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Postoperative complications of minimally invasive esophagectomy for esophageal cancer

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Abstract

Minimally invasive esophagectomy (MIE) has been performed increasingly more frequently for the treatment of esophageal cancer, ever since it was first described in 1992. However, the incidence of postoperative complications of MIE has not yet been well-characterized, because (a) there are few reports of studies with a sufficient sample size, (b) a variety of minimally invasive surgical techniques are used, and (c) there are few reports in which an established system for classifying the severity of complications is examined. According to an analysis performed by the Esophageal Complications Consensus Group, the most common complications of MIE are pneumonia, arrhythmia, anastomotic leakage, conduit necrosis, chylothorax, and recurrent laryngeal nerve palsy. Therefore, we decided to focus on these complications. We selected 48 out of 1245 reports of studies (a) that included more than 50 patients each, (b) in which the esophagectomy technique used was clearly described, and (c) in which the complications were adequately described. The overall incidences of the postoperative complications of MIE for esophageal cancer were analyzed according to the MIE technique adopted, that is, McKeown MIE, Ivor Lewis MIE, robotic-assisted McKeown MIE, robotic-assisted Ivor Lewis MIE, or mediastinoscopic transmediastinal esophagectomy. Pneumonia, arrhythmia, anastomotic leakage, and recurrent laryngeal nerve palsy occurred at an incidence rate of about 10% each; Ivor Lewis MIE was associated with a relatively low incidence of recurrent laryngeal nerve palsy. It is important to recognize that the incidences of complications of MIE are influenced by the MIE technique adopted and the extent of lymph node dissection.

KEYWORDS

complication, Ivor Lewis esophagectomy, McKeown esophagectomy, minimally invasive esophagectomy, transmediastinal esophagectomy

1 | INTRODUCTION

Minimally invasive esophagectomy (MIE) has been performed increasingly more frequently for the treatment of esophageal cancer, ever since it was first reported by Cuschieri et al in 1992.[1] However, in contrast to the case for open transthoracic esophagectomy, the postoperative complications of MIE have not yet been well-characterized, because: (a) there are few reports of studies with a sufficient sample size; (b) a variety of MIE techniques are used, such as McKeown esophagectomy (thoracoscopic esophagectomy with cervical anastomosis),[2] Ivor Lewis esophagectomy (thoracoscopic esophagectomy with intrathoracic anastomosis),[3] and transmediastinal

esophagectomy (TME, mediastinoscopic esophagectomy with cervical anastomosis)[4]; and (c) there are few reports in which an established system for classifying the severity of complications, such as the Clavien–Dindo classification,[5] Common Terminology Criteria for Adverse Events (CTCAE),[6] or Complications Definitions by the Esophageal Complications Consensus Group (ECCG) has been used.[7]

According to an analysis of the data obtained from 24 high-volume centers for esophageal surgery in 14 countries conducted by the ECCG with the objective of developing a standardized platform for recording complications and quality measures associated with esophagectomy, the most common individual complications were pneumonia (14.6%), arrhythmia (14.5%), anastomotic leakage (11.4%), conduit necrosis (1.3%), chylothorax (4.7%), and recurrent laryngeal nerve palsy (4.2%).[7] Therefore, we decided to focus on these complications in this review.

In the initial decades in the history of MIE, the number of studies that included sufficient numbers of patients was too few to allow reliable analysis of the rates of complications. As the number of treated patients at each institution began to increase around the world, studies conducted on larger study samples began to be published. Herein, we present a review of studies that included a sample size of at least 50 cases each. There are no results of nationwide analyses of the complications of MIE depending on the MIE technique adopted. Moreover, robotic-assisted esophagectomy has also begun to be performed and some informative data have been reported, so that all the available data need to be collated and analyzed comprehensively.

To the best of our knowledge, there are only a few reports on the postoperative complications of MIE for esophageal cancer analyzed according to the MIE technique employed. In this review, we analyze very recent evidence reported in respect to the complications of MIE.

2 | STUDY SELECTION

An electronic search for articles was conducted of the Medline database and a manual search was conducted for references related to studies on MIE published until 8 September 2019. A total of 48 out of 1245 studies were selected (a) that included more than 50 patients each, (b) in which the MIE technique used was clearly described, and (c) in which the complications were adequately described.[8–55] Four articles contained descriptions of two different MIE techniques, and a final 52 reports of MIE techniques described in 48 articles were analyzed.

2.1 | Technique of MIE and postoperative complications

The median incidence of pneumonia was 10.6% in the reports of McKeown MIE, 12.3% in the reports of Ivor Lewis MIE, 27.8% in the reports of robotic-assisted McKeown MIE, 6.9% in the reports of robotic-assisted Ivor Lewis MIE, 6.5% in the reports of TME, and 10.6% overall in the reports of MIE (Tables 1 and 2). The median incidence of arrhythmia was 9.3% in the reports of McKeown MIE, 17.2% in the reports of Ivor Lewis MIE, 15.3% in the reports of robotic-assisted McKeown MIE, 11.7% in the reports of robotic-assisted Ivor Lewis MIE, 3.6% in the reports of TME, and 11.7% overall in the reports of MIE. The median incidence of anastomotic leakage was 7.8% in the reports of McKeown MIE, 10.0% in the reports of Ivor Lewis MIE, 18.5% in the reports of robotic-assisted McKeown MIE, 6.0% in the reports of robotic-assisted Ivor Lewis MIE, 9.8% in the reports of TME, and 9.3% overall in the reports of MIE. The median incidence of conduit necrosis ranged from 0% to 4.0%. The median incidence of chylothorax was 3.2% in the reports of McKeown MIE, 3.8% in the reports of Ivor Lewis MIE, 24.6% in the reports of robotic-assisted McKeown MIE, 2.4% in the reports of robotic-assisted Ivor Lewis MIE, 0.0% in the reports of TME, and 3.4% overall in the reports of MIE. The median incidence of recurrent laryngeal nerve palsy was 9.2% in the reports of McKeown MIE, 0.3% in the reports of Ivor Lewis MIE, 9.3% in the reports of robotic-assisted McKeown MIE, 6.6% in the reports of robotic-assisted Ivor Lewis MIE, 19.0% in the reports of TME, and 8.9% overall in the reports of MIE.

2.2 | Extent of lymph node dissection and postoperative complications

The median incidence of recurrent laryngeal nerve palsy was 13.2% in the patients who underwent lymph node dissection of the nodes in the upper, middle, and lower mediastinum, and 1.6% in the patients who underwent lymph node dissection of the nodes in the middle and lower mediastinum (Tables 1 and 3).

2.3 | Technique of MIE and extent of lymph node dissection

Lymph node dissection of the nodes in the upper, middle, and lower mediastinum was adopted in 81% of reports of McKeown MIE or robotic-assisted McKeown MIE, in 11% of reports of Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE, and in 100% of reports of TME (Tables 1 and 4).

2.4 | Technique of MIE and dominant pathology

The percentage of reports with a higher number of cases of squamous cell carcinoma than the number of adenocarcinoma cases was 68% among the reports of McKeown MIE or robotic-assisted McKeown MIE, 27% among the reports of Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE, and 100% among the reports of TME (Tables 1 and 5).

2.5 | Technique of MIE adopted in different countries

Countries in which the rate of selection of McKeown MIE or robotic-assisted McKeown MIE was more than 80% were India, Japan,

TABLE 1 Postoperative complications of MIE

								Pathology (cases)				Complication (%)					
No.	Authors	Year	Ref	Country	Technique	Extent of LND	N (cases)	SCC	Adeno.	Other	Definition of Complication	Pneumonia	Arrhythmia	Leakage	Cond. nec.	Chylothorax	RLNP
1	Osugi	2003	8	Japan	M	UML	77	77	0	0		15.6	1.3	1.3		3.9	14.3
2	Yamamoto	2005	9	Japan	M	UML	112	109	3	0		6.3		8	0.8	2.7	8.9
3	Shiraishi	2006	10	Japan	M	UML	78	73				20.5	2.6	11.5			33.3
4	Palanivelu	2006	11	India	M	UML	130	130	0	0		1.5	5.4	2.3		0.8	1.5
5	Parameswaran	2009	12	UK	M	UML	50	5	41	4		8	0	14	4	6	12
6	Puntambekar	2010	13	India	M	UML	112	100	12	0		7.1		2.7			3.6
7	Gao	2011	14	China	M	UML	96	90	4	2		13.5		7.3		1.1	2.1
8	Kinjo	2012	15	Japan	M	UML	106	102	3	1	CTCAE	16	9.4	10.4		0.9	19.8
9	Shen	2012	16	China	M	UML	76	73	1	2		6.6	11.8	21.1	2.6	1.3	9.2
10	Chen	2013	17	China	M	UML	142	131	11	0		9.2	2.8	6.3	0.7	2.8	5.6
11	Kubo	2014	18	Japan	M	UML	93					8.6		6.4	2.1	8.6	34
12	Meng	2014	19	China	M	UML	94	87	3	4		9.6	4.1	6.4		3.2	4.3
13	Hsu	2014	20	Taiwan	M	UML	66	100	0	0		10.6		27.3		6.1	
14	Nozaki	2015	21	Japan	M	UML	101		0		CTCAE	7.9		6.9			14.9
15	Li	2015	22	China	M	UML	89	82	2	5		7.9	7.9	21.3		1.1	20.2
16	Tanaka	2015	23	Japan	M	UML	59	59	0	0	CTCAE	13.6	11.9	6.8		0	22
17	Uchihara	2018	24	Japan	M	UML	184				CTCAE	12				2.2	
18	Seesing	2018	25	Netherlands	M	UML	121					36.4	19.8	26.4		33.9	7.4
19	Kanekiyo	2018	26	Japan	M	UML	65	65	0	0		16.9	9.2	10.8			23.1
20	Koyanagi	2018	27	Japan	M	UML	67	63	4	0		7.5		7.5			19.4
21	Akiyama	2018	28	Japan	M	UML	87	84	2	1		11.5		0	0	0	18.4
22	Koterazawa	2019	29	Japan	M	UML	162				CD	14.8		17.9			19.8
23	Yamashita	2019	30	Japan	M	UML	104				CD	10.6		5.8		4.8	20.2
24	Luketich	2003	31	USA	M	ML	220					7.7	11.7	11.7	3.2	3.2	3.6
25	Smithers	2007	32	Australia	M	ML	332	77	237			26,0.2	16.6	5.4	1.5	5.1	2.4
26	Dolan	2013	33	USA	M	ML	68					25.6	32.9	9.8		2.4	7.3
27	Hong	2013	34	China	M	ML	55	0	55	0		9.1	9.1	10.9		5.5	0
28	Brown	2018	35	USA	M	ML	61	10	51	0	CD	36.1	36.1	6.6	1.6	3.3	1.6
29	van Workum	2018	36	Netherlands	M	ML	226	45	169	12	CD	24.8	26.1	26.5		13.3	9
30	Zhang	2019	37	China	IL	UML	108	107	0	1		9.3		5.6		2.8	6.5

(Continues)

TABLE 1 (Continued)

No.	Authors	Year	Ref	Country	Technique	Extent of LND	N (cases)	Pathology (cases)			Definition of Complication	Complication (%)					
								SCC	Adeno.	Other		Pneumonia	Arrhythmia	Leakage	Cond. nec.	Chylothorax	RLNP
31	Zingg	2009	38	Australia	IL	ML	56	10	46	0		30.9		20		3.6	
32	Noble	2013	39	UK	IL	ML	53				CD	34	11.3	9.4		1.9	
33	Xie	2014	40	China	IL	ML	106	98	7	1		4.7	2.8	4.7		3.8	3.8
34	Tapias	2014	41	USA	IL	ML	80	11	68	1		6.3	13.8	0	0	3.8	0
35	Sihag	2015	42	USA	IL	ML	600					12.8		13.8		4.3	
36	Tapias	2016	43	USA	IL	ML	56	10	46	0		5.4	17.9	0		5.4	0
37	van Workum	2018	36	Netherlands	IL	ML	561	53	498	10	CD	27.8	17.1	14.4		8.7	0.5
38	Gambhir	2019	44	USA	IL	ML	75							10.6			
39	Meredith	2019	45	USA	IL	ML	95					13.7	17.9	4.2			
40	Souche	2019	46	France	IL	ML	58	13	45	0	CD	10.3	17.2	31	0		0
41	Tagkalos	2019	47	Germany	IL	ML	50					18		18			
42	Naffouje	2019	48	USA	IL	ML	161	14	146	1		11.8		13			
43	Lorimer	2019	49	USA	IL	ML	200	23	176	1		17	23	8.5			
44	van der Sluis	2015	50	Netherlands	RM	UML	108	20	78	10	CD	33.3	8.3	18.5		17.6	9.3
45	Park	2018	51	Korea	RM	UML	140	131				8.8		9.3	0		25
46	van der Sluis	2019	52	Netherlands	RM	UML	54	13	41	0		27.8	22.2	24.1	1.9	31.5	9.3
47	Zhang	2019	37	China	RIL	UML	76	74	0	2		6.6		9.2		1.3	6.6
48	Meredith	2018	53	USA	RIL	ML	147	14	126	7	CD	6.8	11.6	2.7		3.4	
49	Meredith	2019	45	USA	RIL	ML	144					6.9	11.8	2.8			
50	Tagkalos	2019	47	Germany	RIL	ML	50					12		12			
51	Wang	2015	54	China	TME	UML	194	194	0	0		6.2	3.6	4.6			4.6
52	Fujiwara	2017	55	Japan	TME	UML	60	58	2	0	CD, ECCG	6.7		15		0	33.3

Abbreviations: Adeno., adenocarcinoma; CD, Clavien–Dindo classification; cond.nec., conduit necrosis; CTCAE, Common Terminology Criteria for Adverse Events; ECCG, Complications Definitions by the Esophageal Complications Consensus Group; IL, Ivor Lewis; LND, lymph node dissection; M, McKeown; MIE, Minimally invasive esophagectomy; ML, middle and lower mediastinum; RIL, Robotic-assisted Ivor Lewis; RLNP, recurrent laryngeal nerve palsy; RM, Robotic-assisted McKeown; SCC, squamous cell carcinoma; TME, transmediastinal esophagectomy; UML, upper, middle, and lower mediastinum.

TABLE 2 Technique of MIE and postoperative complications

Technique of MIE	Complication (%)					
	Pneumonia	Arrhythmia	Leakage	Cond.nec.	Chylothorax	RLNP
M (n = 29[a])						
Max.	36.4	36.1	27.3	4.0	33.9	34.0
Median	10.6	9.3	7.8	1.6	3.2	9.2
Min.	1.5	0.0	0.0	0.0	0.0	0.0
IL (n = 14)						
Max.	34.0	23.0	31.0	0.0	8.7	6.5
Median	12.8	17.2	10.0	0.0	3.8	0.3
Min.	4.7	2.8	0.0	0.0	1.9	0.0
RM (n = 3)						
Max.	33.3	22.2	24.1	1.9	31.5	25.0
Median	27.8	15.3	18.5	1.0	24.6	9.3
Min.	8.8	8.3	9.3	0.0	17.6	9.3
RIL (n = 4)						
Max.	12.0	11.8	12.0		3.4	6.6
Median	6.9	11.7	6.0		2.4	6.6
Min.	6.6	11.6	2.7		1.3	6.6
TME (n = 2)						
Max.	6.7	3.6	15.0		0.0	33.3
Median	6.5	3.6	9.8		0.0	19.0
Min.	6.2	3.6	4.6		0.0	4.6
Total (n = 52)						
Max.	36.4	36.1	31.0	4.0	33.9	34.0
Median	10.6	11.7	9.3	1.5	3.4	8.9
Min.	1.5	0.0	0.0	0.0	0.0	0.0

Abbreviations: cond.nec., conduit necrosis; IL, Ivor Lewis; M, McKeown; MIE, Minimally invasive esophagectomy; RIL, Robotic-assisted Ivor Lewis; RLNP, recurrent laryngeal nerve palsy; RM, Robotic-assisted McKeown; TME, transmediastinal esophagectomy.

[a]Number of reports.

TABLE 3 Extent of lymph node dissection and postoperative complications

Extent of LND	Complication (%)					
	Pneumonia	Arrhythmia	Leakage	Cond.nec.	Chylothorax	RLNP
UML (n = 30[a])						
Max.	36.4	22.2	27.3	4.0	33.9	34.0
Median	9.5	7.9	8.0	1.4	2.8	13.2
Min.	1.5	0.0	0.0	0.0	0.0	1.5
ML (n = 22)						
Max.	36.1	36.1	31.0	3.2	13.3	9.0
Median	12.4	16.9	10.2	1.5	3.8	1.6
Min.	4.7	2.8	0.0	0.0	1.9	0.0
Total (n = 52)						
Max.	36.4	36.1	31.0	4.0	33.9	34.0
Median	10.6	11.7	9.3	1.5	3.4	8.9
Min.	1.5	0.0	0.0	0.0	0.0	0.0

Abbreviations: cond.nec., conduit necrosis; LND, lymph node dissection; ML, middle and lower mediastinum; RLNP, recurrent laryngeal nerve palsy; UML, upper, middle, and lower mediastinum.

[a]Number of reports.

TABLE 4 Technique of MIE and extent of lymph node dissection

	Extent of LND		
Technique of MIE	UML	ML	Total
M/RM	26 (81%)[a]	6 (19%)	32 (100%)
IL/RIL	2 (11%)	16 (89%)	18 (100%)
TME	2 (100%)	0 (0%)	2 (100%)
Total	30 (58%)	22 (42%)	52 (100%)

Abbreviations: IL, Ivor Lewis; LND, lymph node dissection; M, McKeown; MIE, Minimally invasive esophagectomy; ML, middle and lower mediastinum; RIL, Robotic-assisted Ivor Lewis; RM, Robotic-assisted McKeown; TME, transmediastinal esophagectomy; UML, upper, middle, and lower mediastinum.

[a]Number of reports.

TABLE 5 Technique of MIE and dominant pathology

	Dominant pathology		
Technique of MIE	SCC	Adeno.	Total
M/RM	15 (68%)[a]	7 (32%)	22 (100%)
IL/RIL	3 (27%)	8 (73%)	11 (100%)
TME	2 (100%)	0 (0%)	2 (100%)
Total	20 (57%)	15 (43%)	35 (100%)

Abbreviations: Adeno., adenocarcinoma; IL, Ivor Lewis; M, McKeown; MIE, Minimally invasive esophagectomy; RIL, Robotic-assisted Ivor Lewis; RM, Robotic-assisted McKeown; SCC, squamous cell carcinoma; TME, transmediastinal esophagectomy.

[a]Number of reports.

Korea, Netherlands, and Taiwan. The largest number, that is, 13 out of 29 (45%), of reports of McKeown MIE was from Japan. The median incidences of pneumonia, arrhythmia, anastomotic leakage, conduit necrosis, chylothorax, and recurrent laryngeal nerve palsy were 12.0%, 9.2%, 7.2%, 0.8%, 2.5%, and 19.8%, respectively, in the reports of McKeown MIE in Japan. Countries in which the rate of adoption of Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE was more than 75% were France, Germany, and the USA (Tables 1 and 6).

2.6 | Definition of complications

The Clavien–Dindo classification, CTCAE, or Complications Definitions by the ECCG was used for classifying the severity of complications in 14 of the 52 (27%) reports (Table 1).

3 | DISCUSSION

The median incidences of pneumonia in all reports, except for the reports of robotic-assisted McKeown MIE, were less than the 14.6% indicated in the ECCG report. The incidence of pneumonia was higher in the reports of robotic-assisted McKeown MIE; two out of the three articles written on reports of robotic-assisted McKeown MIE were

TABLE 6 Technique of MIE adopted in different countries

	Technique of MIE			
Country	M/RM	IL/RIL	TME	Total
Australia	1 (50%)[a]	1 (50%)		2 (100%)
China	6 (60%)	3 (30%)	1 (10%)	10 (100%)
France		1 (100%)		1 (100%)
Germany		2 (100%)		2 (100%)
India	2 (100%)			2 (100%)
Japan	13 (93%)		1 (7%)	14 (100%)
Korea	1 (100%)			1 (100%)
Netherlands	4 (80%)	1 (20%)		5 (100%)
Taiwan	1 (100%)			1 (100%)
UK	1 (50%)	1 (50%)		2 (100%)
USA	3 (25%)	9 (75%)		12 (100%)
Total	32 (62%)	18 (35%)	2 (4%)	52 (100%)

Abbreviations: IL, Ivor Lewis; M, McKeown; MIE, Minimally invasive esophagectomy; RIL, Robotic-assisted Ivor Lewis; RM, Robotic-assisted McKeown; TME, transmediastinal esophagectomy.

[a]Number of reports.

written by the same author,[50,52] and it is possible that the surgical technique used by these authors was related to the higher incidence of pneumonia. One of the three reports of robotic-assisted McKeown MIE reported an incidence of 8.8%,[51] which was within the average range. The median incidences of arrhythmia in all reports, except for the reports of Ivor Lewis MIE and robotic-assisted McKeown MIE, were less than the 14.5% indicated in the ECCG report. The median incidences of anastomotic leakage in all reports, except for the reports of robotic-assisted McKeown MIE, were less than the 11.4% indicated in the ECCG report. The incidence of anastomotic leakage was relatively high in two of the three reports of robotic-assisted McKeown MIE,[50,52] and it is possible that this higher incidence was related to the handsewn anastomotic technique used by the authors. However, in the remaining one of the three articles,[51] which described the use of the stapler technique for anastomosis, the reported incidence was only 9.3%, which was within the average range. The heterogeneous anastomotic techniques were used in all studies, and no robust data are currently available on the association of the anastomotic technique (for example, handsewn versus stapled or different types of anastomotic configuration) with differences in outcome.[36] It is necessary to clarify whether anastomotic techniques affect outcome after MIE in the future. Data on the incidence of conduit necrosis was described in only 13 of the 52 reports (23%) and this complication appeared to be rare. The median incidences of chylothorax in all reports, except for the reports of robotic-assisted McKeown MIE, was less than the 4.7% indicated in the ECCG report. Resection of the thoracic duct may increase the risk of this complication.[56] The incidence of chylothorax was relatively high in two reports of robotic-assisted McKeown MIE,[50,52] which could be attributable to resection of the thoracic duct described in both reports.

The median incidences of recurrent laryngeal nerve palsy in all reports, except for the reports of Ivor Lewis MIE, were more than the

4.2% indicated in the ECCG report. Dissection of the upper mediastinal lymph nodes, especially lymph nodes around the right and the left recurrent laryngeal nerves, are oncologically necessary for all patients with thoracic esophageal squamous cell carcinoma, irrespective of the location.[57] In general, lymph node dissection of nodes in the upper, middle, and lower mediastinum is selected in McKeown MIE, and lymph node dissection of only nodes in the middle and lower mediastinum, that is, no dissection of lymph nodes around the recurrent laryngeal nerves, is selected in Ivor Lewis MIE. Therefore, in Ivor Lewis MIE, the recurrent laryngeal nerves were rarely injured, and the rate of recurrent laryngeal nerve palsy was very low. On the other hand, more extensive dissection of lymph nodes from the chest and neck is performed in McKeown MIE than in Ivor Lewis MIE, and when anastomosis was performed in McKeown MIE, the upper esophagus was pulled out from the thoracic inlet. These procedures could lead to injury of the recurrent laryngeal nerves. Actually, when the relationships between the extent of lymph node dissection and the incidences of postoperative complications were analyzed, recurrent laryngeal nerve palsy rarely occurred in the patients who underwent lymph node dissection of nodes in the middle and lower mediastinum than in the patients who underwent lymph node dissection of nodes in the upper, middle, and lower mediastinum (Table 3).

However, is it true that lymph node dissection of the nodes in the upper, middle and lower mediastinum is selected in all cases of McKeown MIE and that lymph node dissection of only nodes in the middle and lower mediastinum is selected in all cases of Ivor Lewis MIE? Surprisingly, lymph node dissection of only nodes in the middle and lower mediastinum was reported in 19% of reports of McKeown MIE or robotic-assisted McKeown MIE. On the other hand, lymph node dissection of nodes in the upper, middle, and lower mediastinum was reported in 11% of reports of Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE (Table 4). For example, Zhang et al adopted robotic-assisted Ivor Lewis MIE with lymph node dissection of nodes in the upper, middle, and lower mediastinum, and reported a recurrent laryngeal nerve palsy rate of 6.6%.[37] Therefore, we would like to mention that the MIE technique adopted does not always automatically reflect the extent of lymph node dissection. Attention must be paid not only to the MIE technique but also to the extent of lymph node dissection when analyzing the postoperative complications of MIE, especially recurrent laryngeal nerve palsy. Van Workum et al performed propensity score-matched analysis to compare minimally invasive Ivor Lewis versus minimally invasive McKeown esophagectomy.[36] They concluded that Ivor Lewis MIE was associated with a lower incidence of anastomotic leakage, 90-day mortality and other postoperative morbidities as compared to McKeown MIE in patients in whom both procedures were oncologically feasible. This is very important information relevant to only patients with tumors in the distal esophagus and gastroesophageal junction. The complication rates in patients with tumors in other locations may not be similar to the rates in patients with tumors in the distal esophagus and gastroesophageal junction.

The pathology of esophageal cancer may be one of the factors guiding selection of the MIE technique to be adopted. The percentage of reports in which the number of cases of squamous cell carcinoma was more than the number of adenocarcinoma cases was 68% among the reports of McKeown MIE or robotic-assisted McKeown MIE. On the other hand, the percentage of reports in which the number of cases of adenocarcinoma was more than the number of squamous cell carcinoma cases was 73% among the reports of Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE. Squamous cell carcinoma arises from stratified squamous epithelium anywhere in the esophagus, and the most frequent location is the middle esophagus.[58,59] Institutions where patients with squamous cell carcinoma were predominant may have tended to select McKeown MIE, robotic-assisted McKeown MIE, or TME so as to accomplish adequate esophageal resection and lymph node dissection. Adenocarcinoma arises mainly from Barrett's epithelium and the most frequent location is the lower esophagus or the esophagogastric junction.[59] Institutions where patients with adenocarcinoma were predominant may have tended to select Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE in order to accomplish adequate esophageal resection and lymph node dissection.

As for the MIE technique adopted in different countries, Asian countries and the Netherlands tended to adopt McKeown MIE, robotic-assisted McKeown MIE, or TME. Japan published the largest number of reports of McKeown MIE. The median incidences of complications, except for the rates of recurrent laryngeal nerve palsy, were within average range. The reason why the rate of recurrent laryngeal nerve palsy was high may be due to the nationwide consensus on the need for intensive lymph node dissection of nodes in the upper, middle, and lower mediastinum, especially of those around the bilateral recurrent laryngeal nerves.[57] Western countries, except the Netherlands, tended to adopt Ivor Lewis MIE or robotic-assisted Ivor Lewis MIE. This may be due to epidemiological and pathological reasons: squamous cell carcinoma patients are more frequent in Asian countries, while adenocarcinoma patients are more frequent in western countries.

The severities of the complications were described in only 27% of the reports. The Clavien–Dindo classification, CTCAE, and Complications Definitions by the ECCG are available. For high-quality analysis of postoperative complications, it would be desirable for surgeons to use officially approved classifications of the severities of complications.

4 | CONCLUSION

The overall incidences of postoperative complications of MIE for esophageal cancer according to the MIE technique adopted, namely, McKeown MIE, Ivor Lewis MIE, robotic-assisted McKeown MIE, robotic-assisted Ivor Lewis MIE or TME, were analyzed. Pneumonia, arrhythmia, anastomotic leakage, and recurrent laryngeal nerve palsy occurred in about 10% of the patients each; Ivor Lewis MIE was associated with a relatively low incidence of recurrent laryngeal nerve palsy. It is important to recognize that the incidences of complications are influenced by the MIE technique adopted and the extent of lymph node dissection.

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