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Laparoscopic–Robotic-Assisted Ivor–Lewis Oesophagectomy Using CMR Versius System: A Single-Centre Early Implementation Case Series

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Highlights

What are the main findings?

- Fully minimally invasive Ivor-Lewis esophagectomy with the CMR Versius system was technically feasible in a 34-patient single-center series.
- Early perioperative outcomes were acceptable, including a 91.2% R0 resection rate, 8.8% anastomotic leak rate, and no 30-day mortality.

What are the implications of the main findings?

- The Versius system may be a viable robotic platform for complex esophageal surgery during the early implementation phase.
- Larger multicenter studies with longer follow-up are needed to confirm oncologic safety, learning-curve behavior, and broader applicability.

Abstract

Background: Evidence on Versius-assisted oesophagectomy remains limited. This retrospective single-centre case series describes the early implementation and outcomes of a fully minimally invasive Ivor–Lewis procedure comprising a laparoscopic abdominal phase and a Versius-assisted thoracic phase. **Methods:** A retrospective analysis was performed on prospectively collected data from 34 consecutive patients who underwent the RAMIE procedure using the Versius Surgical System at Klinikum Chemnitz between September 2024 and July 2025. The surgical technique consisted of a laparoscopic abdominal phase followed by a robotic thoracic phase with intrathoracic circular stapled anastomosis. The primary aim was to assess the safety and feasibility of using the Versius Surgical System in esophageal surgery. **Results:** The mean operative time was 329 min (range: 245–416), and the mean docking time was 11 min (range: 6–27). No conversions to laparoscopic or open procedures occurred (0%). R0 resection was achieved in 91.2% of patients. The median lymph node harvest was 28 (range: 15–44). The anastomotic leak rate was 8.8%, with no associated mortality. No deaths occurred within 90 days after surgery. **Conclusions:** In this initial single-centre series, the planned robotic Versius-assisted approach was completed in all patients. The observed perioperative and pathological outcomes provide preliminary descriptive evidence to support further prospective evaluation. They do not establish comparative safety, efficacy, or oncological equivalence.

Keywords: robotic oesophagectomy; esophageal cancer; minimally invasive oesophagectomy

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1. Introduction

Esophageal cancer is an aggressive malignancy comprising two major histological subtypes: esophageal squamous cell carcinoma (SCC) and adenocarcinoma. Surgical resection remains a central component of curative-intent treatment for resectable disease, usually within a multimodal strategy [1]. Over recent decades, esophagectomy has evolved from open surgery toward minimally invasive and robot-assisted techniques.

Although oesophagectomy remains associated with substantial postoperative morbidity, in-hospital mortality was low across open, hybrid, laparoscopic minimally invasive, and robot-assisted approaches in a recent systematic review of 16 randomised controlled trials, without significant differences between techniques [2].

In the randomized TIME trial, compared with open surgery, minimally invasive esophagectomy reduced pulmonary infections (12% vs. 34%, $p = 0.005$), blood loss (200 vs. 475 mL, $p < 0.001$), and hospital stay (11 vs. 14 days, $p = 0.044$) while improving quality of life six weeks after surgery [1]. Robot-assisted minimally invasive esophagectomies (RAMIEs) represent the latest advancement in esophageal surgery, offering enhanced precision, improved ergonomics, and potentially superior clinical outcomes while maintaining oncological equivalence. Contemporary evidence supports minimally invasive approaches for oesophagectomy, although the magnitude of benefit varies according to the comparator, centre experience, and outcome definition. A recent systematic review and meta-analysis reported that both laparoscopic minimally invasive oesophagectomy and robot-assisted minimally invasive oesophagectomy were associated with lower blood loss, fewer pulmonary complications, shorter hospital stays, improved quality of life, and higher lymph-node yields than open oesophagectomy, while mortality, chyle leak, survival, and oncological outcomes were broadly comparable [2–4]. In an international Oesophagogastric Anastomosis Audit cohort, totally minimally invasive oesophagectomy was associated with a lower 90-day pulmonary-complication rate than open or hybrid oesophagectomy (28% versus 37% and 39%, respectively); compared with open oesophagectomy, the adjusted odds ratio was 0.60 (95% CI, 0.45–0.78). [4]. The introduction of robotic assistance for esophageal surgery began in the early 2000s, with Kernstine et al. reporting the first robotic-assisted esophagectomy series [5]. In a large international multicentre study, Kingma et al. analysed 856 transthoracic RAMIE procedures from 20 centres across four continents. The overall postoperative complication rate was 60%, short-term mortality was 3% (26/856), and anastomotic leakage rates varied from 6% to 33% depending on the procedure and anastomotic technique [6]. While the da Vinci system has extensive validation through numerous cases and multiple randomized controlled trials, emerging platforms like the Versius system require dedicated assessment to establish their safety profile, learning curve characteristics, and comparative effectiveness specifically for esophageal surgery. Published evidence on the use of the Versius Surgical System for oesophagectomy remains limited. A first-in-human single-centre series reported the feasibility of robot-assisted transthoracic oesophagectomy using Versius; however, published data specifically describing a laparoscopic–Versius-assisted Ivor–Lewis procedure with intrathoracic circular-stapled anastomosis remain sparse [7]. The CMR Versius system represents a significant technological advancement with four independent robotic arms. The Versius Surgical System received CE marking in 2019. In the United States, the Food and Drug Administration (FDA) granted De Novo marketing authorization/classification for the Versius Surgical System on 11 October 2024; the initial U.S. indication was adult cholecystectomy [8]. Technical advantages of the Versius system include: (1) a modular design allowing for flexible port placement and optimized workspace utilization; (2) an open console facilitating direct communication between the console surgeon and operative team; (3) reduced operating room footprint compared to integrated systems; and (4) independent arm positioning capabilities enabling

customized surgical approaches based on patient anatomy. A systematic review of the current colorectal literature on the Versius Surgical Robotic System identified nine studies, predominantly observational, comprising 561 procedures. The largest reported series showed a 7.0% conversion rate, and severe complications (Clavien–Dindo grade $\geq$ III) were reported in 5.3% of cases. The authors found no major safety concerns but emphasized that further comparative studies are needed before Versius can be quantitatively compared with established robotic platforms [9]. This report adds a consecutive single-centre experience of a robotic Versius-assisted Ivor–Lewis oesophagectomy with intrathoracic circular-stapled anastomosis to the limited published evidence on Versius use in oesophageal surgery. Since 2024, fully minimally invasive laparoscopic-robot-assisted esophageal resections using the CMR Versius system have been performed at Klinikum Chemnitz. The aim of this study is to evaluate the safety and feasibility of the CMR Versius system for performing Ivor-Lewis esophagectomy, contributing to the evolving evidence base for next-generation robotic platforms in esophageal cancer surgery.

2. Materials and Methods

2.1. Patient Selection

This retrospective analysis included the first 34 patients who underwent the RAMIE procedure using the Versius Surgical System at Klinikum Chemnitz between September 2024 and July 2025. Patients were preoperatively evaluated based on their clinical and oncological characteristics. Inclusion criteria were histologically confirmed esophageal cancer and an indication for surgical resection, as determined by our interdisciplinary tumor board. All consecutive patients who met the inclusion criteria during the study period were included in this analysis, with no exclusions due to incomplete data or loss to follow-up.

2.2. Surgical Technique

All procedures were performed using a minimally invasive approach; the abdominal phase was performed laparoscopically, while the thoracic phase was performed robotically using the Versius Surgical System (CMR Surgical). The system features a modular design with independent robotic arms and an open console, facilitating improved communication between the surgeon and the operating team. The surgery was conducted using a standardized RAMIE technique, encompassing both transthoracic and transabdominal phases. All surgeries were performed by the same experienced surgeon. The surgeon specializes in esophageal resections and had previously spent approximately 3 months gaining experience using the CMR Versius system during other surgeries, as well as having years of experience using the da Vinci system, which was also used to perform an esophageal resection. Before performing surgery with the CMR Versius, he had already performed approximately 150 hybrid, minimally invasive Ivor Lewis esophagectomies. These included 42 robot-assisted procedures using the Da Vinci system.

2.3. Procedure Description

2.3.1. Abdominal Phase

The abdominal phase was initiated laparoscopically. Trocar placement was as follows (Figure 1):

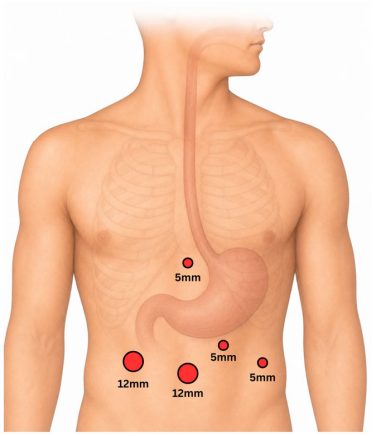


Figure 1. Trocar placement for the abdominal phase. The underlying body outline was generated using Perplexity AI (Perplexity AI, Inc., San Francisco, CA, USA), and the trocar positions were manually added and edited by the authors.

The first step was the exposure and dissection of the hiatus, followed by mobilization the stomach after division of the gastrocolic ligament and short gastric vessels, while carefully preserving the arcade of the right gastroepiploic vessels for the main arterial supply of the gastric conduit. Subsequently, a gastric conduit (width 3–4cm) was built, beginning at the level of angulus and extending towards the fundus, preserving the proximal branches of the right gastric artery to maintain their partial contribution to conduit perfusion [10]. A small tissue bridge was left at the esophagogastric junction to allow for later pull-up of the conduit into the thorax. The abdominal lymphadenectomy was performed along the common hepatic artery, proximal splenic artery, and celiac trunk. The left gastric artery was exposed and divided at its origin using clips. The abdominal phase was completed with mobilization of the distal oesophagus and opening of the right pleura.

2.3.2. Thoracic Phase

For the thoracic phase, the patient was positioned in the left lateral decubitus position. Port placement followed an L-configuration (Figures 2 and 3). The following instruments and ports were used: a Hook or needle driver was introduced through the 2nd–3rd intercostal space (ICS) using a Z-shaped configuration; a 30° camera with a down-angle was positioned in the 4th–5th ICS, also in a Z-shaped configuration; and a bipolar instrument was placed dorsally through the 10th–11th ICS using a C-shaped configuration.

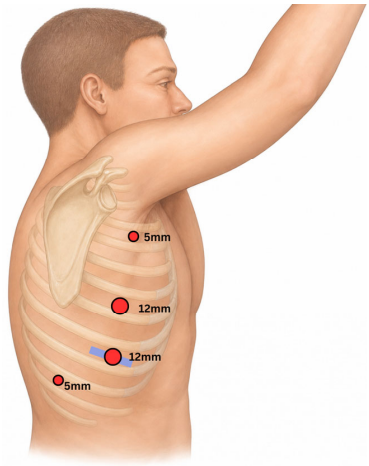


Figure 2. Trocar placement for the thoracic phase. The underlying body outline was generated using Perplexity AI, and the trocar positions were manually added and edited by the authors.



Figure 3. Robotic port configuration for the thoracic phase.

2.3.3. Trocar Placement for the Thoracic Phase

After docking and configuration of the instruments, the thoracic phase began with mobilization of the distal oesophagus. The pulmonary ligament was divided, followed by incision of the mediastinal pleura. Dissection proceeded from the pericardium towards the right main bronchus, with further pleural incision beneath the azygos vein and posteriorly. The oesophagus was mobilized in an en bloc fashion using monopolar (Hook) and bipolar, larger perforans were secured with clips before division, ensuring removal of the mediastinal fatty tissue and lymph nodes surrounding the oesophagus. The thoracic duct was exposed and clipped above the hiatus. The azygos vein was divided, followed by completion the en bloc standardized mediastinal lymphadenectomy at the tracheobronchial bifurcation, thereby exposing both main bronchi. The oesophagus was then mobilized and transected at this level. In selected cases, an extended lymphadenectomy of the upper mediastinum was performed, particularly in patients with adenocarcinomas > 4 cm or with tumors located in the middle thoracic oesophagus.

The gastric conduit was pulled up into the thoracic cavity through the posterior mediastinal route. A blue line was marked on the last vascular supply of the conduit tip to indicate the initially intended anastomotic site. Gastric conduit perfusion was then assessed using indocyanine green fluorescence angiography (ICG-FA) with the integrated vLimeLite near-infrared fluorescence imaging system of the CMR Versius Surgical System. Indocyanine green was administered intravenously at a dose of 0.1 mg/kg body weight. The final anastomotic site was selected within the adequately perfused segment of the conduit, with adjustment of the initially marked site when fluorescence suggested insufficient perfusion [11]. The proximal oesophagus was opened and the anvil of a 28-mm circular stapler was introduced through the mini-thoracotomy and secured within the proximal oesophageal stump using a purse-string suture with 2-0 Prolene. An end-to-side intrathoracic oesophagogastric anastomosis was then constructed at the level of the divided azygos vein using a 28-mm circular stapler. The anastomosis was reinforced with a continuous hand-sewn suture and covered with a pedicled omental flap.

2.4. Pre- and Postoperative Care

All patients underwent standardized preoperative preparation, including neoadjuvant chemotherapy in patients with adenocarcinoma or chemoradiotherapy in patients with SCC and endoscopic pyloric balloon-dilatation. Postoperatively, patients were initially monitored in the intensive care unit followed by transfer to the surgical ward. All patients were managed in accordance with our standard postoperative surgical protocol. Postoperative complications were classified according to the Clavien–Dindo system. Anastomotic leakage (AL) was diagnosed based on radiological and endoscopic findings and was defined in accordance with the criteria of the Esophagectomy Complications Consensus Group (ECCG).

2.5. Data Collection and Analysis

Demographic, clinical, surgical, pathological, and postoperative data were prospectively recorded in the UGIRA registry. For this retrospective analysis, the dataset was reviewed and supplemented using electronic medical records, surgical reports, anesthesia records, and the original pathology reports. The completed dataset was then analyzed retrospectively. Primary endpoints included the R0 resection rate, the number of lymph nodes removed, and the rate of anastomotic leaks. Secondary endpoints included operative time, blood loss, postoperative complication rates, and 30-day mortality. Statistical analyses were performed using Python version 3.12 (Python Software Foundation, Wilmington, DE, USA), using the pandas, SciPy, and statsmodels libraries. Continuous variables were assessed descriptively and are presented as mean ± standard deviation for approximately normally distributed variables or as median with interquartile range for skewed variables. Categorical variables are presented as *n* (%). Exact two-sided 95% confidence intervals for selected binary outcomes were calculated using the Clopper-Pearson method. Missing data were reported for each variable, and no imputation was performed. Given the retrospective, single-centre descriptive case-series design and the small sample size, no hypothesis-testing comparisons were prespecified.

2.6. Follow-Up and Survival

Follow-up data were obtained from hospital records and outpatient visits. Complete follow-up through postoperative day 90 was available for all patients (34/34, 100%) with regard to mortality, postoperative complications, unplanned readmissions, reinterventions, and reoperations. Postoperative outcomes were assessed within 90 days after surgery. Longer-term follow-up beyond postoperative day 90 was not complete for all patients and was therefore not used for formal survival analysis. Overall survival was defined as the time from surgery to death from any cause or last documented follow-up. Overall survival was defined as the time from surgery to death from any cause or last follow-up. Given the short observation period, these results should be interpreted as short-term/perioperative outcomes rather than definitive oncological outcomes.

2.7. Learning Curve Analysis

Docking time was assessed descriptively across all 34 consecutive procedures. Individual docking times were plotted against consecutive case number. An exploratory simple linear regression model was fitted with docking time as the dependent variable and consecutive case number as the independent variable. The fitted regression line and its two-sided 95% confidence interval for the mean fitted value were displayed. The slope, its 95% confidence interval, coefficient of determination (R^2), and two-sided *p* value were reported. No proficiency threshold, case-group comparison, risk adjustment, or formal learning-curve

analysis was prespecified. Docking time was considered a measure of operating-room set-up and team coordination rather than a surrogate marker of surgical proficiency.

3. Results

3.1. Patient Demographics and Clinical Characteristics

A total of 34 patients were included in the analysis. Baseline demographic, clinical, and pathological characteristics of the study cohort are summarized in Table 1. The mean age was 63 years (range: 42–83 years), and the mean body mass index (BMI) was 26.8 kg/m^2 (range: 23.1–29.7). The majority of patients were male (85.3%, n = 29); 97.1% received neoadjuvant therapy. The preoperative ASA score was 2 in 52.9% of patients. Thirty-three patients (97.1%) received neoadjuvant treatment and were staged according to the post-neoadjuvant pathological classification (ypTNM). One patient underwent primary resection without complete neoadjuvant treatment and was therefore classified as pT3. In this patient, neoadjuvant chemotherapy according to the FLOT regimen was discontinued because of intolerance. Among patients receiving neoadjuvant treatment, pathological tumor stages were ypT0 in 18.2% (n = 6), ypT1a in 6.1% (n = 2), ypT1b in 12.1% (n = 4), ypT2 in 9.1% (n = 3), and ypT3 in 54.5% (n = 18).

Table 1. Baseline demographic, clinical, tumour, and treatment characteristics of the study cohort (n = 34). Data are presented as mean ± standard deviation, median (interquartile range), or n (%).

Characteristic	Value
Demographic and clinical characteristics	
Age, years	63.3 ± 9.5
Sex	
Male	29 (85.3)
Female	5 (14.7)
Body mass index, kg/m^2	26.8 (23.1–29.7)
Obesity (BMI ≥ 30 kg/m^2)	4 (11.8)
ASA physical status	
II	18 (52.9)
III	16 (47.1)
ECOG performance status	
0	16 (47.1)
1	16 (47.1)
2	2 (5.9)
Diabetes mellitus	5 (14.7)
Smoking/nicotine use	20 (58.8)
Tumour and treatment characteristics	
Histology	
Adenocarcinoma	28 (82.4)
Squamous cell carcinoma	4 (11.8)
Undifferentiated carcinoma	2 (5.9)
Pathological T category	
ypT0	6/33 (18.2)
ypT1a	2/33 (6.1)

Table 1. *Cont.*

Characteristic	Value
ypT1b	4/33 (12.1)
ypT2	3/33 (9.1)
ypT3	18/33 (54.5)
pT3*	1/1 (100)
Neoadjuvant therapy	
Initiated	34 (100.0)
Incomplete/discontinued *	1 (2.9)

* One patient discontinued the planned neoadjuvant treatment because of intolerance and underwent primary resection. This patient is reported as pT3. The remaining 33 patients are reported using post-neoadjuvant pathological staging (ypT). Pathological staging was classified according to the AJCC/UICC TNM Classification, 8th edition. BMI = body mass index; ASA = American Society of Anesthesiologists; ECOG = Eastern Cooperative Oncology Group.

3.2. Operative Outcomes

Total operative time, including patient positioning and docking, was 329.4 min (SD, 43.5; range, 245–416). Docking time was available for all 34 consecutive procedures and was 10.5 min (IQR, 9–12; range, 6–27). Robotic thoracic operative time was 151.1 min (SD, 37.3; range, 66–254). Docking times across the 34 consecutive procedures are displayed in Figure 4. In an exploratory linear regression analysis, docking time showed a numerically negative, but statistically non-significant, association with consecutive case number (slope, −0.109 min per case; 95% CI, −0.252 to 0.034; R^2 = 0.070; p = 0.131; n = 34). The mean blood loss was 237 mL (range: 50–800 mL). No conversions to laparoscopic or open procedures during the thoracic phase were recorded (0%). Furthermore, no adverse injuries were detected intraoperatively.

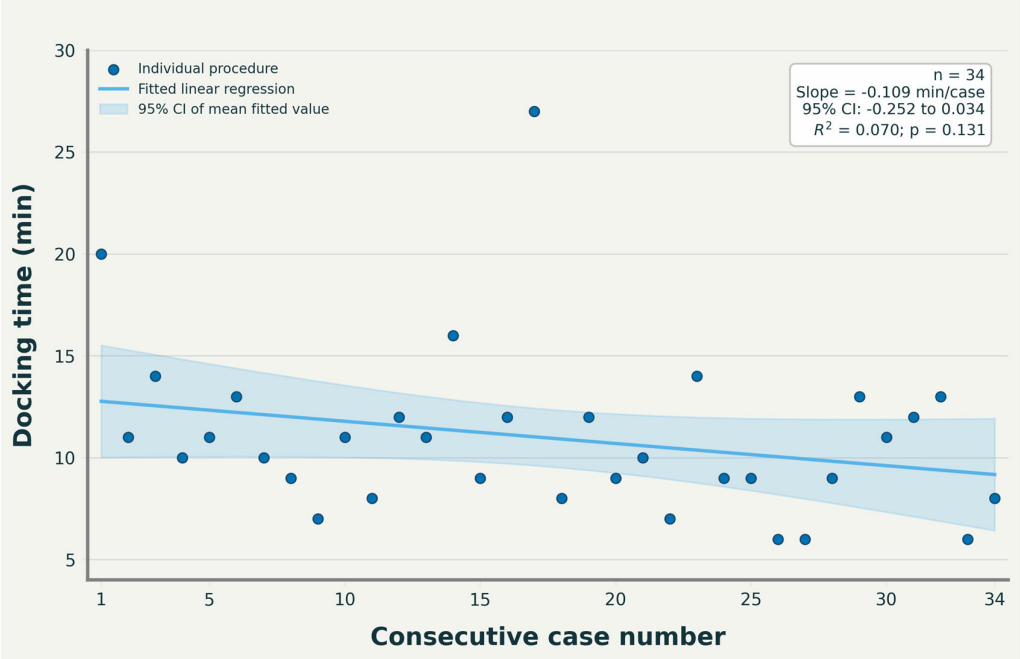


Figure 4. Docking time by consecutive case number. Docking time was measured from the start of robotic arm docking until the system was ready for console operation. Points represent individual procedures; the solid line shows the fitted linear regression and the shaded area the 95% confidence interval. The slope was −0.109 min/case (95% CI, −0.252 to 0.034; R^2 = 0.070; p = 0.131; n = 34).

3.3. Oncological Outcomes

An R0 resection was achieved in 91.2% of patients (95% CI: 76.3–98.1%), while 8.8% had an R1 resection (95% CI: 1.9–23.7%). Among the three patients with R1 resection, two had a positive lateral resection margin (circumferential) and one had involvement of a para-aortic lymph node with aortic infiltration; all three were associated with an advanced tumor stage. The mean number of lymph nodes harvested was 28 (range: 15–44).

3.4. Postoperative Outcome

Postoperative complications occurred in 5 of 34 patients (14.7%; 95% CI, 5.0–31.1) within 90 days and are summarized in Table 2 Three patients developed an ECCG type II anastomotic leak between postoperative days 7 and 10 corresponding to an incidence of 8.8% (95% CI, 1.9–23.7). One patient was treated exclusively by endoscopic intervention without the need for intensive care unit (ICU) admission (Clavien–Dindo grade IIIa). Two patients developed sepsis or respiratory failure requiring ICU admission and were therefore classified as Clavien–Dindo grade IVa. One patient developed a postoperative hiatal herniation of the transverse colon into the hemithorax requiring operative revision (Clavien-Dindo grade IIIb). One patient developed chylothorax, which was managed conservatively (Clavien-Dindo grade I). Overall, major morbidity, defined as Clavien–Dindo grade IIIa or higher, occurred in 4 of 34 patients (11.8%; 95% CI, 3.3–27.5). Complete 90-day follow-up was available for all patients (34/34, 100%). No deaths occurred within 30 or 90 days after surgery (0/34, 0.0%; exact 95% CI, 0.0–10.3 for both endpoints). No patient was lost to follow-up before postoperative day 90.

Table 2. Operative, pathological, and postoperative outcomes (n = 34). Values are mean (SD), median (IQR), or n/N (%); 95% CI: exact two-sided Clopper–Pearson confidence interval.

Outcome	Value	95% CI
Operative characteristics		
Total operative time (min), mean (SD)	329.4 (43.5)	
Laparoscopic abdominal time (min), mean (SD)	167.8 (38.3)	
Docking time (min), median (IQR)	10.5 (9–12)	
Robotic thoracic time (min), mean (SD)	151.1 (37.3)	
Estimated blood loss (mL), median (IQR)	200 (100–300)	
Conversion to laparotomy during abdominal phase	0/34 (0.0)	0.0–10.3
Conversion to thoracotomy or conventional thoracoscopy during thoracic phase	0/34 (0.0)	0.0–10.3
Pathological outcomes		
R0 resection	31/34 (91.2)	76.3–98.1
R1 resection	3/34 (8.8)	1.9–23.7
Lymph nodes retrieved, mean (SD)	28.7 (6.6)	
Lymph nodes retrieved, median (IQR)	28 (24–33)	
Lymph nodes retrieved, range	15–44	
Overall postoperative morbidity within 90 days		
Any postoperative complication	5/34 (14.7)	5.0–31.1
Major morbidity, Clavien–Dindo grade $\geq$ IIIa	4/34 (11.8)	3.3–27.5
ECCG-defined complication category		

Table 2. *Cont.*

Outcome	Value	95% CI
Anastomotic leak	3/34 (8.8)	1.9–23.7
Chyle leak/chylothorax	1/34 (2.9)	0.1–15.3
Diaphragmatic herniation requiring intervention	1/34 (2.9)	0.1–15.3
Recurrent laryngeal nerve palsy	0/34 (0.0)	0.0–10.3
Highest Clavien–Dindo grade for patient		
No complication (Grade 0)	29/34 (85.3)	68.9–95.0
Grade I	1/34 (2.9)	0.1–15.3
Grade II	0/34 (0.0)	0.0–10.3
Grade IIIa	1/34 (2.9)	0.1–15.3
Grade IIIb	1/34 (2.9)	0.1–15.3
Grade IVa	2/34 (5.9)	0.7–19.7
Grade IVb	0/34 (0.0)	0.0–10.3
Grade V	0/34 (0.0)	0.0–10.3
Mortality		
30-day mortality	0/34 (0.0)	0.0–10.3
90-day mortality	0/34 (0.0)	0.0–10.3

4. Discussion

This study presents a single-center case series of fully minimally invasive Ivor-Lewis esophagectomy using the CMR Versius system and provides initial insights into the safety and feasibility of this technique. The R0 resection rate of 91.2%, combined with a low rate of severe complications, suggests acceptable oncological and surgical results with the CMR Versius system RAMIE procedure during this early implementation phase. The mean operative time of 329 min including docking and patient repositioning in our series is still within the expected range for the early implementation phase of a new robotic platform. Given the limited previous experience with RAMIE using the CMR Versius Platform, establishing an optimal surgical setup represented an additional challenge during the initial implementation phase. In the first procedures, different port configurations, instrument combinations, and arm positions were systematically evaluated and modified to identify the setup that provided the most favorable access. Based on our previous experience with other robotic platforms, the setup was progressively standardized, resulting in the port configuration and instrument arrangement described above. Instrument and robotic arm collisions were limited throughout the series, which may be attributable to the surgical team's extensive experience with robotic surgery and familiarity with the technical principles of robotic esophageal surgery. Claassen et al. demonstrated in their systematic analysis of RAMIE learning curves that operative times typically stabilize after 30–45 procedures, with individual studies reporting improvements after 20–26 cases [12]. Specifically for Ivor-Lewis RAMIE, Hernandez et al. found a significant reduction in operative time from 514 to 397 min after 20 cases ($p < 0.005$), placing our results in the context of the early to intermediate learning curve phase [13].

No conversions were required in our series. All procedures were completed as planned with the intended minimally invasive approach, with no conversion from laparoscopy to open surgery during the abdominal phase and no conversion from the robotic approach to either laparoscopy or open surgery during the thoracic phase. However, these findings

should be interpreted with caution given the small sample size and the surgeon's extensive experience with minimally invasive and robotic surgery. Conversion rates during the implementation of RAMIE may vary substantially according to patient selection, operative technique, and prior team experience [14]; our result may reflect a combination of team experience and the flexible arm positioning of the modular Versius system, though this cannot be confirmed without a control group. During the early implementation phase, port configurations, instrument combinations, and bedside-unit positions were iteratively adapted and subsequently standardized. This description reflects the local implementation process; however, the present data do not allow for a formal assessment of a learning curve or attribution of docking performance to specific platform characteristics. The modular design with four independent robotic arms eliminates the complex patient-robot alignment required with integrated systems. The compact size and mobility of the system enable flexible operating room configuration and reduce the space requirements compared to monolithic systems [15]. The open console design represents a paradigmatic difference from closed systems and allows the console surgeon direct visual and verbal communication with the operative team. This feature can be particularly advantageous in critical situations or during training [16].

An R0 resection was achieved in 31 of 34 patients (91.2%). Comparisons with published series should be interpreted cautiously because margin status is influenced by case mix, neoadjuvant treatment, extent of resection, pathological assessment, and the definition used for circumferential margin involvement. The median lymph node harvest was 28 (range: 15–44). A yield of at least 20 retrieved and examined lymph nodes is included in the international consensus-based definition of textbook outcome after oesophageal cancer surgery; however, lymph-node yield should be interpreted in the context of the planned extent of lymphadenectomy, pathology processing, and neoadjuvant treatment [17].

Anastomotic leakage occurred in 3 of 34 patients (8.8%). The observed rate should be interpreted cautiously because of the small cohort and because the clinical severity of leakage differed substantially between patients: one leak required endoscopic intervention and was classified as Clavien–Dindo grade IIIa, whereas two leaks were complicated by sepsis or respiratory failure requiring intensive care management and were classified as grade IVa. Anastomotic leakage is multifactorial and is influenced by patient factors, conduit perfusion, anastomotic technique, and perioperative care. In a recent multicentre RAMIE analysis, anastomotic technique was associated with leak risk; circular end-to-side stapled anastomoses had a reported leak rate of 19.4%, whereas higher rates were observed in the hand-sewn groups [18]. In a published 100-patient series of robot-assisted Ivor–Lewis oesophagectomy with intrathoracic anastomosis, anastomotic leakage occurred in 8% of patients. Nevertheless, comparisons between different studies should be interpreted with caution, as there are differences regarding the patient population (case mix), the anastomotic technique, and the definitions of endpoints [19]. The 30-day mortality rate of 0% is favorable and comparable to outcomes reported by experienced international centres. Xing et al. reported similarly low mortality rates for Ivor-Lewis procedures, with intrathoracic anastomosis generally associated with lower complication rates than cervical anastomoses [20]. The absence of 90-day mortality and the observed rate of severe complications are encouraging; however, these findings should be interpreted cautiously given the small sample size and single-centre design. In the exploratory regression analysis, docking time showed a numerically negative but statistically non-significant association with consecutive case number (slope, −0.109 min per case; 95% CI, −0.252 to 0.034; $R^2 = 0.070$; $p = 0.131$). Given the low explained variance, the small sample size, and the role of docking time as a team set-up metric, this finding should not be interpreted as evidence of improved surgical proficiency or a completed learning curve. In the context of the limited Versius literature for

esophagectomy, our results represent a relevant addition. Puntambekar et al. performed McKeown procedures with cervical anastomosis in a cohort of 57 patients, whereas our series addresses the technically more demanding intrathoracic anastomosis procedure; the different techniques limit direct comparison of the reported operative times [7]. The daVinci surgical system remains the most extensively validated platform for RAMIE, supported by the largest case numbers and several randomized controlled trials. In a single-center series of 422 patients, van der Sluis et al. compared open, hybrid, conventional minimally invasive, and robot-assisted minimally invasive esophagectomy. Pulmonary complications occurred in 57%, 44%, 28%, and 21% of patients, respectively, while uncomplicated postoperative courses were observed in 27%, 34%, 53%, and 63%, respectively [21]. In a published single-centre series of 100 robot-assisted Ivor–Lewis oesophagectomies with intrathoracic anastomosis, anastomotic leakage occurred in 8% of patients, the mean thoracic-phase operative time was 213 $\pm$ 57 minutes, and the overall operative time was 416 $\pm$ 80 minutes. Differences in the operative configuration, definitions of component times, and surgeon experience limit direct comparison with the present laparoscopic-robotic Versius-assisted series [19]. Comparative studies suggest potential advantages of RAMIE over conventional MIE, including reduced operative time, decreased blood loss, and fewer overall complications [22]. Long-term oncological superiority of RAMIE over conventional MIE has not been established. In a retrospective single-centre comparison, Motoyama et al. reported fewer local recurrences after robot-assisted than after conventional thoracoscopic oesophagectomy; this finding should be interpreted cautiously because of the observational design and limited sample size. [23]. The ongoing ROBOT-2 trial is expected to provide further evidence on the comparative effectiveness of robotic versus conventional minimally invasive approaches in a Western population with esophageal adenocarcinoma [24].

The international UGIRA registry demonstrates that even experienced centres continue to show improvements in outcomes over extended periods [25], underscoring that our early results should be interpreted as a starting point rather than a mature performance benchmark.

Strengths of this study include prospective data collection, a homogeneous surgical technique with a fully minimally invasive approach, and one of the earliest descriptions of the Ivor-Lewis technique performed with the Versius system. The consistent application of standardized outcome parameters enables comparison with the international literature.

Limitations include the small sample size, single-center design, retrospective analysis of prospectively collected data, absence of a direct control group, heterogeneous tumor stages, and short follow-up, which precludes definitive conclusions regarding long-term oncological outcomes.

Future studies should include larger patient cohorts, multicenter designs, and direct comparisons with established robotic platforms, alongside systematic learning curve analyses for multiple outcome parameters. Long-term follow-up is essential to evaluate oncological outcomes and validate these short-term results. Development of structured training programs for the Versius system could support implementation at additional centres.

5. Conclusions

This single-center series of fully minimally invasive Ivor-Lewis esophagectomies with the CMR Versius system demonstrates technical feasibility and acceptable early safety outcomes. These short-term results support further evaluation of this platform in larger, multicenter, and ideally controlled studies to define its role in robot-assisted esophageal surgery.

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