus, trachea, RLNs, and surrounding LNs are contained in a common compartment, named mesotracheoesophagus. *E* esophagus, *Tr* trachea, *TD* thoracic duct, *SC* subclavian artery, *CC* common carotid artery, *BCA* brachiocephalic artery, *BCV* brachiocephalic vein, *Lt RLN* left recurrent laryngeal nerve, *Rt VN* right vagus nerve, *CBs* cardiac branches of the sympathetic nervous system, *LNs* lymph nodes

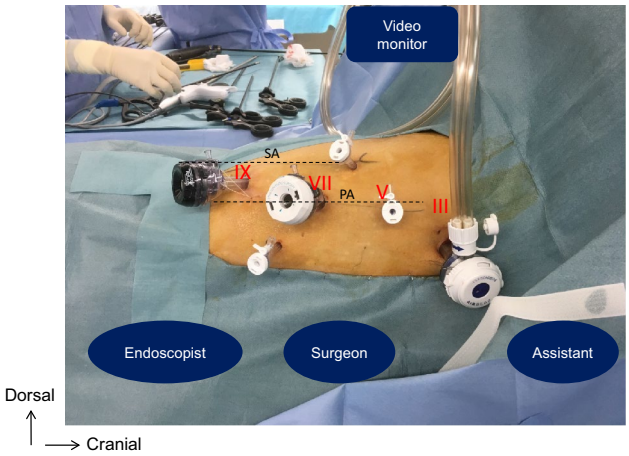

Fig. 2 Position of the patient, surgeons, and video monitor and the positions of the trocars. Roman numerals show the rib number. *SA* scapular angle line, *PA* posterior axillary line

the esophagus and the trachea, which we named mesotracheoesophagus. Similarly, Sarrazin et al. focused on a similar compartment and reported that it was surrounded by a membranous tissue [7].

For radical LN dissection in the upper mediastinum, the trachea and RLNs should be preserved in the mesotracheoesophagus, whereas the rest of the fat tissue, including the esophagus, should be dissected. Outside this compartment, the thoracic duct and its surrounding fat tissue as well as the cardiac branches of the sympathetic nervous system are found with a clear dissectable layer.

Surgical procedure

The patient was placed in a semi-prone position under general anesthesia with bilateral lung ventilation via a single-lumen endotracheal tube. Six trocars were placed into the third, fifth, seventh, and ninth intercostal spaces (Fig. 2). Carbon dioxide pneumothorax was achieved at a pressure of 6 mmHg to collapse the right lung and expand the mediastinum. The surgeon began by opening the mediastinal pleura, followed by separation of the arch of the azygos vein and the right bronchial artery for effective surgical field development. With proper countertraction, a dissectable layer was clearly recognized outside the mesotracheoesophagus. After the dissection of this layer, the parietal tissues and the major vessels were well preserved; the thoracic duct and its surrounding tissues were also preserved in cases without direct tumor invasion. With complete mobilization of the dorsal side of the esophagus, the trachea, esophagus, RLNs, and LNs could be identified in the mesotracheoesophagus.

For dissection in the mesotracheoesophagus, we routinely performed the following procedures to release the trachea and RLNs from the compartment. First, LNs around the right RLN were dissected just below the thyroid gland. Second, the ventral side of the esophagus was dissected from the membranous portion of the trachea and the left main bronchus, with proper countertraction. The tissue, including the left RLN and LNs, was dissected continuously along the left side of the trachea and the left main bronchus to complete the dissection of the ventral border. With these procedures, the plate-like tissue including the left RLN and its esophageal branches, LNs, and primary esophageal arteries were identified. This tissue component was clearly distinguishable in a layer that was different from the fat tissue around the thoracic duct, vascular sheath, or superior cardiac branches of the sympathetic nervous system. Third, LN dissection along the left RLN was performed. We divided the esophagus at the level of the aortic arch using a linear stapler to facilitate LN dissection on the left side of the esophagus with better countertraction. Elastic tape was ligated to both stump of the esophagus and pulled to outside through the trocar incision. Some esophageal branches of RLN were cut, and the left RLN was sharply isolated. With these procedures, all tissues in the mesotracheoesophagus, except the trachea and RLNs, were completely removed from the upper mediastinum.

Results

Table 1 shows the outcomes of thoracoscopic esophageal cancer surgery performed between July 2011 and September 2017. Hundred consecutive patients who underwent thoracoscopic esophagectomy with radical LN dissection based on our concept were analyzed.

These patients were divided into two groups. Fifty patients who underwent operation by June 2014 were labeled

Table 1 The results of thoracoscopic esophageal cancer surgery between July 2011 and September 2017

	Early period ($n=50$)	Latter period ($n=50$)	p
Total operation time (min)	602	563	0.029
Thoracoscopy time (min)	282	260	0.056
Blood loss (ml)	104	75	0.266
Number of dissected thoracic lymph nodes	27.5	27.8	0.88
Thoracoscopy-related complications[a]			
RLN palsy	11 (22.0%)	6 (12.0%)	0.187
Pulmonary complications	8 (16.0%)	8 (16.0%)	> 0.999
Chylothorax	1 (2.0%)	1 (2.0%)	> 0.999
Others[b]	1 (2.0%)	0	0.320

The values are expressed as mean

Differences between the groups were analyzed by Student's t test or χ^2 test using Fisher's exact probability. A two-sided p value of < 0.05 was considered to be statistically significant

[a] ≥ Clavien–Dindo Grade II

[b] Pyothorax

as the early period group, and fifty patients who underwent operation after that were labeled as the latter period group. RLN palsy was routinely assessed by laryngoscopy on 1POD and defined as any dysmotility in the vocal cords.

The latter period group had a significantly shorter total operation time than the early period group, possibly because of a learning curve. The number of retrieved LNs was sufficient in both groups. The rate of RLN palsy decreased in the later years.

Discussion

The essential principle of surgery for intestinal cancer is mesenteric excision. In fact, total excision of the mesorectum, which contains the rectum, intestine, blood vessels, and lymphatic tissues, has improved the surgical outcome for rectal cancer [8, 9]. The concept of TME is based on sharp dissection following the anatomical planes to remove the target mesentery, including the tumor-bearing organ, from the parietal plane [10]. The same concept concerning the embryologic development of the stomach has also been accepted for gastric cancer surgery [3, 4]. In radical gastrectomy, preservation of the pancreas, spleen, liver, and their corresponding feeding arteries from mesogastrium has been proven to allow safe and feasible D2 LN dissection [11–13]. In contrast, for esophageal cancer surgery, the concept of mesenteric excision is not well known.

The respiratory tract and esophagus are derived from the foregut during embryologic development [14]. During the fourth week, a small diverticulum appears in the ventral wall of the pharynx. A tracheoesophageal septum separates the ventral respiratory diverticulum (respiratory primordium) from the dorsal part of the foregut which then forms the esophagus [15]. Our surgical experience in thoracoscopic esophagectomy and the understanding of the surgical anatomy based on embryologic foregut development have led us to understand the concept of mesotracheoesophagus, which is analogous to the mesorectum.

The concept of mesoesophagus has been previously described [5, 16]. Cuesta et al. described that dissection of the perimesoesophageal fascia exposes the mesoesophagus through which the vessels originating from the thoracic aorta to the left side of the esophagus were reproducibly recognized in the middle and lower mediastinum. After division of this mesoesophagus, the left main bronchus, left inferior pulmonary vein, pericardial sac, and left contralateral pleura, which should all be preserved, were visualized. After dividing the thoracic esophagus, Oshikiri et al. described the presence a membranous structure, which was termed as esophageal mesenteriolum or lateral pedicle. Our concept is novel and different from these reports; the mesotracheoesophagus contains the trachea, RLNs, and LNs in the same compartment and is clearly distinguishable from the surrounding tissues, including the thoracic duct, vascular sheath, and superior cardiac branches of the sympathetic nervous system. With proper countertraction and magnified view, these layers could be dissected from each other. Our concept is consistent with the embryologic foregut development, and recognition of this mesotracheoesophagus enabled us to preserve and minimize injury to the parietal tissues. Moreover, careful preservation of the trachea and RLNs in this compartment allowed complete and adequate LN dissection despite total excision of the mesotracheoesophagus being impossible in this situation, unlike TME in the rectum.

Although the data in this study are limited and a larger number of patients is required for validation, the application of our concept enabled us to reproduce the same operative

field and might to contribute to decrease the risk for RLN palsy. We believe that our concept is acceptable and could be the basis for treatment strategies for esophageal cancer surgery.

Conclusions

Here we have introduced the concept of mesotracheoesophagus from an understanding of the surgical anatomy based on embryologic foregut development of the upper mediastinum. We believe that mesenteric excision based on the concept of mesotracheoesophagus could lead to safe and sufficient LN dissection in esophageal cancer surgery.

Author contributions Study conception and design: SK. Drafting of manuscript: SA and HH. Critical revision of manuscript: FY, HK, and SK.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Written informed consent was obtained from the patient for publication of this video article and any accompanying images.

References

1. Heald RJ, Husband EM, Ryall RD (1982) The mesorectum in rectal cancer surgery–the clue to pelvic recurrence? Br J Surg 69(10):613–616
2. Hohenberger W, Weber K, Matzel K, Papadopoulos T, Merkel S (2009) Standardized surgery for colonic cancer: complete mesocolic excision and central ligation–technical notes and outcome. Colorectal Dis 11(4):354–364
3. Borghi F, Gattolin A, Bogliatto F, Garavoglia M, Levi AC (2002) Relationships between gastric development and anatomic bases of radical surgery for cancer. World J Surg 26(9):1139–1144
4. Shinohara H, Kurahashi Y, Haruta S, Ishida Y, Sasako M (2018) Universalization of the operative strategy by systematic mesogastric excision for stomach cancer with that for total mesorectal excision and complete mesocolic excision colorectal counterparts. Ann Gastroenterol Surg 2(1):28–36
5. Cuesta MA, Weijs TJ, Bleys RL, van Hillegersberg R, van Berge Henegouwen MI, Gisbertz SS et al (2015) A new concept of the anatomy of the thoracic oesophagus: the meso-oesophagus. Observational study during thoracoscopic esophagectomy. Surg Endosc 29(9):2576–2582
6. Cuesta MA, van der Wielen N, Weijs TJ, Bleys RL, Gisbertz SS, van Duijvendijk P et al (2017) Surgical anatomy of the supracarinal esophagus based on a minimally invasive approach: vascular and nervous anatomy and technical steps to resection and lymphadenectomy. Surg Endosc 31(4):1863–1870
7. Sarrazin R, Voog R (1971) Anatomical background to mediastinoscopy. In: Jepsen O, Sørensen HR (eds) Mediastinoscopy. Odense University Press, Odense, pp 1–6
8. Heald RJ, Ryall RD (1986) Recurrence and survival after total mesorectal excision for rectal cancer. Lancet 1(8496):1479–1482
9. Kapiteijn E, Putter H, van de Velde CJ (2002) Impact of the introduction and training of total mesorectal excision on recurrence and survival in rectal cancer in The Netherlands. Br J Surg 89(9):1142–1149
10. Heald RJ (1988) The 'Holy Plane' of rectal surgery. J R Soc Med 81(9):503–508
11. Uyama I, Sugioka A, Matsui H, Fujita J, Komori Y, Hasumi A (2000) Laparoscopic D2 lymph node dissection for advanced gastric cancer located in the middle or lower third portion of the stomach. Gastr Cancer Off J Int Gastr Cancer Assoc Jpn Gastr Cancer Assoc 3(1):50–55
12. Noshiro H, Nagai E, Shimizu S, Uchiyama A, Tanaka M (2005) Laparoscopically assisted distal gastrectomy with standard radical lymph node dissection for gastric cancer. Surg Endosc 19(12):1592–1596
13. Katai H, Sasako M, Fukuda H, Nakamura K, Hiki N, Saka M et al (2010) Safety and feasibility of laparoscopy-assisted distal gastrectomy with suprapancreatic nodal dissection for clinical stage I gastric cancer: a multicenter phase II trial (JCOG 0703). Gastr Cancer Off J Int Gastr Cancer Assoc Jpn Gastr Cancer Assoc 13(4):238–244
14. Sutliff KS, Hutchins GM (1994) Septation of the respiratory and digestive tracts in human embryos: crucial role of the tracheoesophageal sulcus. Anat Rec 238(2):237–247
15. Kluth D, Fiegel H (2003) The embryology of the foregut. Semin Pediatr Surg 12(1):3–9
16. Oshikiri T, Yasuda T, Harada H, Goto H, Oyama M, Hasegawa H et al (2015) A new method (the "Bascule method") for lymphadenectomy along the left recurrent laryngeal nerve during prone esophagectomy for esophageal cancer. Surg Endosc 29(8):2442–2450