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Brief Report

Comparative Analysis of Surgical Outcomes in Hybrid and Open Esophagectomy for Esophageal Cancer: A Regional Russian Cancer Centre Experience

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What's Known

- The minimally invasive esophagectomy has emerged as an advanced surgical technique for treating esophageal cancer.
- Its growing popularity reflects a shift toward improving patient outcomes through minimizing the need for surgery.

What's New

- Hybrid approaches in esophageal surgery may reduce the risk of postoperative cardiac complications and other severe adverse events while maintaining acceptable oncological outcomes.

Abstract

Surgery is pivotal in treating esophageal cancer; hybrid esophagectomy, which combines minimally invasive and open techniques, shows promising outcomes. This historical cohort study compared the surgical outcomes of standard open esophagectomy with hybrid esophagectomy. Overall, 58 patients who underwent either hybrid or open esophagectomy at the Ulyanovsk Regional Clinical Oncology Clinic, Russia, from January 2015 to December 2023 were included. Data on demographics, surgical details, and postoperative outcomes were analyzed. The primary measures were overall complications and anastomotic leakage rates. Statistical analysis was performed using Pearson's Chi square test and *t* test via StatTech software (version 2.8.8). The number of removed lymph nodes was higher in the hybrid group (24±9) than in the open group (15±7) ($P<0.001$). In addition, the hybrid esophagectomy group showed significant reductions in operational time and blood loss ($P<0.001$ and $P=0.014$, respectively). The need for blood transfusion was higher in the open esophagectomy group ($P=0.043$). The postoperative length of stay in the hospital did not differ significantly between the two groups (open=20±8 days, hybrid=17±7 days, $P=0.178$). Cardiac complications were more frequent after an open esophagectomy ($P=0.044$). Hybrid esophagectomy reduced postoperative cardiac complications and other adverse events while maintaining satisfactory oncological outcomes. It had advantages over standard open esophagectomy in terms of lymphadenectomy, operative time, blood loss, and transfusion requirements, suggesting its efficacy for esophageal cancer patients.

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Keywords ● Esophageal neoplasms ● Esophagectomy ● Postoperative complications

Introduction

Esophageal cancer is an aggressive oncological disease with a very poor prognosis. Despite the implementation of a multimodal approach in treating this group of patients, surgical methods continue to play an important role in radical treatment.[1] In clinical practice, the two most prevalent surgical procedures are the McKeown procedure with neck anastomosis and the Ivor-Lewis procedure with intrathoracic anastomosis. With advances in

surgical technology since the late 20th century, minimally invasive techniques have been actively used. There is limited research on the outcomes of open and hybrid esophagectomies in Russia.[2] The present study aimed to compare short-term and long-term treatment outcomes for patients with esophageal cancer who underwent hybrid and open esophagectomy using the McKeown method.

Patients and Methods

In this study, a historical cohort study was conducted to examine the treatment outcomes of esophageal cancer patients who underwent hybrid and open esophagectomy using the McKeown method between January 1, 2015, and 2015, at the Ulyanovsk Regional Clinical Oncology Clinic, Russia.

For patient assessment, a standardized methodology with inclusion and exclusion criteria was developed. Preoperatively, patients were examined and treated in accordance with the Association of Oncologists of Russia (AOR) guidelines.[3] All patients' stages were classified using the TNM Classification of Malignant Tumors (TNM) 8th edition, which was approved by the International Union Against Cancer (UICC).[4] Prior to surgery, patients were stratified according to ASA classification. In all cases, the graft was formed from the greater curvature of the stomach.

The inclusion criteria were patients aged from 18 to 75 years with esophageal squamous cell carcinoma or adenocarcinoma, Siewert type I, Eastern Cooperative Oncology Group (ECOG) performance status 0-2, and being scheduled for esophagectomy procedure.[5, 6] The exclusion criteria included Siewert type II-III disease and emergency or palliative esophagectomies.

All patients were operated according to a standardized protocol. In hybrid esophagectomy, the procedure was started with a thoracoscopy on the right side, followed by laparotomy to form a graft, and then cervicotomy to create an anastomosis in the neck (figure 1). The anastomosis was formed manually using the end-to-side esophagus-anterior wall-stomach technique with knotted sutures.

Age, body mass index (BMI), length of the tumor, index pack-years, Charlson's index, clinical and pathological TNM stage, histology, tumor location, neoadjuvant therapy, ASA score, number of removed lymph nodes, duration of the procedure, blood loss, haemo transfusion, postoperative length of stay, overall complications rate, and anastomotic leakage as a critical postoperative event were all evaluated. Pulmonary complications included pneumonia, pulmonary atelectasis, and impaired pulmonary ventilation, requiring bronchoscopic clearance. Cardiac complications included persistent arrhythmias requiring medical correction or electrical cardioversion, pulmonary artery thromboembolism, acute coronary syndrome, and acute heart failure. Postoperative complications were classified according to the thoracic morbidity and mortality (TMM) classification.[7] This classification system included minor complications and major complications. Minor complications were defined as Grade I, which required no pharmacological treatment or intervention; and Grade II, which required pharmacological treatment or minor intervention. Major complications were further divided into Grade IIIa, which required surgical, radiological, or endoscopic intervention, or multi-therapy without involving general anesthesia; and Grade IIIb, which necessitated such intervention under general anesthesia. Grade IVa involved ICU management and life support for single-organ dysfunction, and Grade IVb required ICU management and life support for multi-organ dysfunction. The Grade V caused the patient's death. The length of the tumor, index pack-years, Charlson's index, and clinical and pathological TNM stage were evaluated.

The study was approved by the Institutional Review Board in Regional Clinical Oncology Center Ulyanovsk, Russia (#48-A, 13.10.2023).

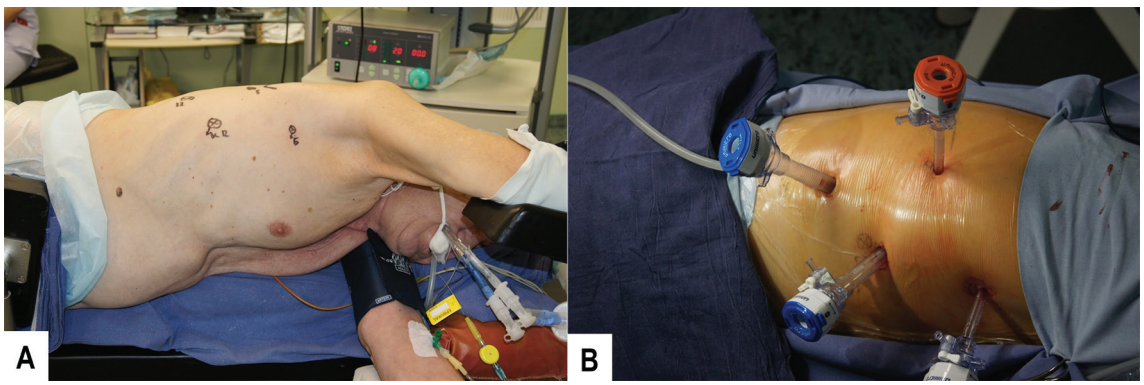

Figure 1: The patient's position on the operating table (A), where the thoracic stage ports are located (B).

Written informed consent was obtained from all the patients prior to participation in the study.

Statistical Analysis

The primary data acquisition, calculation of assessed parameters, systematization, and data aggregation were all executed using Microsoft Office Excel software 2022 (Microsoft, USA).

Quantitative variables with a normal distribution were described using mean±standard deviation (Mean±SD), and 95% confidence interval. The independent samples *t* test was used to compare mean values between two groups, and categorical data were presented as absolute and relative frequencies. Pearson's Chi square test was used to analyze frequencies in contingency tables. P<0.05 was considered statistically significant. The StatTech software (version 2.8.8, LLC Co., Russia) was used to analyze the data.

Results

Overall, 19 patients were enrolled in the hybrid esophagectomy group and 39 patients in the open esophagectomy group. The mean age was statistically comparable in both groups. The average body mass index (BMI) was 23, with five patients classified as first-degree obesity (two in the open esophagectomy group and three in the hybrid group). The minimum recorded BMI was 16.8 and 17.3 in the open esophagectomy and hybrid groups, respectively. Remarkably, ASA II and III predominated in both groups (84.2% in the hybrid group and 92.3% in the open esophagectomy group). The details of clinical demographic characteristics of participants is presented in table 1.

Surgical Parameters

The results of surgical treatment are shown in table 2. There was a statistically significant difference in the number of removed lymph nodes between the hybrid group (24±9) and the open group (15±7) (P<0.001). In addition, the hybrid esophagectomy group indicated significant reductions in operational time and the amount of

Table 1: Clinical demographic parameters

Characteristics		Hybrid esophagectomy (n=19)	Open esophagectomy (n=39)	P value
Sex	Female	9 (47.4)	8 (20.5)	0.035[a]
	Male	10 (52.6)	31 (79.5)	
Age, years, (mean±SD)		59.2±10.3	60.8±8.3	0.459[b]
BMI, Kg/m^2 (mean±SD)		23.8±3.6	23.2±4.5	0.807[b]
Length of tumour, mm (mean±SD)		51.4±15.4	49.6±14.1	0.839[b]
Index pack-years (mean±SD)		17.1±14.9	20.3±18.0	0.427[b]
Charlson's index (mean±SD)		4.3±1.5	4.2±2.7	0.467[b]
Diabetes mellitus		2 (10.5%)	3 (7.7%)	0.165[a]
cT	T1	1 (5.3)	2 (5.1)	0.998[a]
	T2	5 (26.3)	10 (25.6)	
	T3	13 (68.4)	27 (69.2)	
cN	N0	10 (52.6)	16 (41.0)	0.282[a]
	N1	7 (36.8)	19 (48.7)	
	N2	0 (0.0)	3 (7.7)	
	N3	2 (10.5)	1 (2.6)	
Clinical stage	I	1 (5.3)	2 (5.1)	0.341[a]
	II	9 (47.4)	11 (28.2)	
	III	9 (47.4)	26 (66.7)	
Histology	Squamous cell	15 (78.9)	33 (84.6)	0.714[a]
	Adenocarcinoma	4 (21.1)	6 (15.4)	
Tumor location	Between the aorta and bronchi	3 (15.8)	3 (7.7)	0.638[a]
	Bronchial segment	5 (26.3)	11 (28.2)	
	Infrabronchial segment	5 (26.3)	12 (30.8)	
	Retropericardial segment	6 (31.6)	10 (25.6)	
	Abdominal part	0 (0.0)	3 (7.7)	
Neoadjuvant therapy	Chemoradiotherapy	14 (73.7%)	28 (71.8%)	0.754[a]
	Chemotherapy	5 (26.3%)	11 (28.2%)	
ASA	ASA I	3 (15.8)	3 (7.7)	0.387[a]
	ASA II	15 (78.9)	30 (76.9)	
	ASA III	1 (5.3)	6 (15.4)	

cT: Clinical "Tumor" stage according to the TNM 8th edition; cN: Clinical "Nodes" stage according to the TNM 8th edition; BMI: Body mass index; ASA: American society of anaesthesiologists physical status; [a]Pearson's Chi square test; [b]*t* test

Table 2: Surgical parameters of the study

Characteristics		Hybrid esophagectomy (n=19)	Open esophagectomy (n=39)	P value
pT	0	0 (0.0)	1 (2.6)	0.012[a]
	1a	0 (0.0)	3 (7.7)	
	1b	3 (15.8)	1 (2.6)	
	2	1 (5.3)	14 (35.9)	
	3	13 (68.4)	20 (51.3)	
	4a	2 (10.5)	0 (0.0)	
pN	pN0	5 (26.3)	20 (51.3)	0.156[a]
	pN1	8 (42.1)	14 (35.9)	
	pN2	4 (21.1)	2 (5.1)	
	pN3	2 (10.5)	3 (7.7)	
Lymph nodes removed, n, (mean±SD)		24.2±9.5	15.3±7.7	<0.001[b]
Lymph nodes affected, n, (mean±SD)		3.1±1.6	4.2±1.3	0.783[b]
Surgery duration, min, (mean±SD)		377.2±97.7	269.3±51.4	< 0.001[b]
Blood loss, mL (mean±SD)		263.5±158.7	360.8±126.2	0.014[b]
Haemo transfusion		0	6	0.043[a]
Postoperative length of stay, days, (mean±SD)		17.7±7.5	20.7±8.4	0.178[b]

pT: Pathological "Tumor" stage according to the TNM 8th edition; pN: Pathological "Nodes" stage according to the TNM 8th edition; [a]Pearson's Chi square test, [b]*t* test

blood loss (P<0.001 and P=0.014, respectively). All cases (n=6) in the open esophagectomy group required blood transfusion (P=0.043). The postoperative length of stay was not significantly different between the groups (open group: 20±8 days; hybrid group: 17±7 days; P=0.178).

Postoperative Complications

Postoperative complications were observed in 10 (52.6%) of patients in the hybrid esophagectomy group and in 23 (59%) of patients who underwent esophagectomy after open esophagectomy. All types of complications, including grade I (based on TMM), were considered and documented. In the hybrid esophagectomy group, 1 (5.3%) patient died, while in the open esophagectomy group, 4 (10.2%) patients died. Severe complications (III-V grade based on TMM) occurred significantly more frequently in the open esophagectomy group, with 20 (51.3%) cases against 5 (26.4%) cases in the hybrid group.

Overall, anastomotic leakage was observed in 10 (17.2%) patients, with 3 (15.8%) cases occurring after hybrid esophagectomy and 7 (17.9%) cases following open esophagectomy.

In group analysis, there was no statistically significant difference in the incidence of anastomotic leakage between patients who underwent hybrid esophagectomy and open esophagectomy (P=0.385). When categorized by type of insufficiency, type IV (gastric conduction necrosis) had no complications, whereas type III was observed in 5.1% of patients after open esophagectomy and in 5.2% after hybrid esophagectomy. One patient in the open esophagectomy group passed away as a result of right-side pleural empyema and mediastinitis. In all cases, the treatment was conservative with daily dressing changes and irrigation of the purulent cavity. Pulmonary complications did not differ between groups (P=0.252), occurring in 5.3% of cases after hybrid esophagectomy and in 17.9% after open esophagectomy. Two patients died from pneumonia, one after open and one after hybrid esophagectomy, with aspiration pneumonia due to swallowing disorder being the cause of death after hybrid esophagostomy. Cardiac complications were encountered more often after open esophagectomy (P=0.044). Two patients died as a result of cardiac complications; one from major thromboembolism after open procedure, and the other two from acute heart failure that occurred soon after surgery.

Discussion

The findings of the present study revealed that the hybrid esophagostomy approach reduces the likelihood of developing higher-grade complications, resulting in a decrease in operative time and blood loss. There was comparable radicality in both surgical approaches. However, there were significant differences in the amount of removed lymph nodes. In contrast to open esophagostomy, less invasive technology allowed more accurate dissection under visual control.

Esophageal cancer is a major global health concern, accounting for 2.6% of all cancer cases.[8] In Russia, the incidence of EC is on the rise, rising from 8.2 in 2012 to 9.46 in 2022 per 100,000 people. Despite advancements in treatment, the five-year survival rate for patients

with EC was still low, not exceeding 10-15%.[9]

The development of minimally invasive esophagectomy (MIE) has been a significant milestone in the surgical management of esophageal cancer, providing a promising alternative to traditional open esophagectomy. The evolution of MIE techniques reflects advances in surgical technology and aims to reduce morbidity and improve postoperative outcomes for patients.

Despite significant advances in esophageal surgery in recent decades, including improved surgical techniques, anesthesiological support, and multimodal treatment, the overall rate of postoperative complications and mortality is still unsatisfactorily high.[10] Previous studies reported that minimally invasive esophagectomies, including both the traditional laparoscopic and thoracoscopic approaches, might be associated with lower rates of anastomotic leak than open esophagectomies.[11] This difference could be attributed to the reduced surgical trauma, improved visualization, and enhanced precision provided by minimally invasive techniques, which could contribute to better tissue handling and less tension on the anastomosis. However, due to the complexity of the procedure, this type of surgery is typically performed in high-volume regional cancer centers. In the present study, no statistically significant difference was found in the development or severity rating of anastomotic leakage.

This study had several limitations. Its retrospective and nonrandomized nature might result in potential selection bias. Since the study was conducted at a single center, its findings might not be generalizable. To validate these findings, future research should use randomized controlled trials with multiple centers, and long-term follow-ups.

Conclusion

This study indicated that using hybrid esophagostomy approaches reduced the risk of cardiac and other complications during the postoperative period while simultaneously providing satisfactory oncological outcomes. The hybrid esophagectomy group exhibited a higher number of removed lymph nodes, had a shorter operational time and blood loss, and required fewer blood transfusions than the standard open esophagectomy group. These findings suggested that the hybrid esophagectomy approach might improve surgical and oncologic outcomes for esophageal cancer patients. Further research and prospective studies are required to validate these findings and determine the long-term impact of the hybrid approach on patient outcomes.

Authors' Contribution

E.T, O.A, and O.P designed the surgery, operated on the patients, and collected data; L.D and O.M designed the study, collected data, and performed the analysis; V.M, A.C. guided the study and supervised the surgery; V.M, O.A, and E.T analyzed data and wrote the manuscript; All authors contributed in revising the manuscript. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest: None declared.

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