Robot-assisted surgery in esophageal cancer – perioperative results and morbidity

I. A. Ivanov[1], S. Chakarov[2,3], N. Dragnev[1], D. Mitev[1],

[1]Thoracic Surgery Department, "Heart and Brain" Hospital – Burgas
[2]Department of Diagnostic Imaging, "Heart and Brain" Hospital – Burgas
[3]Department of Physics, Biophysics, Radiography and Radiology – Burgas State University – Burgas, Bulgaria

Робот-асистирани резекции при карцином на хранопровода – периоперативни резултати и усложнения

И. А. Иванов[1], С. Чакъров[2,3], Н. Драгнев[1], Д. Митев[1]

[1]Отделение по гръдна хирургия, УМБАЛ „Сърце и мозък" – Бургас
[2]Отделение по образна диагностика, УМБАЛ „Сърце и мозък" – Бургас
[3]Катедра по физика, биофизика, рентгенология и радиология, Бургаски държавен университет

Abstract:

Introduction: Robot-assisted minimally invasive esophagectomy (RAMIE) is becoming increasingly common as a clinically and oncologically safe technique in the surgical treatment of esophageal cancer. **Aim:** To study the advantages of a relatively new technique and to present the possible indications of the method, as well as to analyze the results obtained and to discuss the future prospects of the surgical management of esophageal carcinoma. **Materials and methods:** In this report 8 patients were studied over a period of 6 months, operated on with robot-assisted technique and the results of the intervention were examined in terms of postoperative complications, recovery speed and advantages of the method in terms of oncological radicality. **Conclusion:** The performed operations demonstrate the possibility of performing robot-assisted interventions with a high level of safety, efficacy and accelerated patient recovery. In the majority of cases of esophageal carcinoma that are operable the robot-assisted approach is our method of choice.

Key words: robot-assisted surgery, esophagectomy, esophageal carcinoma

Address for correspondence: *Ivoslav A. Ivanov, MD, e-mail: ivoslavivanov@gmail.com*

Резюме:

Въведение: Робот-асистираната минимално инвазивна езофагектомия (РАМИЕ) започва да се прилага все по-често като клинично и онкологично безопасна техника при хирургично лечение на рак на хранопровода. **Цел:** Да се изследват предимствата на една сравнително нова техника и да се представят възможните приложения на метода. Да се анализират получените резултати и да се обсъдят бъдещите перспективи на оперативното лечение на езофагеален карцином. **Материал и методи:** Изследвани са 8 пациенти за период от 6 месеца, оперирани с робот-асистирана техника и са изследвани резултатите от проведената интервенция от гледна точка на постоперативни усложнения, период на възстановяване и предимства на метода по отношение на онкологичната радикалност. **Заключение:** Проведените операции демонстрират възможността за извършване на робот-асистирани интервенции с високо ниво на безопасност, ефикасност и ускорено възстановяване на пациентите. При мнозинството случаи на езофагеален карцином, които подлежат на оперативна намеса, дву- или триполевата езофагектомия е основният ни метод на избор за хирургично лечение.

Ключови думи: робот-асистирана хирургия, езофагектомия, езофагеален карцином

Адрес за кореспонденция: *Д-р Ивослав А. Иванов, e-mail: ivoslavivanov@gmail.com*

Introduction

The mainstay of treatment for esophageal and gastroesophageal junction carcinoma is esophagectomy. This surgery has traditionally been associated with significant postoperative morbidity and mortality [1]. In recent decades, advances such as centralization of care, development of improved recovery protocols, and implementation of minimally invasive techniques have improved perioperative outcomes in surgically treated patients with esophageal cancer [2]. However, a recent international comparative study reported a complication rate of approximately 60% and the data were reported from centers with a large volume of operations [3]. In order to improve outcomes in patients undergoing esophagectomy for carcinoma, it is necessary to optimize every perioperative aspect. One of the most recent developments is the introduction of robot-assisted minimally invasive esophagectomy (RAMIE).

Materials and methods

In the Department of Thoracic Surgery of the "Heart and Brain" Hospital – Burgas, a retrospective analysis of 8 patients who underwent robot-assisted resection of the esophagus due to carcinoma was conducted for the period from May 2025 to November 2025. Of the patients studied, 7 were men and 1 was a woman. The average age of the patients in the study group was 68 years, varying between 58 and 76 years. Three of the patients had adenocarcinoma of the gastroesophageal junction - classified according to Siewert I, one had squamous cell carcinoma of the distal esophagus, and the remaining four had squamous cell carcinoma of the middle third of the esophagus. In the four patients with cancer of the gastroesophageal junction and distal esophagus, a two-field robot-assisted resection with intrathoracic anastomosis according to Ivor-Lewis was performed, and in the four patients with carcinoma of the middle third, a three-field robot-assisted resection according to McKeown was performed (Table 1).

Table 1. Patients with robot-assisted esophagectomy

Patient demographics and tumor data	
Average Age	68 (58-76)
Male patients	7 (8)
Approach **Three field resection (McKeown)** **Two field resection (Ivor-Lewis)**	 4 4
Histology **Adenocarcinoma** **Squamous cell carcinoma**	 3 4
Clinical Stage **IIB** **IIIA** **IIIB** **IIIC**	 2 3 1 2

Results

Perioperative outcomes and complications are summarized in Table 2. The mean operative time (from skin incision to closure) was 496 minutes, with a range of 441 to 602 minutes. The mean blood loss was 250 ml. The mean number of lymph nodes removed was 24 nodes, with a range of 14 to 32. A total of 2 conversions were performed, both at the abdominal stage to laparotomy, due to locally advanced gastroesophageal junction carcinomas. There were no conversions at the thoracic stage of the operation and all were completed with robot-assisted thoracic dissection and anastomosis (in the Ivor-Lewis cases) (Fig. 1). Three of the McKeown cervical anastomoses were performed with a circular mechanical stapler, and one was performed by hand due to tension and inability to place a stapler. Our team implemented a protocol for assessing gastric graft perfusion with intravenously administered Indocyanine Green (ICG) dye prior to anastomosis construction. After dye administration, a DaVinci robotic system Firefly program was used to assess blood flow in the anastomotic region of the stomach (Fig.2).

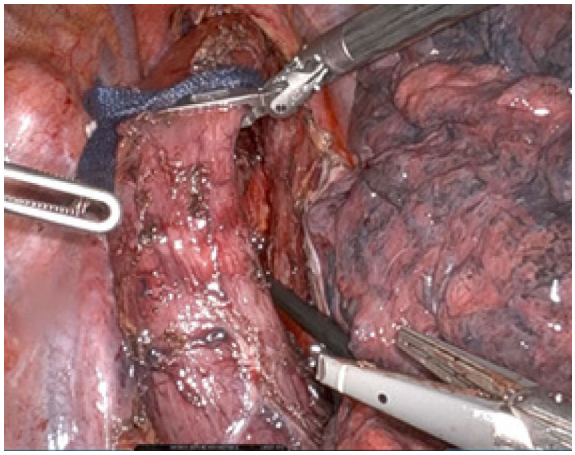

Fig. 1. Thoracic esophageal dissection during McKeown robot-assisted esophagectomy

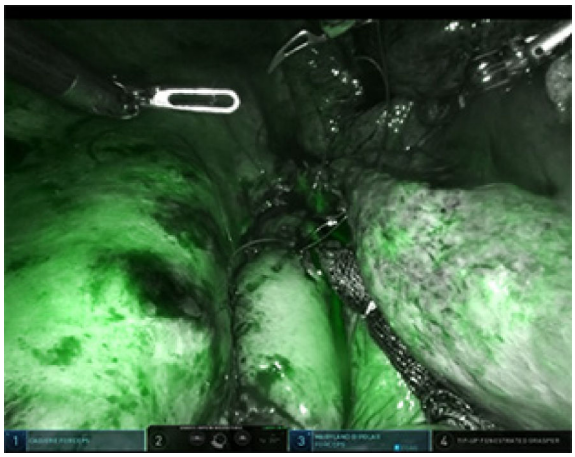

Fig. 2. Perfusion assessment of gastric conduit with intravenous application of ICG

Table 2. Postoperative results

Perioperative results and complications in RAMIE	
Average operative time (minutes)	496 (441-602)
Average bloodloss (ml)	250 (150-400)
Conversions **Laparotomy** **Thoracotomy**	 2 0
Average stay in ICU (days)	2 (1-4)
Complications (Clavien Dindo) **Class I** **Gastric Outlet Obstruction** **Billiary leakage from drain** **Class II** **Drain controled anastomotic leakage** **Class IIIa** **Peripancreatic collection (CT drained)**	 1 1 1 1

The average hospital stay for the operated patients was 8 days, with an average stay in the intensive care unit for 2 days. Four (50%) patients had uneventful hospital stay. One patient (12%) suffered anastomotic leakage controlled by a cervical drain and was self-limited on the 20th postoperative day. The patient was discharged with the drain and it was removed on an outpatient basis. One complication was observed for which there are no reported data in the literature – biliary leakage verified by biochemical analysis of the discharge from the drain. The described leakage of biliary fluid from the abdominal drain stopped spontaneously within 8 days after the operation and did not require interventional or surgical treatment and did not lead to septic manifestations. Another, also unusual and rare complication registered in one of the patients, was pancreatitis with peripancreatic collection. In this case interventional treatment with percutaneous drainage of the collection under CT control was applied (Fig. 3). In all the patients who underwent surgery, no reoperations were recorded due to the mild severity of the complications, allowing for conservative management. There was no mortality registered within the 30- or 90-day postoperative period. No patients were removed from follow-up. The median follow-up time was 3 months, with a range of 1 to 6 months. In all patients complete resection with microscopically negative resection lines (R0) was achieved.

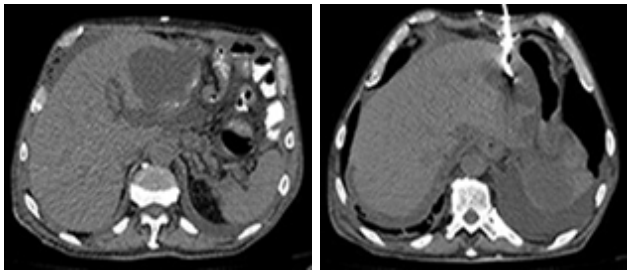

Fig. 3. Postoperative peripancreatic collection and percutaneous CT drainage

Discussion

This study reports our first experience with RAMIE and from the data obtained we can report that the procedure can be performed with satisfactory results and a high safety index in a practice with a large volume of esophageal surgeries and a developed robot-assisted surgical program.

The operation time for RAMIE is longer compared to open surgeries and this is largely due to the preparation of the robot and the docking of the system in two anatomical cavities sequentially [4].

The rate of anastomotic leakage (12%) in robot-assisted interventions performed in the department is fully comparable to that in open surgeries reported by many leading centers and varies between 8% and 20%, with some places reporting a frequency reaching 50% [5, 6]. It should be noted that aero-digestive fistulas were not observed in the studied series, which is a frequently reported complication in this type of interventions (about 4%) [7, 8].

There are several other potential advantages of robot-assisted procedures that remain to be explored in greater detail. These include dissection in areas such as the esophageal hiatus and mediastinum, especially in patients who have responded to neoadjuvant therapy, which may be facilitated by the superior optics and visualization of robot-assisted surgery, as well as the instrumentation with multiple degrees of freedom [9, 10]. From a financial perspective, robot-assisted esophageal surgery is more expensive due to the equipment and consumables used, but the fact that it reduces complications and the severity of their manifestation allows for a reduction in the cost of the method, even compared to the open method, by saving resources on the treatment of perioperative complications and prolonged hospital stay [11].

Conclusion

Robot-assisted bi- and tri-pole esophagectomy is a procedure associated with a significantly lower risk of postoperative complications, such as anastomotic leak and respiratory failure, compared to open surgery. The technique has a low frequency of reoperations and, accordingly, a shorter hospital stay and lower financial costs in the treatment of patients. The method demonstrates completely comparable early oncological results, expressed in a large average number of dissected lymph nodes and clean resection lines. In order to assess the long-term oncological results and advantages of the method, an even longer period of study and follow-up of patients and a larger number of operations are needed.

References

1. Van Hillegersberg R, Boone J, Draaisma WA, et al. First experience with robot-assisted thoracoscopic esophagolymphadenectomy for esophageal cancer. Surg Endosc 2006;20:1435-9.
2. Ruurda JP, Draaisma WA, van Hillegersberg R, et al. Robot-assisted endoscopic surgery: a four-year single-center experience. Dig Surg 2005;22:313-20.
3. Cuschieri A, Shimi S, Banting S. Endoscopic oesophagectomy through a right thoracoscopic approach. J R Coll Surg Edinb 1992;37:7-11.
4. Biere SS, van Berge Henegouwen MI, Maas KW, et al. Minimally invasive versus open oesophagectomy for patients with oesophageal cancer: a multicentre, open-label, randomised controlled trial. Lancet 2012;379:1887-92.
5. Straatman J, van der Wielen N, Cuesta MA, et al. Minimally Invasive Versus Open Esophageal Resection: Three-year Follow-up of the Previously Reported Randomized Controlled Trial: the TIME Trial. Ann Surg 2017;266:232-6.
6. Yibulayin W, Abulizi S, Lv H, et al. Minimally invasive oesophagectomy versus open esophagectomy for resectable esophageal cancer: a meta-analysis. World J Surg Oncol 2016;14:304.
7. Sihag S, Kosinski AS, Gaissert HA, et al. Minimally Invasive Versus Open Esophagectomy for Esophageal Cancer: A Comparison of Early Surgical Outcomes From The Society of Thoracic Surgeons National Database. Ann Thorac Surg 2016;101:1281-8; discussion 1288-9.
8. Minchev Ts. Robot asistirani operatsii pri kartsinom na hranoprovoda i gastroezofagealnata vruzka; Sofia, Simolini 94, 2005: 71-73.
9. Seesing MF, Gisbertz SS, Goense L, et al. A Propensity Score Matched Analysis of Open Versus Minimally Invasive Transthoracic Esophagectomy in the Netherlands. Ann Surg 2017.
10. Van der Sluis PC, Ruurda JP, Verhage RJ, et al. Oncologic Long-Term Results of Robot-Assisted Minimally Invasive Thoraco-Laparoscopic Esophagectomy with Two-Field Lymphadenectomy for Esophageal Cancer. Ann Surg Oncol 2015;22 Suppl 3:S1350-6.
11. Van der Sluis PC, van der Horst S, May AM, et al. Robot-assisted Minimally Invasive Thoracolaparoscopic Esophagectomy Versus Open Transthoracic Esophagectomy for Resectable Esophageal Cancer: A Randomized Controlled Trial. Ann Surg 2019;269:621-30.

Received May 12th 2026