Journal of Gastrointestinal Cancer (2025) 56:102
https://doi.org/10.1007/s12029-025-01228-6

RESEARCH

Effects of Palliative Esophageal External Beam Radiation Therapy in Patients with Stent for Esophageal Cancer: A Retrospective Cohort Study

Emily Adams[1] · Héloïse Lavoie-Gagnon[2] · Farhana Islam[3] · Michael Humer[4] · Benjamin Mou[5,6] · Theodora A. Koulis[5,7] · David Kim[5,6] · Siavash Atrchian[5,6]

Accepted: 7 April 2025

Abstract

Purpose Self-expandable metallic stents (SEMS) provide immediate but nondurable dysphagia relief in esophageal cancer, while external beam radiotherapy (EBRT) provides slower, more durable dysphagia relief. While the combination of SEMS with EBRT would seem to offer both rapid and durable dysphagia relief in the palliative setting, there remains controversy on its safety and efficacy. We investigated patient outcomes regarding EBRT after SEMS placement in patients with incurable esophageal cancer at a regional Canadian cancer program.

Methods We conducted a single-centre retrospective chart review from January 2010 to July 2020 to compare stent-related complications and survival in patients with incurable esophageal cancer treated with SEMS alone or SEMS + EBRT at Kelowna General Hospital.

Results 66 patients were included in the SEMS alone group and 26 in the SEMS + EBRT group. Patients treated with SEMS alone showed an average of 3.05 fewer stent-related complications compared to patients who received SEMS + EBRT. The SEMS alone group also had 9.05 greater odds of experiencing higher grade complications compared to the SEMS + EBRT group ($p < 0.001$). Patients in the SEMS + EBRT group survived significantly longer than those treated with SEMS alone, with a median overall survival of 163.5 days and 65 days, respectively.

Conclusions SEMS monotherapy was associated with significantly fewer, yet higher grade stent-related complications compared to palliative EBRT after SEMS placement. SEMS + EBRT treatment was associated with significantly prolonged survival compared to SEMS alone. Prospective studies are needed to confirm these findings.

Keywords EBRT · SEMS · Esophageal cancer · Dysphagia · Radiotherapy · Stent

Introduction

Esophageal cancer is the eighth most common cancer globally and the sixth leading cause of cancer deaths [1]. In British Columbia (BC), 355 new esophageal cancer cases were diagnosed in 2017 with a dismal observed five-year survival of 13% [2]. This poor prognosis is attributed to the disease's late clinical presentation, resulting in the majority of tumours being diagnosed at an unresectable or metastatic stage [1]. The most common presenting symptom is

✉ Emily Adams
emily.adams@mail.utoronto.ca

1 Faculty of Medicine, University of Toronto, Toronto, ON, Canada

2 Département de Radiobiologie et Médecine Nucléaire, Université de Sherbrooke/Centre Hospitalier Universitaire de L'Université Sherbrooke (CHUS), Sherbrooke, QC, Canada

3 Department of Pharmacology and Toxicology, University of Toronto, Toronto, ON, Canada

4 Division of Thoracic Surgery, Department of Surgery, University of British Columbia, Kelowna, BC, Canada

5 Department of Radiation Oncology, Faculty of Medicine, University of British Columbia, Vancouver, BC, Canada

6 Department of Radiation Oncology, BC Cancer, Kelowna, Canada

7 Department of Radiation Oncology, BC Cancer, Victoria, Canada

Published online: 18 April 2025

dysphagia which occurs in 74% of patients at diagnosis [1]. For patients with unresectable tumours experiencing dysphagia, one of the standard methods of palliation is insertion of an esophageal self-expanding metal stent (SEMS) [3].

While SEMS are effective at providing immediate dysphagia relief, their utility is limited due to complications such as stent migration and blockage, leading to recurrent dysphagia [4]. Another modality for treating tumour-related dysphagia is external beam radiotherapy (EBRT), which provides more durable dysphagia relief but may require up to 6 weeks for maximum benefit [4]. The combination of esophageal SEMS placement with subsequent EBRT may provide optimized palliation with short- and long-term dysphagia relief, potentially leading to improved overall survival [5]. Additionally, post-stent EBRT may prevent stent blockage due to tumour in- or over-growth, reducing the need for re-intervention [4]. Despite the potential benefits of SEMS with EBRT, this therapy option is often not advised because of increased risk of major adverse events, such as esophageal fistula and massive gastrointestinal (GI) bleeding [5, 6]. The question of whether EBRT should be utilized when SEMS are present is debated in the literature and among physicians [3–5]. The lack of consensus on the issue results in ambiguity regarding best treatment practices to palliate patients with esophageal cancer.

A recent randomized controlled trial conducted in the UK compared the efficacy of EBRT versus usual care alone after SEMS insertion in preventing worsening dysphagia in patients with advanced esophageal cancer [3]. They concluded that EBRT after SEMS should not be routinely offered because it does not demonstrate further benefit compared to SEMS alone, except for patients who are at high risk of tumour bleeding [3]. Alternatively, a similarly designed randomized trial concluded that post-stent EBRT produces sustained dysphagia relief and prolongs overall survival in inoperable esophageal cancer [4]. Lastly, an earlier survey of Japanese therapeutic radiology departments, without a control group, found that esophageal cancer patients receiving stents before or during EBRT are at high risk of life-threatening complications, including hematemesis, esophageal fistula and pneumonitis, and stated that stenting should be postponed until after radiation therapies have been trialed [6]. Contradictory results among these studies warrant further investigation to understand the safety and efficacy of SEMS with EBRT in palliative esophageal cancer.

In the present study, we conducted a single-centre retrospective chart review of patients treated with SEMS alone versus SEMS with palliative EBRT at Kelowna General Hospital (KGH). This study aims to understand local patient outcomes to inform best practices in palliating dysphagia for esophageal cancer patients. Our study will create a representative source for Interior and Northern BC physicians to consult when developing future treatment plans.

We hypothesized that patients receiving SEMS plus EBRT would have longer survival, but experience a greater number and increased severity of stent-related complications compared to patients treated with SEMS alone. Additionally, we hypothesized that, among patients receiving EBRT, higher radiation dose would have a detrimental impact on complication number and severity.

Methods

Patients

After harmonized research ethics board approval and waiver of patient consent for our chart review, we reviewed KGH Thoracic Surgery department patient records via Accuro EMR to identify eligible patients via consecutive convenience sampling. We reviewed 255 patient charts for potential inclusion in the study. Eligible patients were included in one of two treatment groups. The SEMS alone control group included patients who had an esophageal stent placed and never received esophageal EBRT, and the SEMS + EBRT group received palliative esophageal EBRT while an esophageal stent was in place.

For both groups, eligible patients were those with unresectable esophageal cancer who never received any form of curative-intent treatment and had an esophageal SEMS placed at KGH Thoracic Surgery from January 1st, 2010, to July 24th, 2020. KGH Thoracic Surgery is a centralized surgical service that provides all thoracic surgery procedures, including SEMS placement, for patients across interior and northern BC. Exclusion criteria included patients without esophageal cancer who received SEMS placement, radioactive stent placements, and patients who had an esophagectomy. Patients who had radiotherapy to or near the esophagus before stent placement were also excluded. Patients in the SEMS alone group who had post-stent radiotherapy near but not targeting the esophagus were excluded. Patients in the SEMS + EBRT group were excluded if they received a curative-intent EBRT dose or if their stent was removed or migrated fully out of the radiotherapy field before EBRT.

Procedures

Patient demographics, treatment conditions, stent-related complications, and mortality details were collected via a standardized form. Data abstraction forms were completed using patient records on BC Cancer's Cancer Agency Information System (CAIS) and KGH Thoracic Surgery's Accuro EMR software before de-identification. Recorded stent-related complications included stent food impaction, tumour in- or overgrowth, stent migration, dysphagia, gastroesophageal reflux, anorexia, malnutrition, nausea, esophagitis,

esophageal stricture, ulcer, pain, perforation, fistula or hemorrhage, hematemesis, melena, aspiration/pneumonia and cardiac tamponade. Complication grade was recorded according to the Clavien-Dindo classification of surgical complications (Table 1) [7]. For the majority of complication types, only grades IIIa and above were recorded, as these complications required, at minimum, some surgical, endoscopic or radiologic intervention and would therefore be more objective and reliably reported than grades I and II. For complications directly involving the stent (stent food impaction, migration and tumour ingrowth or overgrowth), all grades were recorded because these complications are often surgical and would be inherently more objective and reliably reported at all severity levels. Analyses investigating stent-related complications used data on complication number and severity. Complication number data consisted of the total number of complications recorded for each patient. Complication severity data was reported as the highest complication grade experienced by each patient. Repeat complications were counted as separate occurrences if they had a new onset presentation after previous resolution. Additionally, one patient presentation or admission may have involved multiple complication types, which would have been counted as multiple complications. For both treatment groups, all complications occurring after 1st stent placement were recorded, meaning that some complications may have occurred before EBRT in the SEMS + EBRT group.

Analysis

Patient Characteristics and Treatment

Inferential statistics comparing patient baseline characteristics and treatment details between the SEMS alone group and SEMS + EBRT group were conducted in GraphPad Prism 9 and Microsoft Excel 365. Shapiro–Wilk normality tests were conducted for continuous variables before completing Mann–Whitney tests for non-normally distributed variables and unpaired t-tests for normally distributed variables. Chi-square and Fisher's exact tests were conducted on categorical variables. A significance level of $p < 0.05$ was used.

Stent-Related Complications, Survival and Follow Up

Descriptive statistics for stent-related complications, survival and follow up between treatment groups were completed in Microsoft Excel 365. Frequency, percentage, median and interquartile range (IQR) were reported.

Stent-Related Complication and Survival Analyses

Multiple linear, logistic, and Cox proportional hazard (CPH) regressions and Kaplan–Meier survival analyses were conducted for between-group comparison of the SEMS alone group to the SEMS + EBRT group. These analyses were performed using R version 4.2.1 and RStudio version 2022.02.3.

Multiple linear regressions evaluated the association between treatment group and total number of stent-related complications. Multiple logistic regressions assessed the relationship between treatment group and severity of stent-related complications.

We assessed overall survival from first esophageal stent insertion using a CPH model with death from any cause as the endpoint. Kaplan–Meier curves were used to estimate overall survival and Mantel–Haenszel log-rank test was applied for between-group comparisons.

All analyses were adjusted for age at first stent placement, days from diagnosis to first stent placement, first stent type

Table 1 Clavien-Dindo classification of surgical complications [7]

Grade	Definition
I	Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic or radiological interventions Allowed therapeutic regimens are: antiemetics, antipyretics, analgesics, diuretics, electrolytes and physiotherapy. This grade also includes wound infections opened at the bedside
II	Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions and total parenteral nutrition are also included
III	Requiring surgical, endoscopic or radiological intervention
IIIa	Intervention not under general anesthesia
IIIb	Intervention under general anesthesia
IV	Life-threatening complication (including CNS complications[a]) requiring IC/ICU management
IVa	Single organ dysfunction
IVb	Multiorgan dysfunction
V	Death

CNS: central nervous system, IC: intermediate care, ICU: intensive care unit.

[a]Brain hemorrhage, ischemic stroke, subarachnoid bleeding, but excluding transient ischemic attacks.

placed (fully covered, partially covered, uncovered), chemotherapy status, esophageal dilation status, and esophageal tumour location (upper, middle, lower) [8]. Likelihood ratio tests were conducted to evaluate how well the inclusion of the exposure variable (i.e. treatment group) fits the data relative to when it is not included in the model. A significance level of $p < 0.05$ (2-tailed tests) was used.

SEMS + EBRT Group Analysis

Descriptive statistics of radiation details for the SEMS + EBRT group was conducted in Microsoft Excel 365. Within the SEMS + EBRT group, multiple linear and logistic regressions assessed the associations between radiation dose, represented by equivalent dose in 2 Gy fractions (EQD2), and the number and severity of stent-related complications, respectively. EQD2 was calculated using $\alpha/\beta = 10$. These regressions used a significance level of $p < 0.05$ and were adjusted for age at first stent placement, days from diagnosis to first stent, first stent type placed, history of chemotherapy, dilation, and esophageal tumour location.

Results

Patient Characteristics and Treatment

Baseline patient characteristics including age, sex and tumour staging at diagnosis are reported in Table 2 along with treatment details regarding chemotherapy, esophageal dilation, and stenting. No significant differences between treatment groups were identified for any of the characteristics investigated. Of the 92 patients included in the study, 66 (72%) were treated with SEMS alone while 26 (28%) were treated with SEMS + EBRT. For all included patients, the median age at esophageal cancer diagnosis was 70 years and the male:female ratio was 2.41:1. In each treatment group, over 80% of patients had lower esophageal tumours and over 65% had adenocarcinoma histology. Across both groups, 26 patients (28%) had received chemotherapy while 50 (54%) had received an esophageal dilation. The majority (67%) of patients included in the study received a partially covered stent for their first stent placement, while 33% received a fully covered stent and none had an uncovered stent placed first. For both groups, 20 patients had 2 stents placed, 3 had 3, 1 had 4 and 1 patient had 7 stents placed. A total of 8 patients had stent removals.

Stent-Related Complications, Survival and Follow Up

Table 3 reports descriptive statistics for survival and follow up intervals, cause of death, and complication details for patients in each group. No patients were lost to follow up as date and cause of death were recorded for all patients and chart data was collected until last follow up. For all patients, the median number of days from a) diagnosis to death was 120; b) first stent placement to death was 74; c) last follow up to death was 19.5; and d) diagnosis to last follow up was 57. For 88% of patients, the primary cause of death was esophageal cancer. Three patients in each treatment group died of stent-related complications. 71% of the SEMS alone group and 19% of the SEMS + EBRT group had no stent-related complications. Of the complications which were recorded (all grades for complications directly involving the stent and grades IIIa+ for all others), the most frequent maximum complication grade was IIIb in the SEMS alone group and IIIa in the SEMS + EBRT group. The highest number of separate complications counted in a patient was 27, this patient was in the SEMS + EBRT group. 16 complications were counted in a patient in the SEMS alone group, and 11 were counted in a SEMS + EBRT patient. Across both treatment groups, the 37 remaining patients who experienced complications each had a total of 9 complications or less. Table A1[1] reports, for each type and grade of complication directly involving the stent, the number and percentage of patients affected, and the absolute number of complications recorded. Among complications directly involving the stent, stent migration was the most common in both groups, with 15% and 38% of patients experiencing this complication in the SEMS alone and SEMS + EBRT group, respectively. The most frequent grade for stent migration was IIIb in both groups. Table A2 reports the same parameters for complications not directly involving the stent (grades IIIa+ only). For both treatment groups, dysphagia was the most common complication not directly involving the stent, with 24% and 58% of patients experiencing this complication in the SEMS alone and SEMS + EBRT group, respectively.

Stent-Related Complication Analysis

Number of Complications

There was a significant effect of radiation status (i.e. treatment group) on number of stent-related complications ($F(1,83) = 14.13$, $p < 0.001$) (Fig. 1, Table A3). Patients in the SEMS alone group experienced an average of 3.05 (95% CI: [-4.67, -1.44]) fewer stent-related complications compared to those in the SEMS + EBRT group (Table 4). Furthermore, positive chemotherapy history for esophageal cancer showed a significant association with the number of stent-related complications experienced ($F(1,83) = 19.2$,

[1] All tables designated 'A' are provided in the Appendix found in Supplementary Information.

Table 2 Baseline patient characteristics and treatment details

Characteristic	SEMS Alone (n = 66)	SEMS + EBRT (n = 26)	p-value
Age (median, IQR)	70 (64–79.8)	68.5 (61.5–74)	0.285
Sex (%)			0.457
Male	45 (68.2)	20 (76.9)	
Female	21 (31.8)	6 (23.1)	
Tumour Location (%)			0.077
Upper	0 (0.0)	1 (3.9)	
Middle	12 (18.2)	2 (7.7)	
Lower	54 (81.8)	23 (88.5)	
T stage (%)			0.234[a]
Tx	8 (12.1)	2 (7.7)	
T1	1 (1.5)	0 (0.0)	
T2	0 (0.0)	0 (0.0)	
T2 or T3 (can't specify)	48 (72.7)	18 (69.2)	
T3	5 (7.6)	6 (23.1)	
T4	4 (6.1)	0 (0.0)	
N stage (%)			0.679
Nx	14 (21.2)	4 (15.4)	
N0	13 (19.7)	3 (11.5)	
N1	7 (10.6)	2 (7.7)	
N2	6 (9.1)	2 (7.7)	
N3	26 (39.4)	15 (57.7)	
M stage (%)			0.921
Mx	12 (18.2)	5 (19.2)	
M0	18 (27.3)	8 (30.8)	
M1	36 (54.6)	13 (50.0)	
Tumour grade (%)			0.072
Gx	18 (27.3)	2 (7.7)	
G1	5 (7.6)	1 (3.9)	
G2	11 (16.7)	9 (34.6)	
G3	32 (48.5)	14 (53.9)	
Tumour histologic type (%)			0.47
Squamous Cell Carcinoma	13 (19.7)	5 (19.2)	
Adenocarcinoma	45 (68.2)	20 (76.9)	
Small Cell/Neuroendocrine	4 (6.1)	0 (0.0)	
Other/Undermined	4 (6.1)	1 (3.9)	
Treatment characteristics			
Chemotherapy (%)			0.203[b]
No chemotherapy	50 (75.8)	15 (57.7)	
Chemotherapy status unknown	0 (0.0)	1 (3.9)	
Chemotherapy before 1 st stent only	0 (0.0)	0 (0.0)	
Chemotherapy after 1 st stent only	12 (18.2)	8 (30.8)	
Chemotherapy before and after 1 st stent	4 (6.1)	2 (7.7)	
Esophageal Dilation (%)			0.647[c]
No dilation	29 (43.9)	13 (50.0)	
Dilation before 1 st stent only	27 (40.9)	11 (42.3)	
Dilation after 1 st stent only	6 (9.1)	0 (0.0)	
Dilation before and after 1 st stent	4 (6.1)	2 (7.7)	
Age at 1st stent placement (median, IQR)	70 (64.3–79.8)	68.5 (61.5–74.0)	0.274
1st stent type placed (%)			0.323[d]
Fully covered	24 (36.4)	6 (23.1)	

Table 2 (Continued)

Characteristic	SEMS Alone (n = 66)	SEMS + EBRT (n = 26)	p-value
Partially covered	42 (63.6)	20 (76.9)	
Uncovered	0 (0.0)	0 (0.0)	
Days from diagnosis to 1st stent (median, IQR)	23 (7.3–42.8)	31 (14.0–38.8)	0.287

IQR: interquartile range.

[a]T2 data was removed from Fisher's Exact because 0 patients had T2 staging at diagnosis.

[b]Fisher's Exact tested for differences between any timing of chemotherapy vs no chemotherapy.

[c]Fisher's Exact tested for differences between any timing of dilation vs no dilation.

[d] "Uncovered" data was removed from Fisher's Exact because 0 patients received uncovered stents in both groups.

Table 3 Clinical results

Survival, follow up and cause of death	SEMS Alone (n = 66)	SEMS + EBRT (n = 26)
Days from diagnosis to death (median, IQR)	102 (46–166.8)	208 (83–364.5)
Days from 1 stent insertion to death (median, IQR)	65 (24.8–139.3)	163.5 (64.3–311.8)
Days from last follow up to death (median, IQR)	18 (7.3–50)	24 (3.5–38.5)
Days from diagnosis to last follow up (median, IQR)	48 (23–137.8)	162 (57–302.3)
Cause of death (%)		
Esophageal cancer	58 (87.9)	23 (88.5)
Stent-related complication (grade V)	3 (4.5)	3 (11.5)
Other	2 (3.0)	0 (0.0)
Unknown	3 (4.5)	0 (0.0)
Complications		
Highest stent-related complication grade (%)		
No complication	47 (71.2)	5 (19.2)
I	0 (0.0)	0 (0.0)
II	0 (0.0)	0 (0.0)
IIIa	3 (4.5)	10 (38.5)
IIIb	12 (18.2)	8 (30.8)
IVa	1 (1.5)	0 (0.0)
IVb	0 (0.0)	0 (0.0)
V	3 (4.5)	3 (11.5)
Total number of stent-related complications (%)		
0	47 (71.2)	5 (19.2)
1	5 (7.6)	2 (7.7)
2	3 (4.6)	4 (15.4)
3+	11 (16.7)	15 (57.7)

IQR: interquartile range.

$p < 0.001$) (Table A3). Patients who did not receive chemotherapy demonstrated an average of 3.93 (95% CI: [-5.71, -2.14]) fewer complications than those who did (Table 4).

Complication Severity

Table A4 shows the ANOVA for the logistic regression evaluating the effects of radiation status on the severity of stent-related complications. The results showed that patients who did not receive radiation post stent placement had 9.05 (95% CI: [3.11, 26.27]) greater odds of experiencing higher grade complications compared to patients who received radiation (Wald $\chi^2(1) = 16.39$, $p < 0.001$) (Table 4, Table A4, Fig. 2).

History of chemotherapy and age at first stent placement were also significantly associated with severity of stent-related complications (Table A4). Patients who did not receive chemotherapy had more severe complications relative to those who did by a factor of 9.35 (95% CI: [2.86, 30.61]) (Table 4). Furthermore, the odds of experiencing more severe stent-related complications decreased with higher age at first stent placement (Wald $\chi^2(1) = 4.50$, $p = 0.034$) (Table A4). Patients between the age of 50–65 years had 0.47 (95% CI: [0.23, 0.94])

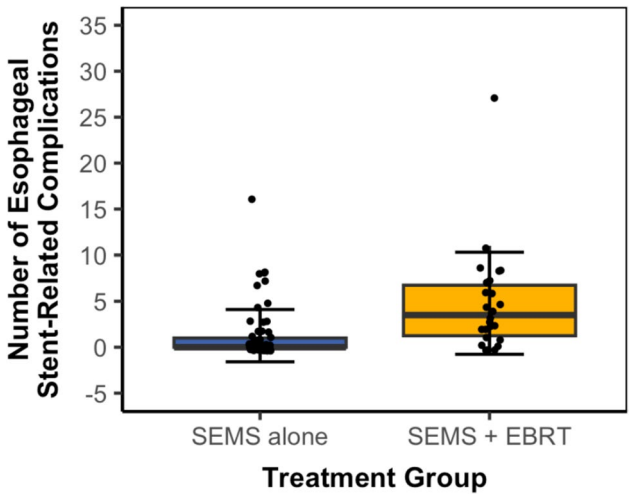

Fig. 1 Relationship between number of esophageal stent-related complications and radiation status. *SEMS: self-expanding metallic stent, EBRT: external beam radiotherapy*

odds of experiencing higher grade complications while those 65–95 years had 0.22 (95% CI: [0.05, 0.89]) odds (Table 4).

Survival Analysis

Figure 3 displays the estimated Kaplan–Meier survival curve for overall survival. This analysis revealed a significant difference in overall survival between treatment groups, with longer survival in the group receiving radiation (log rank (Mantel-Haenzsel) $\chi^2(1) = 4.00$, $p = 0.040$) (Table A5). The median overall survival was 163.5 days (95% CI: [65, 302]) in the SEMS + EBRT group and 65 days (95% CI: [36, 105]) in the SEMS alone group.

In the CPH analysis, time to all-cause mortality was associated with radiation status (Wald $\chi^2(1) = 3.92$, $p = 0.048$) (Table A6). Patients who did not receive radiation following stent placement had 1.68 (95% CI: [1.01, 2.81]) times the hazard of all-cause mortality relative to those who did (Table 4). The likelihood ratio test indicated that radiation status is a meaningful parameter which is strongly associated with mortality (L.R. $\chi^2(1) = 4.12$, $p = 0.042$) (Table A7).

Chemotherapy also showed a strong association with all-cause mortality (Wald $\chi^2(1) = 25.90$, $p < 0.001$) (Table A6). Patients with no chemotherapy history had 5.28 (95% CI: [2.78, 10.01]) times the hazard of all-cause mortality compared to patients who received chemotherapy (Table 4).

SEMS + EBRT Group Analysis

Radiation details for patients in the SEMS + EBRT treatment group are reported in Table 5. All but one patient received a single course of radiation, and 22 of the 26 patients completed their EBRT course as prescribed. The majority of patients (85%) received parallel-opposed pair planning and the median EQD2 was 23.3 ($\alpha/\beta = 10$). Thirteen patients had a prescribed dose of 20 Gy in 5 fractions while 9 patients had 30 Gy in 10 fractions prescribed.

There were no significant associations between EQD2 and the number or severity of stent-related complications (Table A8).

Table 4 Survival and complication analyses parameters

	Effects of variables on number of complications in linear regression model		**Estimated odds ratio for complication severity in logistic regression model**	**Estimated hazard ratio for days from 1st SEMS insertion to all-cause mortality in CPH model**
Model predictor variables	Effect [Lower 95% CI, Upper 95% CI]	S.E.	Odds Ratio [Lower 95% CI, Upper 95% CI]	Hazard Ratio [Lower 95% CI, Upper 95% CI]
Age at first stent placement	–0.30 [–1.41, 0.8]	0.55	0.47 [0.23, 0.94]	0.77 [0.55, 1.07]
Days from diagnosis to first stent placement	–0.09 [–0.23, 0.04]	0.07	1.03 [0.95, 1.11]	1.01 [0.97, 1.06]
First stent type placed (Fully Covered:Partially Covered)	–0.72 [–2.26, 0.83]	0.78	1.27 [0.5, 3.22]	0.99 [0.61, 1.63]
Chemotherapy (No:Yes)	–3.93 [–5.71, –2.14]	0.90	9.35 [2.86, 30.61]	5.28 [2.78, 10.01]
Esophageal dilation (Yes:No)	1.24 [–0.19, 2.67]	0.72	0.70 [0.29, 1.67]	0.78 [0.5, 1.21]
Tumour esophageal location (Middle:Lower)	–0.11 [–2.09, 1.87]	0.99	0.61 [0.19, 1.99]	0.74 [0.4, 1.39]
Tumour esophageal location (Upper:Lower)	–4.18 [–11.05, 2.69]	3.45	14.73 [0.2, 1075]	1.28 [0.17, 9.84]
Radiation Status (SEMS Alone:SEMS + EBRT)	–3.05 [–4.67, –1.44]	0.81	9.05 [3.11, 26.27]	1.68 [1.01, 2.81]

SEMS: self-expanding metallic stent, CPH: Cox proportional hazard, EBRT: external beam radiotherapy

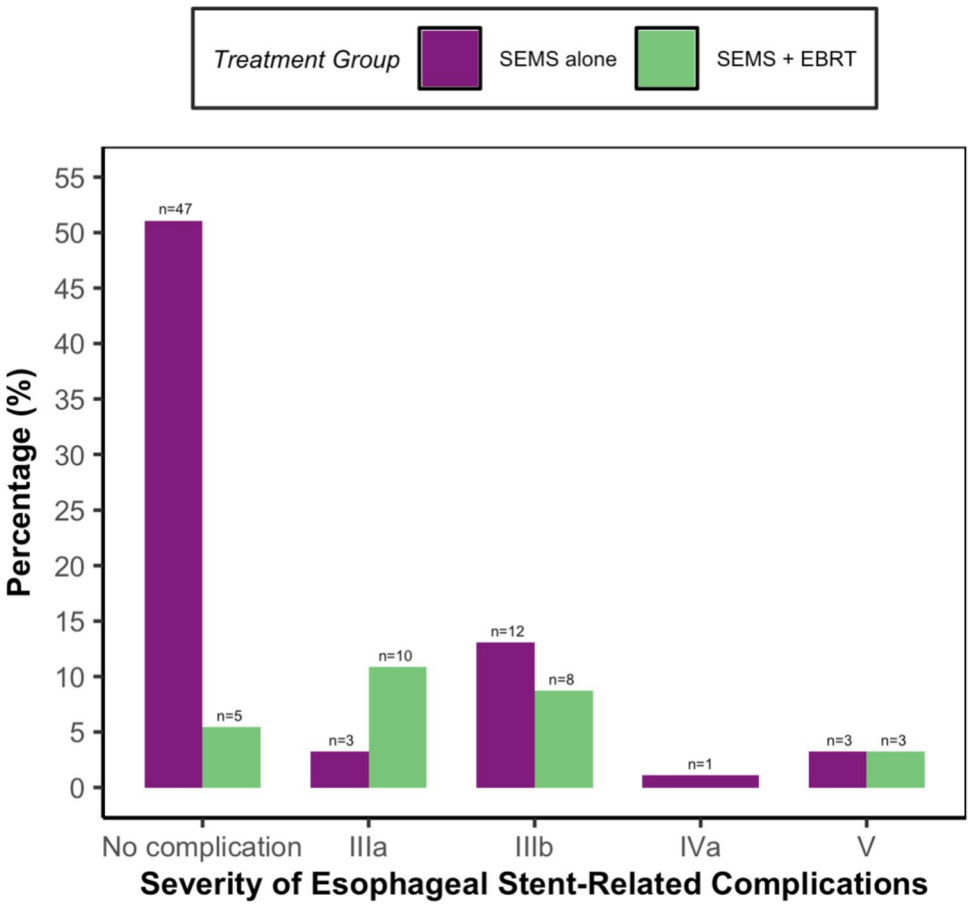

Fig. 2 Relationship between severity of stent-related complications and radiation status. *SEMS: self-expanding metallic stent, EBRT: external beam radiotherapy*

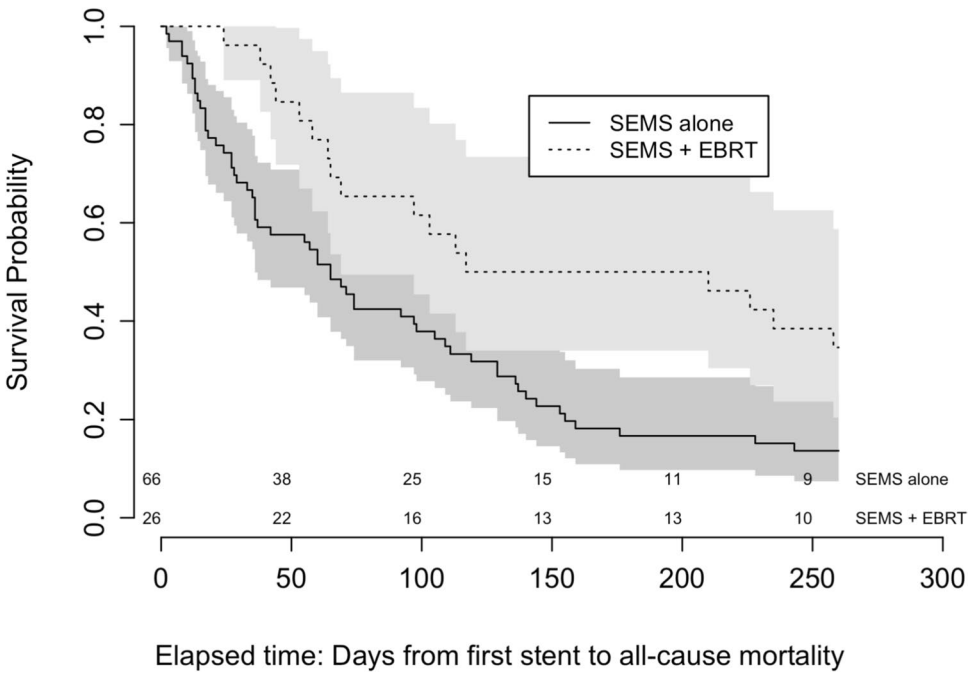

Fig. 3 Kaplan–Meier curves for all-cause mortality by radiation status. *SEMS: self-expanding metallic stent, EBRT: external beam radiotherapy*

Table 5 SEMS + EBRT radiotherapy details

Number of esophageal EBRT courses (%)	
1 course	25 (96.2)
2 courses	1 (3.9)
Days from 1 st stent placement to 1 st EBRT course start date (median, IQR)	41 (18.3–88)
RT Parameters[a]	
EBRT type (%)	
POP	22 (84.6)
3DCRT/4-field	3 (11.5)
VMAT(IMRT)	1 (3.9)
EQD2 (median, IQR)	23.3 (23.3–32.5)
Fraction number (median, IQR)	5 (5–10)
Prescribed dose/fractionation (%)	
20 Gy/5	13 (50)
30 Gy/10	9 (34.6)
Other	4 (15.4)
Completed dose/fractionation (%)	
20 Gy/5	11 (42.3)
30 Gy/10	8 (30.8)
Other	7 (26.9)
RT course completed as prescribed (%)	
Yes	22 (84.6)
No	4 (15.4)

SEMS: self-expanding metallic stent, EBRT: external beam radiotherapy, IQR: interquartile range, POP: parallel opposed pair, 3DCRT: three-dimensional conformal radiotherapy, VMAT: volumetric-modulated arc therapy, IMRT: intensity modulated radiotherapy, EQD2: equivalent dose in 2 Gy fractions.

[a]For the single patient who had 2 EBRT courses, details for each course were combined: EBRT type was the same for each course, EQD2 accounts for both courses, fraction number used was the sum of the 2 course's fraction numbers, prescribed and completed dose/fractionation used was from the 1st course only, and both courses were completed.

Discussion

Our study investigated BC Interior patient outcomes regarding the use of palliative EBRT after SEMS placement in palliative esophageal cancer. Addition of EBRT to SEMS was associated with a higher number and lower severity of stent-related complications as well as increased overall survival, suggesting that post-stent EBRT may have a neutral or at least non-detrimental effect on stent complications and may benefit survival, although the overall impact on quality of life is unclear.

Patients in the SEMS + EBRT group had a significantly higher number of stent-related complications compared to the SEMS alone group, including dysphagia, GI bleeding, stent food impaction, esophagitis and aspiration pneumonia. This finding is supported by Song et al. [9], who reported that patients treated with pre-stent radiation or stent alone had significantly less stent migration, fistulas, severe pain and massive bleeding than those treated with post-stent radiation. Our study expands on Song et al. by investigating a much greater variety of complications, including stent food impaction, stent tumour in- or overgrowth, esophageal stricture and esophagitis, to better characterize how palliative EBRT impacts stent-related morbidity. To our knowledge, the present study is the first to assess how addition of EBRT impacts complication grade in patients with pre-existing SEMS. Similar to others [4, 9, 10], our study showed improved overall survival in the SEMS + EBRT group compared to SEMS alone. In the SEMS + EBRT group, our median overall survival of 163.5 days is comparable to Javed et al.'s [4] result of 180 days. However, this study's SEMS alone median survival of 120 days is almost twice our value of 65 days [4]. Contrastingly, Adamson et al.'s [3] randomized controlled trial conducted in the UK found that addition of EBRT in patients with SEMS did not reduce dysphagia deterioration and resulted in no significant difference in overall survival or time to first stent complication or re-intervention. They did, however, find that EBRT after SEMS placement was associated with a reduced hazard of bleeding events [3]. Adamson et al.'s prospective design and larger sample size may explain this discrepancy from the present study's outcomes [3], which may be affected by our smaller scale and retrospective design.

The increased incidence of stent-related complications in the SEMS + EBRT group suggests that complications associated with each treatment modality may be additive. However, the decreased severity of complications associated with combined treatment may be because this complication effect is not synergistic, and radiation may be reducing the severity of stent-related complications. This would be a likely case for stent tumour in- or overgrowth, which would be reduced by post-stent radiation. However, stent migration could be worsened by EBRT, as radiation can cause tumour shrinkage and subsequent loosening of the stent [10]. This notion is supported by our data as a notably greater proportion of patients experienced stent migration in the SEMS + EBRT group (38%) compared to SEMS alone (15%).

The observed survival benefit of adding EBRT to SEMS may be due to the tumoricidal effect of radiation on locoregional disease. Additionally, the combined modalities may provide sufficient dysphagia relief to improve patients' nutritional status. While this alone could significantly improve survival, it may also contribute to patients' maintained performance status and eligibility for further treatment, such as palliative chemotherapy. Additionally, it cannot be ignored that the survival benefit seen in the SEMS + EBRT group may be in part due to palliative chemotherapy treatment, especially as 38.5% of this group received chemotherapy compared to 24.3% of the SEMS alone group. Indeed, radiation's association with decreased mortality is not significant

when patients who received chemotherapy are removed from both groups, indicating that patients who received both chemotherapy and radiation have a different mortality risk than those who received radiation alone. There is a need for further investigation with a larger sample size to better characterize the effect of chemotherapy on radiation and mortality risk.

The present study suggests that the use of palliative radiotherapy when indicated after stent placement is non-inferior to SEMS alone as it is associated with prolonged survival and reduced stent-related complication severity. However, the increased incidence of complications in the radiation group implies that combination therapy may have a clinically significant impact on patient quality of life. Descriptive statistics show that dysphagia, stent migration and esophageal stricture are the most frequent complications in the SEMS + EBRT group, indicating that the cost-benefits of dual treatment should be carefully considered when palliating esophageal cancer. While several guidelines advise against EBRT with a SEMS in place [5, 11], our results suggest that radiation oncologists should not withhold palliative radiotherapy in select esophageal cancer patients with SEMS due to concerns of major adverse events or lack of perceived benefit due to shortened survival.

The most notable yet unavoidable limitation of our study is the potential selection bias in which improved survival and decreased complication severity in the SEMS + EBRT group may have been due to radiotherapy being preferentially offered to patients with higher functional status who were likely to survive longer and did not already have severe SEMS complications. Indeed, in the SEMS alone group, the median time from 1st stent placement to 1st complication was 25 days, while in the SEMS + EBRT group, the median time from 1st stent placement to start of EBRT was 41 days. However, an unpaired t-test between these data sets reveals no significant difference between time intervals ($t(43) = -0.0596$, $p = 0.953$), suggesting that patients in the SEMS alone group did not experience complications significantly earlier than EBRT was initiated in their SEMS + EBRT counterparts.

Other limitations of this study include the retrospective, single-centre design and smaller sample size, which limits the statistical power of our chart review. Despite this, our robust statistical analysis adjusted for 6 potential confounding variables in the complication and survival analyses, increasing the likelihood that differences between groups were due to EBRT status. Furthermore, patient charts may have been missing some complication data, especially if patients sought care for complications at hospitals outside Kelowna. To address this, we cross-referenced data between CAIS and KGH Thoracic Surgery records. Despite recording data until last follow up and capturing date and cause of death in all patients, there may have been missing patient data between last follow up and death, as KGH Thoracic Surgery and Radiation Oncology departments do not have regular follow up schedules after SEMS or EBRT. Additionally, while it was necessary to exclude grades I and II for most complication types to ensure consistency and reliability of data reporting, it may have resulted in some clinically significant stent-related complications not being captured in our chart review. Lastly, it is possible that patients in the SEMS + EBRT group received more post-stent follow up than the SEMS alone group, which may explain why there were more reported complications in the SEMS + EBRT group. This may also explain why the SEMS alone group had fewer, more severe complications, as the complications which were known to the care team may have only been the more severe ones. Unfortunately, this tendency of less severe complications to go undocumented in outpatients remains a known limitation of retrospective chart reviews.

The results of this study showed that addition of palliative EBRT to SEMS was associated with significantly improved survival and reduced stent-related complication severity compared to SEMS alone in esophageal cancer patients. However, patients in the SEMS + EBRT group experienced a significantly higher number of complications than those with SEMS monotherapy, aligning with previous literature which highlights safety concerns with this combination therapy. Further research investigating quality of life outcomes in SEMS plus EBRT palliation would help elucidate the utility of this treatment option, particularly as palliation approaches often emphasize quality of life over longevity.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12029-025-01228-6.

Acknowledgements The authors would like to acknowledge Kelowna General Hospital Thoracic Surgery Department for their assistance in this study.

Author Contributions All authors contributed to study design and methodology. Chart review, assessing patient eligibility and data collection was performed by Emily Adams and Dr. Lavoie-Gagnon. Statistical analysis was performed by Dr. Islam and Emily Adams. The first draft of the manuscript was written by Emily Adams and Dr. Islam and all authors commented on previous versions of the manuscript. All authors have read and approved the final manuscript.

Funding A studentship was provided to Emily Adams from the Kelowna Association of Radiation Oncology, a local professional organization. Emily Adams also received a research conference bursary from Temerty Faculty of Medicine, University of Toronto to attend and present a poster on this study at the CARO-COMP Joint Scientific Meeting, 2023.

Data Availability Research data are stored in an institutional repository and any data sharing requests will be referred to the Information Access Privacy Office at British Columbia's Provincial Health Services Authority (PHSA).

Declarations

Ethics Approval This study received harmonized research ethics board approval from UBC BC Cancer Research Ethics Board and Interior Health Research Ethics Board (study number H20 - 01958). We received a waiver of patient consent for our retrospective chart review and all study procedures were performed in accordance with the 1964 Helsinki Declaration.

Consent to Participate & Consent to Publish This study was granted a waiver of patient consent by the UBC BC Cancer and Interior Health Research Ethics Boards, so no patient consent is required for participation or publication. No identifying patient information is included in this article.

Competing Interests Dr. Theodora Koulis has received honoraria from Merck for a speaker presentation and has attended and lectured at the Canadian Breast Cancer Symposium. Dr. Benjamin Mou has received honoraria from AstraZeneca, Bristol Myers Squibb and Amgen. The remaining authors have declared no financial or non-financial interests.

References

1. Tinusz B, Soós A, Hegyi P, et al. Efficacy and safety of stenting and additional oncological treatment versus stenting alone in unresectable esophageal cancer: a meta-analysis and systematic review. Radiother Oncol. 2020;147:169–77. https://doi.org/10.1016/j.radonc.2020.05.015.
2. BC Cancer. Statistics by cancer type – esophagus. Bccancer.bc.ca. Published December 2019. Accessed April 30, 2023. http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Esophagus_2017_20200327.pdf
3. Adamson D, Byrne A, Porter C, et al. Palliative radiotherapy after oesophageal cancer stenting (ROCS): a multicentre, open-label, phase 3 randomised controlled trial. Lancet Gastroenterol Hepatol. 2021;6(4):292–303. https://doi.org/10.1016/S2468-1253(21)00004-2.
4. Javed A, Pal S, Dash NR, et al. Palliative stenting with or without radiotherapy for inoperable esophageal carcinoma: a randomized trial. J Gastrointest Cancer. 2012;43(1):63–9. https://doi.org/10.1007/s12029-010-9206-4.
5. Spaander MCW, van der Bogt RD, Baron TH, et al. Esophageal stenting for benign and malignant disease: European Society of Gastrointestinal Endoscopy (ESGE) guideline - update 2021. Endoscopy. 2021;53(7):751–62. https://doi.org/10.1055/a-1475-0063.
6. Nishimura Y, Nagata K, Katano S, et al. Severe complications in advanced esophageal cancer treated with radiotherapy after intubation of esophageal stents: a questionnaire survey of the Japanese Society for Esophageal Diseases. Int J Radiat Oncol. 2003;56(5):1327–32. https://doi.org/10.1016/s0360-3016(03)00198-6.
7. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg. 2004;240(2):205–13. https://doi.org/10.1097/01.sla.0000133083.54934.ae.
8. Rice TW, Kelsen D, Blackstone EH, et al. 2017 Esophagus and esophagogastric junction. In: *AJCC Cancer Staging Manual*. 8th ed. Springer Nature; 185–202.
9. Song HY, Lee DH, Seo TS, et al. Retrievable covered nitinol stents: experiences in 108 patients with malignant esophageal strictures. J Vasc Interv Radiol. 2002;13(3):285–92. https://doi.org/10.1016/S1051-0443(07)61722-9.
10. Rueth NM, Shaw D, D'Cunha J, Cho C, Maddaus MA, Andrade RS. Esophageal stenting and radiotherapy: a multimodal approach for the palliation of symptomatic malignant dysphagia. Ann Surg Oncol. 2012;19(13):4223–8. https://doi.org/10.1245/s10434-012-2459-3.
11. Guideline Resource Unit, Cancer Care Alberta. Esophageal Cancer: Clinical Practice Guideline GI-009 – Version 6. Albertahealthservices.ca. Published June 2021. Accessed January 31, 2023. https://www.albertahealthservices.ca/assets/info/hp/cancer/if-hp-cancer-guide-gi009-esophageal.pdf