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RESEARCH

Outcomes of Early Esophageal Adenocarcinoma with Lymphovascular Invasion Following Endoscopic Submucosal Dissection: A Multicenter Retrospective Series

Johanna Schreiber[1] · Alanna Ebigbo[1,2] · Dani Dakkak[3] · Ingo Steinbrück[4] · Hans-Peter Allgaier[5] · Andreas Wannhoff[6] · Jörg Schirra[7] · Siegbert Faiss[8] · Viktor Rempel[9] · Anna Muzalyova[1] · Carola Fleischmann[1,10] · Helmut Messmann[1] · Andreas Probst[1]

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Abstract

Background and Aims Endoscopic submucosal dissection (ESD) is an accepted treatment option for early esophageal adenocarcinoma (EAC) with negligible risk of lymph node metastasis (LNM). Lymphovascular invasion (LVI) is a known risk factor for LNM, and surgery (SR) is recommended. However, real-life data on long-term follow-up after endoscopic resection (ER) of EAC with LVI are scarce. The aim of this study was to analyze the clinical course of patients after ER of EAC with LVI.

Methods Patients from 16 German centers were included when ESD specimens showed EAC with LVI and R0 resection. Outcome parameters were survival and the rate of metastasis during follow-up. Analysis was performed retrospectively from a prospective database.

Results 23 patients were included. 14/23 (60.9%) underwent endoscopic follow-up (EFU) while 9/23 (39.1%) were treated with additional SR after ESD. The EFU group included more ASA 3/4 patients (64.3% vs. 11.1%), fewer lesions with submucosal invasion (35.7% vs. 66.7%) and fewer lesions with poor differentiation (28.6% vs. 66.7%). In the EFU group, 4/14 patients died during follow-up (related to ESD $n=1$, metastatic recurrence of EAC $n=1$, unrelated to EAC $n=2$). No deaths or recurrences were observed in the SR group. The LNM rate was 44.4% (4/9) in surgical specimens. Mean follow-up was 34 months.

Conclusion LVI indicates a high risk of LNM in early EAC. However, in clinical practice a substantial portion of affected patients do not undergo surgery, and only a minority die from EAC. The data underscore the need for individualized treatment decisions — especially in elderly and comorbid patients.

Keywords Esophageal adenocarcinoma · Lymphovascular invasion · Endoscopic resection · Endoscopic submucosal dissection · Lymph node metastasis

✉ Johanna Schreiber
Johanna.schreiber@uk-augsburg.de

[1] Department of Gastroenterology, University Hospital Augsburg, Stenglinstraße 2, 86156 Augsburg, Germany

[2] Department of Internal Medicine and Gastroenterology, St. Josef University Hospital, Ruhr-University Bochum, Bochum, Germany

[3] Department of Gastroenterology, Elisabeth-Krankenhaus Essen, Essen, Germany

[4] Department of Gastroenterology, Asklepios Klinik Barmbek, Hamburg, Germany

[5] Department of Medicine and Gastroenterology, Evangelisches Diakoniekrankenhaus Freiburg, Freiburg, Germany

[6] Department of Gastroenterology, RKH Klinikum Ludwigsburg, Ludwigsburg, Germany

[7] Department of Internal Medicine II, Ludwig Maximilian University, Munich, Germany

[8] Department of Gastroenterology, Sana Klinikum Lichtenberg, Berlin, Germany

[9] Department of Gastroenterology, St. Anna Hospital Herne, Herne, Germany

[10] Department of Gastroenterology, Hepatology and Endocrinology, University Hospital, Paracelsus Medical University Nuremberg, Nuremberg, Germany

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Introduction

For T1 esophageal adenocarcinomas (EAC) without histopathological risk factors, endoscopic resection (ER) is recommended [1]. In contrast to surgical treatment, ER is minimally invasive, associated with a favorable risk profile, and allows for a shorter hospital stay. Tumors exhibiting high-risk features—such as deep submucosal invasion (> 500 µm), lymphovascular invasion (LVI), or poor differentiation—are considered high-risk. Although prospective data are limited, current recommendations advise completion of staging and interdisciplinary discussion to evaluate the need for additional treatment or surgical resection [1]. Although LVI in EAC is classified as a "high-risk" feature, the precise risk of LNM remains largely unclear. Surgical intervention poses substantial risks, particularly for patients with additional factors such as advanced age, cardiovascular comorbidities, cigarette smoking, underweight or morbid obesity [2, 3]. Especially for such high-risk patients, the risk of LNM has to be balanced against the morbidity and mortality of surgery and close endoscopic follow-up may offer a viable alternative. The aim of the current study was to assess the long-term outcome of patients after ER for EAC with LVI followed by esophagectomy or by endoscopic follow-up.

Methods

Patients were selected from the German ESD registry, which includes patients undergoing ESD for various indications at 20 German referral centers between January 2017 and December 2020. The German ESD registry was initiated by the University Hospital of Augsburg as a prospective multicenter registry and received ethical approval from the Ludwig Maximilian University Munich's ethics committee (study identifier DRKS00011781). Additionally, all patients who underwent ESD for Barrett's neoplasia at the University Hospital of Augsburg, between April 2008 and September 2024 were screened. At this department, all patients undergoing ESD are prospectively included in a local database after providing informed consent. For this analysis, patients were included when LVI was histopathologically confirmed in the resection specimen. Data were analyzed retrospectively.

The study adhered to the principles of Good Clinical Practice and the ethical standards outlined in the 1975 Declaration of Helsinki."

Inclusion Criteria

Study inclusion criteria were as follows:

(1) EAC with LVI in the resection specimen after ESD
(2) Written informed consent to the ESD procedure after receipt of detailed information about ESD and alternative treatment strategies
(3) Written informed consent to the enrollment in the database of the German ESD registry or in a local database at the University Hospital of Augsburg

Exclusion Criteria

Study exclusion criteria were as follows: When inclusion criteria were fulfilled, patients were categorized in 2 groups according to the follow-up strategy. Patients who underwent endoscopic follow-up after ESD (Group A) were compared to patients who were treated with additional surgery (esophagectomy with lymph node dissection) after ESD (Group B).

(1) R1 resection at the vertical margin (VM)
(2) Patients who underwent radiotherapy or chemoradiation after ESD

Outcome Criteria

The primary outcome parameter was overall survival and disease-free survival Secondary outcome parameters were the rate of metastasis (lymph node metastases LNM or distant metastasis) and procedural characteristics of ESD (R0 resection rate, adverse events).

Diagnostic Workup and ESD Procedure

Diagnostic endoscopy and the ESD procedure were carried out at various centers, with the choice of procedure at the discretion of the local endoscopist. ESD was selected in cases where en bloc resection was deemed unlikely with alternative techniques, such as endoscopic mucosal resection (EMR). The lesions morphology and the extent of the underlying Barrett's esophagus were documented using the Paris and the Prague classification [4, 5].

There was no standardized protocol for baseline staging before or after endoscopic resection. Decisions regarding additional diagnostic assessments, such as endoscopic ultrasound (EUS), computed tomography (CT) scans, or other measures, were made by the treating endoscopist and guided by the recommendations of the local multidisciplinary board.

Follow-up information were collected retrospectively from all participating centers. Adverse events were defined as bleeding, perforation, stricture formation, or death related to the procedure.

Histopathological Workup

Histopathological evaluation of the ESD specimens was conducted by pathologists at the respective centers, all of whom had substantial experience in diagnosing Barrett's neoplasia. The specimens were mounted onto cork boards using needles to maintain their orientation, then fixed in formalin for preservation. Subsequently, the specimens were sectioned into parallel slices, each no thicker than 2 mm, to facilitate detailed examination. Routine staining was performed using hematoxylin and eosin (H&E), while additional immunohistochemical staining such as D2-40, desmin, or smoothelin was conducted on a case-by-case decision at the discretion of the local pathologist.

The diameter of both the resected specimen and the EAC were recorded. For mucosal lesions, the depth of invasion was categorized into four levels (m1 no invasion into the superficial muscularis mucosae, m2 infiltration of the superficial muscularis mucosae, m3 infiltration of the space between the superficial and deep muscularis mucosae, and m4 invasion into the deep muscularis mucosae [6]. For submucosal lesions, the maximum depth of submucosal (SM) invasion was measured in micrometers.

The grade of differentiation, and the presence or absence of LVI were described. Additionally, information was given regarding R0 resection at the horizontal margin (HM) and the vertical margin (VM).

Follow-Up

When ESD had achieved complete eradication of Barrett's metaplasia and surgery was not performed, follow-up endoscopy was scheduled 3 to 6 months after ESD, again at 12 months, and then annually. For patients with residual non-neoplastic Barrett's epithelium, endoscopic ablation was initiated 3 to 6 months after ESD and repeated at similar intervals until Barrett's metaplasia was completely removed. Ablation methods included radiofrequency ablation (RFA) and argon plasma coagulation (APC). The choice of technique depended on the extent of the residual Barrett's epithelium and was performed at the discretion of the treating endoscopist.

During follow-up, biopsies were taken from areas with macroscopic signs suggesting residual or metachronous neoplasia. Local recurrence was defined as histopathologically confirmed neoplasia at the site of the initial resection, while neoplasia identified at a different site from the ESD scar was classified as metachronous. Both local recurrences and metachronous lesions were managed at the discretion of the treating endoscopist. Complete eradication of Barrett's esophagus was defined as the absence of visible Barrett's metaplasia after ESD or during follow-up. When the macroscopic appearance was ambiguous, biopsy specimens were taken to confirm the absence of residual Barrett's epithelium.

Additional diagnostic procedures, such as endoscopic ultrasound (EUS) and computed tomography (CT) scans, were performed based on the judgment of the local endoscopist, considering the patient's condition and treatment preferences.

Statistical Analysis

Categorical variables are presented as absolute numbers and percentages. Continuous metrics are shown as medians and interquartile ranges (IQRs). Due to the limited sample size, standard parametric methods were not applicable. Therefore, the Clopper-Pearson method was employed to calculate confidence intervals for binomial proportions, as the assumption of normal distribution could not be met.

To compare the overall survival distribution of the groups, Kaplan-Meier analysis was used. Descriptive statistics were used to summarize patient characteristics and outcomes.

As part of the revised analysis, we decided not to report p-values in order to avoid potential misinterpretation of associations as causal relationships.

All calculations were performed by using SPSS version 28.0 (IBM SPSS Statistics, IBM Corporation, Armonk, NY, USA).

Results

Patient Inclusion

From April 2008 to September 2024, ESD was performed on 832 patients with Barrett's neoplasia of the esophagus. LVI was detected in 36/832 patients (4.3%). 13/36 patients had to be excluded from the follow-up analysis. Reasons were additional chemoradiation in two patients and R1 resection at the VM in another eleven cases. The remaining 23 patients were included in this case series. Of these 23 patients, 14 (60.9%) received endoscopic follow-up (60.4%), while 9 underwent surgical esophagectomy (39.1%) (Fig. 1).

Patient and Lesion Characteristics

The characteristics of the patients and lesions are summarized in Table 1.

Age, sex, Barretts extent and size of the EACs were comparable between Group A and B. Group A included more ASA 3/4 patients (64.3% vs. 11.1%). Group A included fewer lesions with submucosal invasion (35.7% vs. 66.7%)

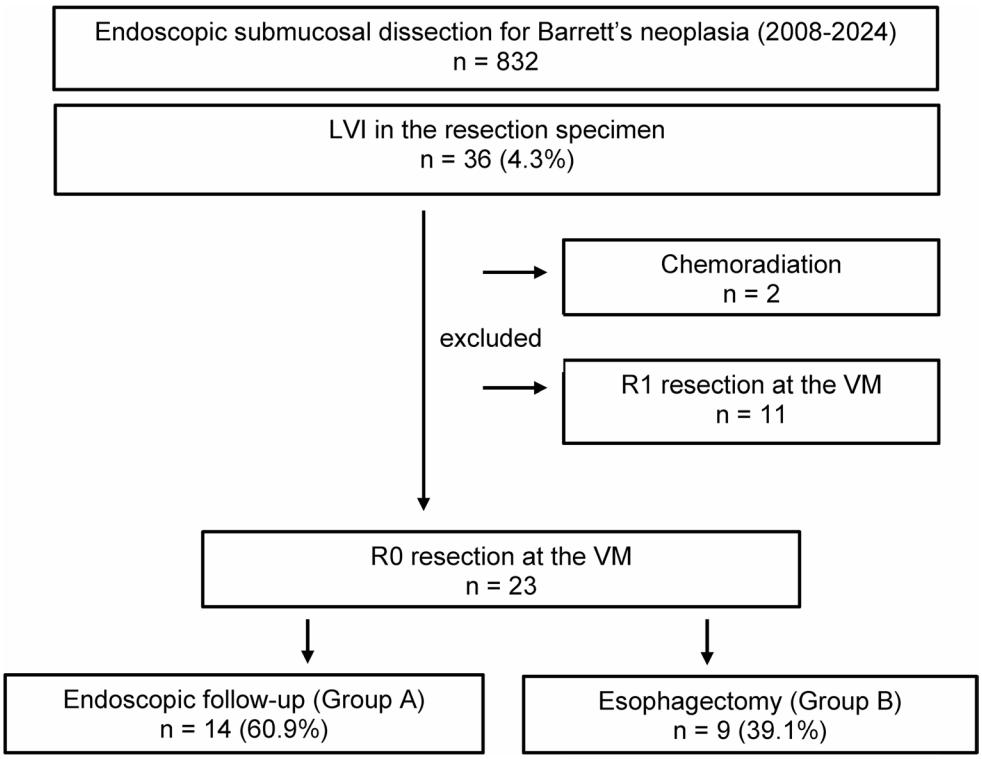

Fig. 1 Inclusion of patients. VM, vertical margin

and fewer lesions with poor differentiation (28.6% vs. 66.7%). Due to the small patient numbers, these differences were not statistically significant. LVI was the single high-risk factor (pT1a G1/2 L1 V0 R0) in 8/14 patients in Group A and in 2/9 in Group B.

In Group A, surgical treatment was withheld in 6 out of 14 patients based on patient preference. In the remaining 8 patients, endoscopic therapy and follow-up were preferred due to comorbidities and the assumed higher surgical risk. Among these patients, one suffered from liver cirrhosis, two had severe coronary artery disease, one was diagnosed with synchronous lung cancer, and another had interstitial lung disease. Three patients with comorbidities were not further classified.

Procedure Characteristics and Adverse Events

Regarding resection margins, Groups A and B were comparable.

One patient in Group A experienced a perforation during ESD which was treated endoscopically. During the post-interventional course, this patient died from respiratory insufficiency 10 days after the procedure.

In Group B, adverse events were observed in four patients (hemorrhagic shock and sepsis after intraoperative splenic laceration, anastomotic leakage, postoperative ileus and pneumonia, impaired wound healing) No deaths were observed related to esophagectomy.

Additional Treatment After ESD

7/14 patients (50%) in Group A had residual Barrett's metaplasia after ESD which was managed using radiofrequency ablation or argon plasma coagulation, based on the decision of the treating endoscopist.

Follow Up

Endoluminal Recurrence

During follow-up, 1/14 patients (7.1%) (CI [0.18%; 33.87%]) from Group A developed an endoluminal recurrence, LNM and distant metastases 27 months after ESD. Initial histology had confirmed an EAC with submucosal invasion (180 µm) and poor differentiation. Because of severe comorbidities including liver cirrhosis (ASA 3), surgery was not pursued. The patient passed away 29 months after the procedure.

Lymph Node Metastases and Distant Metastases

As mentioned above, 1/14 patients from group A (7.1%) (CI [0.18%; 33.87%]) developed an endoluminal recurrence as well as LNM and liver metastases. This patient passed away 29 months after the procedure.

In Group B, synchronous LNM were detected in the surgical resection specimen in 4/9 patients (44.4%) (CI [13.7%;

Table 1 Patient and lesion characteristics

Characteristic	All patients n = 23	Group A (endoscopic follow-up) n = 14	Group B (surgery) n = 9
Patient characteristics			
Age, y	67 [60 - 75]	67.5 [63 - 75.25]	66 [63.5 - 75]
Sex, male	19 (82.6)	11 (78.6)	8 (88.9)
ASA status I/II/III/IV	3/10/9/1 (13.0/43.5/39.1/4.3)	1/4/8/1	2/6/1/0
Barrett's characteristics			
circumferential length, cm	2 [1 - 5]	2 [1.25 - 5.5]	2 [1 - 5]
maximal length, cm	3 [2.75 - 6.25]	3 [2 - 6.5]	3 [3 - 6.5]
Lesion characteristics			
maximal diameter of EAC, mm	30 [23 - 40]	25.5 [20 - 40]	32 [27.5 - 42.5]
Paris classification			
0-Ip	0	0	0
0-Is	2 (8.7)	1 (7.1)	1 (11.1)
0-IIa	13 (56.5)	8 (57.1)	5 (55.6)
0-IIa+Is	3 (13.0)	2 (14.3)	1 (11.1)
0-IIa+IIc	3 (13.0)	1 (7.1)	2 (22.2)
0-IIb	0	0	0
0-IIc	2 (8.7)	2 (14.3)	0
missing information	0	0	0
Histopathology			
Depth of invasion			
M2	1 (4.3)	0	1 (11.1)
M3	3 (13.0)	2 (14.3)	1 (11.1)
M4	8 (34.0)	7 (50.0)	1 (11.1)
Submucosal invasion	11 (47.8)	5 (35.7)	6 (66.7)
Grading			
G1	2 (8.7)	1 (7.1)	1 (11.1)
G2	11 (47.8)	9 (64.3)	2 (22.2)
G3	10 (43.5)	4 (28.6)	6 (66.7)
Vascular invasion			
V1	1	0	1 (11.1)
ER resection characteristics			
maximal diameter of the resection	45 [36 - 53]	43 [31.75 - 50.75]	50 [45 - 63.5]
R0 resection	19 (82.6)	12 (85.7)	7 (77.8)
R1 lateral margin	4 (17.4)	2 (14.3)	2 (22.2)
Endoscopic adverse events			
Bleeding	0	0	n.a.
Perforation	1 (4.3)	1 (7.1)	n.a.
Stricture	0	0	n.a.
Death	1 (4.3)	1 (7.1)	n.a.
Reason for non-surgical Management			
Comorbidities	n.a.	8 (57.14%)	n.a.
Patient's choice	n.a.	6 (42.86%)	n.a.

78.8%]). During subsequent follow-up, these patients were classified as disease-free until the occurrence of local recurrence or the later detection of LNM or distant metastasis by imaging, including CT, MRT or endoscopic ultrasound. The interval until the occurrence of any such event was defined as disease-free survival.

Three of the ESD specimens had shown EAC with poor differentiation and submucosal invasion (100 µm, 2400 µm, missing information in one pathology report). The lesion with the invasion depth of 2400 µm showed vascular invasion additionally. The fourth specimen had shown a moderate differentiated EAC invading to the m4 level. None of the patients with LNM in surgical specimens received additional chemotherapy and/or radiation therapy. None of the patients in Group B developed distant metastases during follow-up. The clinical course during follow-up is summarized in Table 2; Fig. 2.

Table 2 Clinical course, recurrences and deaths during follow-up

Follow-up related to ESD or Surgery	All patients n = 23	Group A (endoscopic follow-up) n = 14	Group B (surgery) n = 9
further course related to ESD			
complete eradication of Barrett's after ESD	16 (69.6)	7 (50)	9 (100)
residual Barrett's after ESD	7 (30.4)	7 (50)	0
endoluminal recurrence, n			
any endoluminal recurrence	1 (4.3)	1 (7.1)	0
metachronous neoplasia	0	0	0
metastasis, n			
LNM in surgical specimens	4 (17.4)	n.a.	4 (44.4)
LNM during follow-up	1 (4.3)	1 (7.1)	0
Distant metastases during follow-up	1 (4.3)	1 (7.1)	0
Any metastases during follow-up	1 (4.3)	1 (7.1)	0
Death			
Nr. of Deaths	4 (17.4)	4 (28.6)	0
EAC	1 (4.3)	1 (7.1)	0
other cancer	1 (4.3)	1 (7.1)	0
cardiopulmonary	1 (4.3)	1 (7.1)	0
after surgery	0	n.a.	0
after ESD	1 (4.3)	1 (7.1)	n.a.
survival, %			
overall survival at 2 y	91.3%	85.7%	100%
overall survival at 5 y	86.96%	71.3%	100%
disease-free survival at 2 y	91.3%	85.7%	100%
disease-free survival at 5 y	86.96%	71.3%	100%
FU, mo (mean)	34 (1-140)	37 (1-140)	30 (1-80)

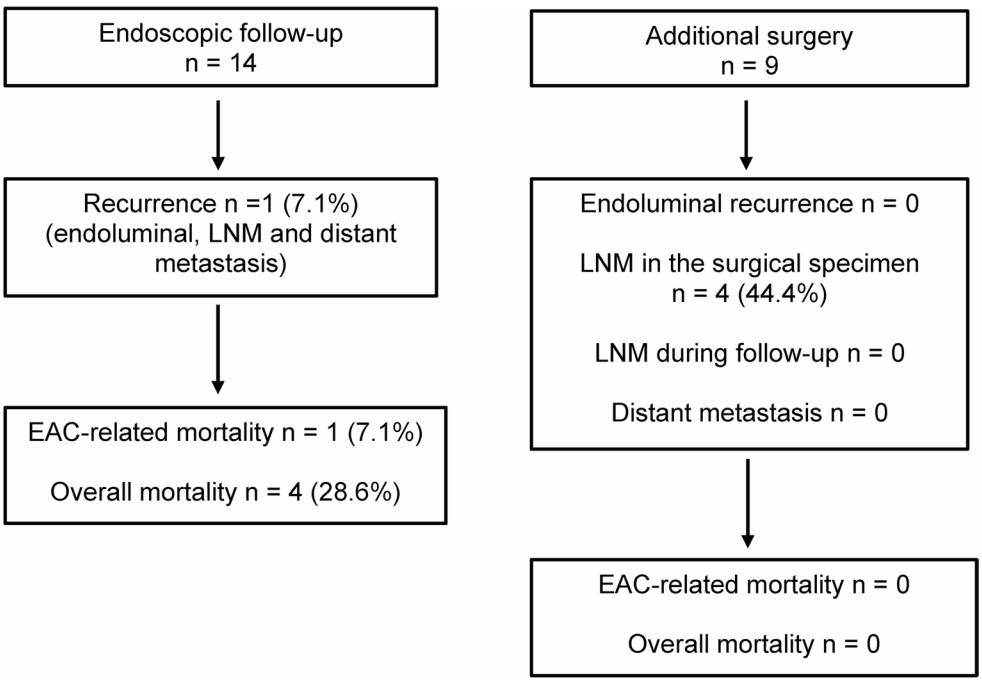

Fig. 2 Clinical course of patients after endoscopic submucosal dissection for esophageal adenocarcinoma (EAC) with lymphovascular invasion

Survival

4/23 patients (17.4%) (CI [4.95; 38.78]) died during the follow-up period, all of whom were from the endoscopic follow-up group. One patient, as previously mentioned, died from a metastatic recurrence of EAC. Another patient passed away 10 days after ESD due to respiratory insufficiency. During the procedure, a perforation had occurred, leading to a complicated post-interventional course. A third patient died 20 months later from lung cancer. The fourth patient passed away due to cardiopulmonary failure during the follow-up period after 12 months. No deaths have been

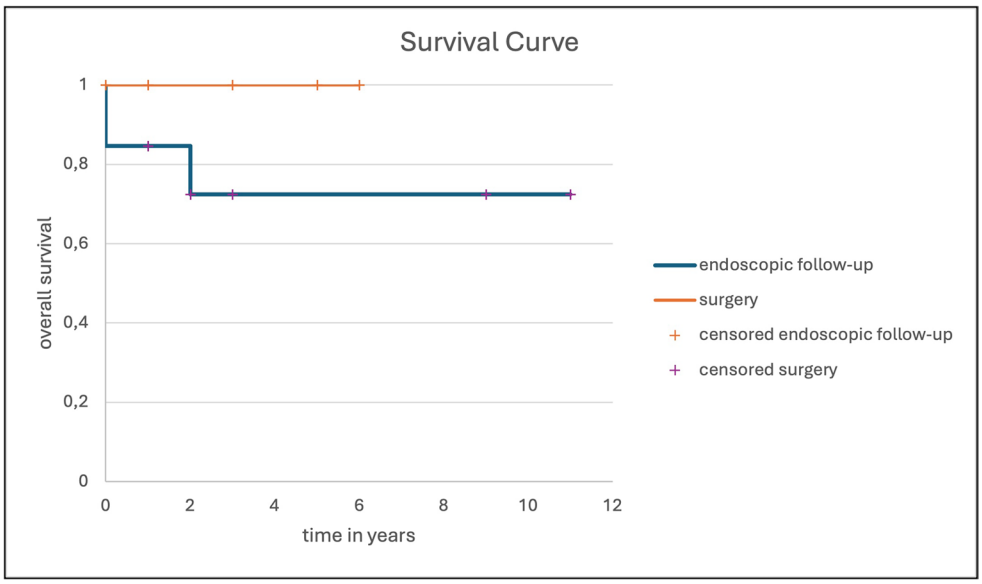

Fig. 3 Overall survival for the different groups

recorded so far in the surgical group during the follow-up interval. Figure 3 shows the overall survival for the different groups.

Mean follow-up was 34 months (range 1-140 months), 37 months (range 1-140 months; median 24 months; IQR [10;46]) and 30 months (range 1–80 months; median 15 months, IQR [7;52]) for all patients, patients in Group A and patients in Group B, respectively.

Discussion

Limited data is available regarding the clinical course of patients with EAC with LVI after ER. A retrospective study from the Netherlands suggests that a high-risk constellation, characterized by poor differentiation and LVI, is associated with a surprisingly high risk of metastasis, even in mucosal carcinomas [7]. Other studies indicate that the risk of LNM is primarily influenced by factors such as depth of infiltration, poor differentiation, LVI and the diameter of EAC. However, due to the overlap of these various risk factors, it is still challenging to make a definitive statement regarding LNM in lesions with single risk factors or a combination of different risk factors [8, 9].

The combination of a T1b tumor with LVI appears to be associated with significantly higher LNM rates of up to 43.3%, compared to 15.6% for T1b tumors without LVI [8, 10, 11].

Based on several studies there is a recommendation for ER in T1b cases, provided that the depth of invasion is less than 500 µm, the tumor is well or moderately differentiated, there is no evidence of tumor invasion into lymphatic or blood vessels, and an R0 situation is achieved at the deep resection margin [1]. However, it is often debated that the depth of invasion may potentially be underestimated if the specimens are analyzed by a pathologist without specialized experience in gastro-oncological pathology. This risk is exacerbated when sections are prepared with widths of up to 5 mm [7, 12].

The finding of LVI is rare in specimens after ER of EAC (4.3% in our study). When LVI is found after ER, surgery has to be recommended according to current guidelines. [1] However, the individual decision can be difficult regarding patients' comorbidities and preferences. In our cohort which reflects the real-life scenario in daily clinical practice, surgery was not performed in 14/23 patients (60.9%) mainly due to comorbidities. When surgery was performed, the LNM rate was substantial (44.4%; CI [13.7%; 78.8%]) underlining the role of LVI as an undisputable risk factor.

In our limited cohort all deaths (4/23 17.4% CI [4.95%; 38.78%]) occurred within the group of endoscopically followed patients. Only one of the deaths was associated to recurrent EAC. Another patient with severe comorbidity making major surgery impossible died after ESD and another two patients died unrelated to EAC. No death was observed after esophagectomy. The clinical course reflects the difference between the surgical and non-surgical group. The patients' condition contributes to the primary treatment decision (ER versus primary surgery) and also for the treatment decision after ER (follow-up versus secondary surgery).

Despite being performed predominantly at high-volume centers, the mortality rate for esophagectomies varies between 0.5% and 9%.[3] A study from the US which included 51 studies reports that theaverage mortality rate for conventional esophagectomy (Ivor Lewis procedure) remains at 1.5%. For robot-assisted surgeries, this rate is slightly lower at 1.4%. However, the complication rates highlighted in this

meta-analysis are substantial. The conventional Ivor Lewis procedure is associated with a complication rate of 30.9%, while robot-assisted surgeries report a lower but still significant rate of 23.6%.[2] Another retrospective study, which analyzed more than 11.000 esophagectomy patients, alarmingly found that 63.9% of these patients experienced a postoperative adverse event [3]. Particularly for patients with preexisting comorbidities and a reduced life expectancy, it is important to discuss whether the risks of a surgical intervention under these high-risk conditions are always justifiable. Additionally, the postoperative limitations associated with esophagectomy, such as changes in quality of life and functional impairments, must also be carefully weighed in this decision-making process.

A study from the United States comparing T1a carcinomas with high-risk features to T1a carcinomas with low-risk features found that, while there was an increased risk of distant metastases, particularly in cases with LVI and poor differentiation, the risk of intraluminal recurrence remained the same in both groups. The study also reported that LNM appeared very late, up to 7 years post-intervention [13].

The main limitation of this case series lies in the small sample size and the selection bias for the different treatment regimens after ESD. Since isolated LVI is rare and often occurs alongside other risk factors, it is challenging to evaluate this factor independently. In our cohort, the majority of EACs with LVI exhibited additional high-risk features, such as poor differentiation or submucosal invasion, leading to significant heterogeneity.

As mentioned above, a substantial proportion of the patients who underwent endoscopic follow-up had considerably more severe comorbidities than those who underwent surgery. In particular, given the significantly higher proportion of patients with ASA class 3 or 4 in this group, an overall increased mortality risk attributable to the underlying comorbidities must be assumed.

The reported number of LNM may have been affected by occult nodal metastases that were not detectable by endoscopic ultrasound or CT imaging at the time of initial staging and therefore were not captured in the present analysis. Furthermore, owing to the retrospective nature of the study, no standardized surveillance protocol was applied across all patients, and follow-up was frequently conducted at the discretion of the treating physician. This represents an additional important limitation.

Another limitation is the retrospective nature of the analysis, which inherently carries the potential for biases. Additionally, a further source of bias can be identified in the endoscopic follow-up group, as this group includes patients for whom surgery was not pursued due to a high intra- and postoperative risk of mortality and morbidity.

Furthermore, we would like to disclose that the follow-up duration used in the overall survival analysis varied substantially, ranging from 1 to 140 months, which complicates the interpretation of the Kaplan–Meier analysis. The endoscopic follow-up group had a mean follow-up duration of 37 months (median 24 months; IQR [10;46]), whereas the surgically treated group had a mean follow-up duration of 15 months (median 15 months; IQR [7;52]). These findings demonstrate the considerable heterogeneity in follow-up duration.

Because of the multicenter design, the histopathological assessment was not centralized at a single institution but was generally performed locally by each participating center's pathologists. This may have introduced interinstitutional and interobserver variability. Furthermore, no distinction was made between vascular and lymphatic invasion.

Due to the small sample size and the limitations discussed above, particularly the retrospective study design, the results should be interpreted with caution. We would therefore like to emphasize once again the observational, descriptive case-series nature of this study.

Nonetheless, patients with one or more histopathological risk factor should be evaluated for surgical resection in an interdisciplinary tumor board. However, in cases where morbidity and mortality risks remain high, and given evidence that lymph node or distant metastases often appear with a significant delay, the option of endoscopic follow-up should be discussed, especially for patients with a high-risk profile.

Here, the morbidity rates of approximately 50% and mortality rates, which depending on the literature are reported to be as high as 9%, must be weighed against the risk of LNM. The 5-year-risk of LNM of deeply invasive T1b lesions with LVI is estimated to be as high as 50–70% [3, 7, 9]

Overall, the likelihood of LNM and for recurrence after ER alone seems high in patients with LVI, especially when other risk factors are also present. Still, given that these recurrences may appear relatively late and considering the risks associated with surgery—particularly in older or frail patients—it's important to weigh the oncologic risk against the surgical mortality and the potential impact on quality of life. For some patients, avoiding major surgery in favor of a less invasive approach may ultimately offer a better balance between disease control and well-being.

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Author Contributions J.S. and A.P. analyzed the data and wrote the main manuscript text. J.S. prepared all figures and tables. A.E., D.D., I.S., H.-P.A., A.W., Jö.S., S.F., V.R., C.F., and H.M. collected and provided patient data. A.M. contributed to the statistical analysis. All authors reviewed and approved the final manuscript.

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Data Availability Due to the ongoing registry and to protect the privacy of the 23 participating patients, the data are not publicly available.

Code Availability Not applicable.

Declarations

Ethics Approval The German ESD registry was initiated by the University Hospital of Augsburg as a prospective multicenter registry and received ethical approval from the Ludwig Maximilian University Munich's ethics committee (study identifier DRKS00011781).

Consent to Participate Written informed consent was obtained from all individuals participating in this study.

Consent to Publish The authors confirm that all participants consented to the anonymized analysis of their data and clinical outcomes and to the publication of the resulting data.

Competing Interests Dr. Helmut Messmann has received speaker fees from Falk Pharma, Olympus, Norgine, IPSEN, medupdate, and Erbe. He has received consultation fees from Olympus, Ambu, Boston Scientific, Covidien, and Takeda. He has received research grants from Olympus and Satisfai.Dr. Alanna Ebigbo has received consulting fees from Olympus, Fujifilm, Ambu, Pentax, Boston Scientific, and Creo Medical. He has also received speaker honoraria from Olympus, Pentax, Fujifilm, Ambu, Falk Pharma, Boston Scientific, and Celltrion.Dr. Viktor Rempel has received honoraria from Olympus.Dr. Jörg Schirra has received honoraria from Falk Pharma.Dr. Ingo Steinbrück has received honoraria and consulting fees from Olympus and Falk Pharma. Dr. Andreas Wannhoff has received research grants from Ovesco Endoscopy and Fujifilm. He has also received honoraria from Ovesco Endoscopy AG, Boston Scientific, Olympus, and the Falk Foundation, as well as equipment support from Ovesco Endoscopy.Dr. Hans-Peter Allgaier has received honoraria from Olympus.Drs. Dani Dakkak, Siegbert Faiss, Carola Fleischmann, Anna Muzalyova, Andreas Probst and Johanna Schreiber declare no conflicts of interest.

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