Propensity Score-Matched Comparison of Stenting as Bridge to Surgery and Emergency Surgery for Acute Malignant Left-Sided Colonic Obstruction

Yuepeng Cao
Tongji University Affiliated Shanghai Tongji Hospital
Qing Chen
Tongji University Affiliated Shanghai Tenth People's Hospital
Zhizhan Ni
Tongji University Affiliated Shanghai Tongji Hospital
Feng Wu
Tongji University Affiliated Shanghai Tongji Hospital
Chenshen Huang
Tongji University Affiliated Shanghai Tongji Hospital
Jinzhe Zhou
Tongji University Affiliated Shanghai Tongji Hospital
Songze Zhang
Tongji University Affiliated Shanghai Tongji Hospital
Bujun Ge (bujun_ge@163.com)
Tongji University School of Medicine
Qi Huang
Tongji University Affiliated Shanghai Tongji Hospital

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Abstract

Purpose

Bridge to elective surgery (BTS) using self-expanding metal stents (SEMS) is a common alternative to emergency surgery (ES) for acute malignant left-sided colonic obstruction (AMLCO). However, the study regarding long-term impact of BTS is limited and unclear.

Methods

A multicenter observational study was performed at three hospitals from April 2012 to December 2019. Propensity score matching (PSM) was introduced to minimize selection bias. The primary endpoint was overall survival. The secondary endpoints included surgical approaches, primary resection types, total stent related adverse effects (AEs), surgical AEs, length of hospital stay, 30-day mortality and tumor recurrence.

Results

49 patients in both BTS and ES group were matched. Patients in the BTS group more often underwent laparoscopic resection (31 [63.3%] vs 8 [16.3%], p<0.001), less likely to have a primary stoma (13 [26.5%] vs 26 [53.1%], p=0.007) and more often had perineural invasion (25 [51.0%] vs 13 [26.5%], p=0.013). The median overall survival was significantly lower in patients with stent insertion (41 vs 65 months, p=0.041). 3-year overall survival (53.0% vs 77.2%, p=0.039) and 5-year overall survival (30.6% vs 55.0%, p=0.025) were significantly less favorable in the BTS group. In the multivariate Cox regression analysis, stenting (hazard ratio(HR)= 2.309(1.052-5.066), p=0.037), surgical AEs (HR=1.394(1.053-1.845), p=0.020) and pTNM stage (HR=1.706(1.116-2.607), p=0.014) were positively correlated with overall survival in matched patients.

Conclusions

Self-expanding metal stents as “a bridge to surgery” is associated with more perineural invasion, higher recurrence rate and worse overall survival in patients with acute malignant left-sided colonic obstruction compared with emergency surgery.

1. Introduction

Colorectal cancer (CRC) is the third most common diagnosed cancer and accounts for approximately 10% of cancer-related deaths worldwide[1]. 7–29% of CRC patients present with acute large bowel obstruction[2]. These patients are mainly in advanced disease stage and under poor clinical condition, and most of them need urgent surgical interventions[3]. In addition to high morbidity and mortality rates of acute malignant colonic obstruction (AMCO) itself in the emergency setting, conventional emergency surgery (ES) is frequently followed by severe complications such as anastomotic leakage and surgical site infection[4, 5]. Moreover, ES is accompanied by a high chance of stoma creation, which often becomes permanent[6].

In the 1900s, self-expanding metal stents (SEMS) was first utilized in the treatment of palliative malignant rectal obstruction[7]. Since then, SEMS has been increasingly used as an alternative option for AMCO treatment either as palliation or as a bridge to surgery (BTS). BTS provides a period of “optimization” of the patients’ clinical condition, allowing adequate oncological staging, accurate anesthetic assessment, optimal colonic preparation and early peri-operational chemotherapy[2, 5]. Therefore, decompression by SEMS insertion can transform the ES into an elective procedure, leading to subsequent medical stabilization and an increased rate of primary anastomosis. SEMS seems to be an effective and safe technique, and the benefits of short-term outcomes have been confirmed by recent meta-analysis, compared to ES[8–10]. However, randomized controlled trials (RCT) and related meta-analysis comparing BTS and ES are population limited and provide inconsistent results on surgical and oncological outcomes. Most studies evaluating outcomes of BTS are conducted at single centers, and optimal matching is often lacking[2, 5, 11]. The objective of this study was to compare the surgical and oncological outcomes of BTS and ES in the management of AMLCO, using propensity score-matched (PSM) analysis.

SEMS as BTS is also associated with annoying stent-related complications including perforation, stent migration and re-obstruction[6, 12]. In addition, BTS has the potential risk of tumor cell dissemination after stent insertion, leading to worse oncologic outcomes[13, 14].

2. Material And Methods

We performed a retrospective observational study of patients with AMLCO, treated with a curative intent, in three hospitals (Shanghai Tongji Hospital, Shanghai, China; Ningbo First Hospital, Ningbo, China; Ningbo Second Hospital, Ningbo, China) from April 2012 to December 2019. All patients who underwent resection for AMLCO were identified from in-hospital medical records. Data of baseline characteristics and short-term surgical outcomes were collected from medical records. Data of long-term oncological outcomes were collected upon follow-up treatment or survey. This study was approved by the institutional review board of Shanghai Tongji Hospital, Ningbo First Hospital and Ningbo Second Hospital.

Patient selection

Patients were considered to have acute colonic obstruction based on clinical signs of colonic obstruction (abdominal distention, constipation and vomiting) and related radiological signs under computed tomography (CT) scan. Patients were then separated into 2 distinct groups based on the type of procedure performed. The BTS group includes patients who underwent SEMS placement followed by scheduled elective surgery, and the ES group includes patients who were treated with emergency surgery. Patients undergoing SEMS placement or ES, as a palliative treatment, were excluded. Patients that lost follow-up were also excluded from the analysis. Patients who failed in SEMS insertion procedure and underwent emergency surgery, were classified in the BTS group, according to the intention-to-treat concept.

Data recording and follow-up

Patient baseline characteristics (age, gender, ASA score, comorbidities, tumor location and clinical TNM stage) and perioperational characteristics (surgical approach, operation method, total hospital stay, stent-related adverse effects (AEs), surgical AEs and adjuvant chemotherapy) were collected from medical records. Follow-up data, including tumor recurrence and overall survival, were obtained during routine clinical care and telephone contact with the patient.

Stent placement and surgery

Colonic stents used in this study were uncovered and inserted with direct visualization endoscopically. All procedures were carried out under general anesthesia. Stent placement was performed following standard protocols as previously described[15]. A guidewire was introduced across the stenosis and beyond the obstruction and the stent was deployed over the guidewire. Correct positioning of the stent was confirmed by fluoroscopy.

Elective surgery was performed at median 11.5 days after stent insertion. All patients underwent standard colectomy and regional lymphadenectomy. The surgical approaches, operation methods and the range of resection were determined by the surgeon, based on the tumor location, tumor stage and the patients' general condition.

Endpoints

The technical success of SEMS placement was defined by successful stent placement and the ability to pass stool. The clinical success was defined as relief of obstructive symptoms within 48 hours of SEMS placement or ES. Stoma creation included temporary stoma with return after initial decompression surgery, and also permanent stoma according to the patient's general condition, cancer progression and patient's choice. The primary endpoint for this study was overall survival (OS). The secondary endpoints included surgical approach, primary resection type, total stent related AEs (tumor perforation, bleeding and re-obstruction), surgical AEs (wound infection, anastomosis leakage), length of hospital stay, 30-day mortality and tumor recurrence. Surgical AEs were classified according to the Clavien-Dindo classification[16].

Statistical Analysis

Propensity score matching (PSM) is used for best possible matching when randomized control trial (RCT) studies are not possible or not available. PSM represents the probability of receiving treatment A rather than B for a patient with given observed baseline characteristics with a summary score, the propensity score. The variables selected in PSM analysis include age, sex, ASA score, comorbidities, tumor location and clinical TNM (cTNM) stage. These variables were selected since they could affect the oncological outcomes of ACMO. PSM analysis was performed using a logistic regression model. This one-to-one matching was performed by using a caliper width that was 0.2 of the standard deviation of the log of the propensity score.

Data were analyzed using SPSS 22.0 (Chicago, IL, USA). Categorical variables were analyzed using χ^2 test or Fisher exact test. Continuous data were analyzed using the Students' t test and presented as means ± standard deviation. Overall survival was defined as the time between diagnosis and the time of death or last follow-up. Survival curves were generated using adjusted Kaplan-Meier method[17] and compared using a log-rank test. A $p < 0.05$ was considered statistically significant.

3. Results

3.1 Baseline characteristics

From April 2012 to December 2019, we retrospectively identified 287 patients who were admitted as AMLCO in three hospitals. Patient selection was shown in Fig. 1. After exclusion of patients with palliative operation (n = 79) and patients with failed follow-up (n = 38), a total of 167 patients who received either SEMS as BTS (n = 49) or ES (n = 118) are included in the analysis. Using 1:1 propensity score matching, 49 patients in the ES group were matched to 49 in the SEMS group.

Before matching, baseline characteristics were comparable between BTS and ES groups, except that more patients had coronary artery disease in the SEMS group (9 of 49 in the SEMS group (18.4%) and 10 of 118 in the ES group (8.5%)) (Table 1). After propensity matching, no significant difference was found between BTS and ES group regarding gender (36 male patients [73.5%] in the BTS group and 37 [75.5%] in the ES group, p = 0.817), age (mean [SD] age, 68.8 [11.1] years in the BTS group and 68.8 [13.8] years in the ES group, p = 0.872), age range (p = 0.757), ASA score (p = 0.399), comorbidities, tumor location (p = 0.243) or clinical TNM (cTNM) stage (2 patients (4.1%) with stage IV CRCs in the BTS group and 1 (2.0%) in the ES group, p = 0.560).

Table 1
Baseline characteristics*

	Before propensity score matching			After propensity score matching(1:1)		
	BTS(n = 49)	ES(n = 118)	P	BTS(n = 49)	ES(n = 49)	P
Gender			0.152			0.817
Male	36(73.5%)	73(61.9%)		36(73.5%)	37(75.5%)	
Female	13(26.5%)	45(38.1%)		13(26.5%)	12(24.5%)	
Age(mean(SD),y)	68.8(11.1)	68.3(12.6)	0.811	68.8(11.1)	68.8(13.8)	0.872
Age Range (y)			0.843			0.757
25–59	10(20.4%)	26(22.0%)		10(20.4%)	13(26.5%)	
60–69	18(36.7%)	36(30.5%)		18(36.7%)	15(30.6%)	
70–79	10(20.4%)	29(24.6%)		10(20.4%)	10(20.4%)	
80–95	11(22.4%)	27(22.9%)		11(22.4%)	11(22.4%)	
ASA score			0.348			0.399
I	6(12.2%)	28(23.7%)		6(12.2%)	13(26.5%)	
II	23(46.9%)	48(40.7%)		23(46.9%)	16(32.7%)	
III	17(34.7%)	40(33.9%)		17(34.7%)	18(36.7%)	
IV	3(6.1%)	2(1.7%)		3(6.1%)	2(4.1%)	
Comorbidities						
CAD	9(18.4%)	10(8.5%)	0.007	9(18.4%)	6(12.2%)	0.400
Hypertension	18(36.7%)	43(36.4%)	0.133	18(36.7%)	17(34.7%)	0.833
Diabetes	3(6.1%)	18(15.3%)	0.333	3(6.1%)	5(10.2%)	0.461
CPD	4(8.2%)	6(5.1%)	0.181	4(8.2%)	4(8.2%)	1.000
Renal dysfunction	2(4.1%)	5(4.2%)	0.705	2(4.1%)	3(6.1%)	0.646
Biliary diseases	6(12.2%)	14(11.9%)	0.412	6(12.2%)	5(10.2%)	0.749
CVD	2(4.1%)	6(5.1%)	0.873	2(4.1%)	3(6.1%)	0.646
Tumor location			0.086			0.243

Abbreviations: CAD, coronary artery disease; CPD, chronic pulmonary disease; CVD, cerebrovascular disease

*Data are presented as number (percentage) of patients unless otherwise indicated.

	Before propensity score matching			After propensity score matching(1:1)		
Splenic Flexure	8(16.3%)	10(8.5%)		8(16.3%)	5(10.2%)	
Descending colon	6(12.2%)	30(25.4%)		6(12.2%)	12(24.5%)	
Sigmoid colon	35(71.4%)	78(66.1%)		35(71.4%)	32(65.3%)	
cTNM stage			0.630			0.560
I-III	47(95.9%)	111(94.1%)		47(95.9%)	48(98.0%)	
IV	2(4.1%)	7(5.9%)		2(4.1%)	1(2.0%)	
Abbreviations: CAD, coronary artery disease; CPD, chronic pulmonary disease; CVD, cerebrovascular disease						
*Data are presented as number (percentage) of patients unless otherwise indicated.						

3.2 Procedure-related characteristics and perioperational outcomes

SEMS insertion was attempted in 49 patients and was successful in 44 of them with a technical success rate of 89.8%. The technique failure in 5 patients is attributed to a complete colonic obstruction, leading to unsuccessful stent insertions. Stent related colonic perforation occurred in 2 of 44 patients within 24 hours after stent insertion, with a clinical success rate of 85.7%. These 7 patients underwent emergency open surgery of tumor resection.

Table 2 summarized the procedure-related characteristics and perioperational outcomes. The median interval between SEMS and resection was 11 days (IQR, 7-19days). After PSM matching, patients in the BTS group more often underwent laparoscopic resection (31 [63.3%] in the BTS group and 8 [16.3%] in the ES group, $p < 0.001$), less likely to have a primary stoma (13 [26.5%] in the BTS group and 26 [53.1%] in the ES group, $p = 0.007$), had a higher total in-hospital cost (78.0 ± 30.3 thousand yuan in the BTS group and 62.2 ± 46.1 thousand yuan in the ES group, $p = 0.049$) and more often had perineural invasion (25 [51.0%] in the BTS group and 13 [26.5%] in the ES group, $p = 0.013$). Other perioperational outcomes, including surgical adverse effects (Clavien-Dindo classification) ($p = 0.416$), pT stage ($p = 0.301$), pN stage (0.639), pM stage ($p = 1.000$), patients who had vascular invasion (15 [30.6%] vs 18 [36.7%], $p = 0.521$), patients who received adjuvant chemotherapy (26 [53.1%] vs 25 [51.0%], $p = 0.686$), total hospital stay (27.2 days vs 24.1, $p = 0.321$) and 30-day mortality (1 [2.0%] vs 1 [2.0%], $p = 1.000$), did not differ between treatment groups.

Table 2
Clinicopathological characteristics

	Before propensity score matching			After propensity score matching(1:1)		
	BTS(n = 49)	ES(n = 118)	P Value	BTS(n = 49)	ES(n = 49)	P Value
Surgical approach			0.000			0.000
Laparotomy	18(36.7%)	79(66.9%)		18(36.7%)	41(83.7%)	
Laparoscopy	31(63.3%)	39(33.1%)		31(63.3%)	8(16.3%)	
Primary resection type			0.068			0.007
Without stoma	36(73.5%)	69(58.5%)		36(73.5%)	23(46.9%)	
With stoma	13(26.5%)	49(41.5%)		13(26.5%)	26(53.1%)	
Stent procedure						
Technique failure	5(10.2%)			5(10.2%)		
Stent-related perforations	2(4.1%)			2(4.1%)		
Clinical success	42(85.7%)			42(85.7%)		
Surgical AEs (Clavien-Dindo classification)			0.447			0.416
1	0	0		0	0	
2	2(4.1%)	11(9.3%)		2(4.1%)	8(16.3%)	
3	8(16.3%)	3(2.5%)		8(16.3%)	0	
4	0	2(1.7%)		0	1(2.0%)	
5	1(2.0%)	5(4.2%)		1(2.0%)	0	
pT stage			0.136			0.301
T1	1(2.0%)	2(1.7%)		1(2.0%)	2(4.1%)	
T2	1(2.0%)	2(1.7%)		1(2.0%)	1(2.0%)	
T3	19(38.8%)	52(44.1%)		19(38.8%)	23(46.9%)	
T4	28(57.1%)	62(52.5%)		28(57.1%)	23(46.9%)	
pN stage			0.655			0.639
N0	25(51.0%)	69(58.5%)		25(51.0%)	25(51.0%)	
N1	19(38.8%)	26(22.0%)		19(38.8%)	14(28.6%)	

	Before propensity score matching			After propensity score matching(1:1)		
N2	5(10.2%)	23(19.5%)		5(10.2%)	10(20.4%)	
pM stage			0.898			1.000
M0	41(83.7%)	98(83.1%)		41(83.7%)	41(83.7%)	
M1	8(16.3%)	20(16.9%)		8(16.3%)	8(16.3%)	
Vascular invasion	15(30.6%)	50(42.4%)	0.681	15(30.6%)	18(36.7%)	0.521
Perineural invasion	25(51%)	40(33.9%)	0.039	25(51.0%)	13(26.5%)	0.013
Adjuvant therapy	26(53.1%)	56(47.5%)	0.510	26(53.1%)	25(51.0%)	0.686
Total hospital stay (mean(SD), d)	27.2(15.9)	24.7(14.5)	0.353	27.2(15.9)	24.1(13.8)	0.321
Total in-hospital cost(mean(SD), 10^3 RMB yuan)	78.0(30.3)	61.2(40.7)	0.004	78.0(30.3)	62.2(46.1)	0.049
30-day mortality	1(2.0%)	3(2.5%)	0.847	1(2.0%)	1(2.0%)	1.000

3.3 Long-term outcomes

The mean follow-up period was 31.7 ± 3.06 months in the BTS group and 31.5 ± 3.32 months in the ES group (p = 0.970) (Table 3). In PSM matched population, overall survival was significantly less favorable for patients with stent insertion, as indicated by 3-year OS (53.0% in the BTS group and 77.2% in the ES group, p = 0.039) and 5-year OS (30.6% in the BTS group and 55.0% in the ES group, p = 0.025). The median overall survival was 41 months in the BTS group and 65 months in the ES group(p = 0.041) (Fig. 2). Total recurrence rate was significant higher in the BTS group (25(51.0%) vs 13(26.5%), p = 0.013). However, there was no significant differences between the two groups in terms of regional recurrence (10(20.4%) vs 4(8.2%), p = 0.083) and distant metastasis (15(30.6%) vs 9(18.4%), p = 0.159).

In the multivariate Cox regression analysis, stenting (hazard ratio(HR) = 2.309(1.052–5.066), p = 0.037), surgical AEs (HR = 1.394(1.053–1.845), p = 0.020) and pTNM stage (HR = 1.706(1.116–2.607), p = 0.014) were positively correlated with overall survival in matched patients. Other factors, including ASA score, stoma creation and perineural invasion, showed significant differences in univariate analysis, but no significant differences in multivariate analysis. In the BTS group only, surgical AEs (p = 0.011) and pTNM stage (p = 0.012) were associated with overall survival estimate. Other factors that are known for predictors of postoperational survival, including age, time from stenting to resection, perineural invasion and adjuvant therapy, were also included in the analysis but showed no significance.

Table 3
Long-term outcomes in PSM-matched patients

	BTS (n = 49)	ES (n = 49)	P
Mean follow-up period (mo)	31.7 ± 3.06	31.5 ± 3.32	0.970
Overall survival (%)			
At 1y	93.8 ± 3.4	89.6 ± 4.4	0.450
At 3y	53.0 ± 8.1	77.2 ± 7.0	0.039
At 5y	30.6 ± 8.4	55.0 ± 12.0	0.025
Recurrence	25(51.0%)	13(26.5%)	0.013
Regional recurrence	10(20.4%)	4(8.2%)	0.083
Distant metastasis	15(30.6%)	9(18.4%)	0.159

Table 4
Multivariable analysis of known risk factors for overall survival

	Hazard ratio	P
BTS and ES patients (After PSM analysis)		
ASA score	1.271(0.827–1.953)	0.274
Stenting	2.309(1.052–5.066)	0.037
Stoma creation	1.61(0.764–3.391)	0.210
Surgical AEs	1.394(1.053–1.845)	0.020
pTNM stage	1.706(1.116–2.607)	0.014
Perineural invasion	0.82(0.371–1.809)	0.622
BTS patients only		
Time from stenting to resection	1.003 (0.997,1.01)	0.315
Surgical AEs	1.678 (1.126,2.501)	0.011
pTNM stage	2.125 (1.177,3.836)	0.012
Perineural invasion	1.158 (0.42,3.195)	0.776
Adjuvant therapy	1.194 (0.447,3.191)	0.723

4. Discussion

This study is a multicenter trial that analyzed retrospective data from three hospitals with considerable follow-up periods where both BTS and ES were available. The results of this observational study suggest that SEMS placement as BTS in patients with AMLCO was associated with fewer primary stoma creation, higher total in-hospital cost and more perineural invasion. Patients in the BTS group had a higher recurrence rate, a poorer 3-year and 5-year overall survival, which is closely correlated with surgical adverse effects and pTNM stage.

Successful placement of the stent relies on the severity of colonic obstruction and expertise of the endoscopist. The technical (89.8%) and clinical success (85.7%) rates in this study were similar to previous studies (84.2–100% and 78.9–100%, respectively)[18]. Established short-term advantages of bridged surgery include less temporary and permanent stoma creation, as analyzed in many meta-analysis[18, 19]. Our study confirmed that BTS significantly increased the use of laparoscopy and decreased stoma creation.

However, recent studies have failed to show beneficial effects of stenting as BTS over emergency surgery, due to uncertainty of its impact on long-term oncological outcomes[20, 21]. This originates from concerns about tumor manipulation during stent insertion, guidewire perforations during stent placement[22], stent deployment force and eventual micro-perforations at the proximal and distal ends of the stent[23], which may induce tumor cell dissemination locally, but also in the blood stream[14]. In our study, we found patients with BTS had a higher chance of perineural invasion, similar to Kim's findings[24]. In a multivariate analysis by Leibig et al.[25], perineural invasion was thought to be an independent prognostic factors of oncological outcomes in colorectal cancer. In our analysis, perineural invasion was significantly associated with overall survival of propensity score matched patients by univariate survival analysis (data not shown). However, the correlation was not significant in multivariate analysis. Long-term large-scale studies are needed to better investigate the correlation of perineural invasion and oncological outcomes. Stent insertion was associated with more total recurrence in this study, although the difference was not significant in regional or distant recurrence alone. Similar to the findings in our study, a recent meta-analysis[26] of 7 randomized controlled trials demonstrated that BTS significantly increase the risk of recurrence, especially distant recurrence.

To date, very few studies report on long-term survival after SEMS placement as a BTS, due to a scarcity of clinical data and the lack of comparable studies. Femke et al.[19] found that SEMS placement as BTS did not influence 3-year and 5-year overall survival in a meta-analysis, similar to Sun's findings[13], which suggest colonic stenting did not affect 5- and 10- year survival, although the study population is relatively small and an accurate conclusion cannot be drawn. However, in Kim's study[27], SEMS placement could negatively affected 5-year overall survival and disease-free survival (DFS) in stage II and III CRCs(5-year OS: 44% after SEMS versus 87% after elective surgery for non-obstructing CRC). Sabbagh et al.[21] also found that 5-year overall survival was significantly lower in the BTS group, while 5-year cancer-specific mortality was significantly higher (48% vs 21%, p = 0.02), although there were no significant differences in terms of 5-year DFS. In our study, we found 3-year and 5-year overall survival were significantly lower in patients who underwent SEMS as BTS compared to those underwent ES.

Colonic stent insertion also affects patient survival in multi-aspects. Avlund et al performed a 10-year follow-up study and concluded an association between SEMS-related perforations and decreased survival[28]. The interval from SEMS to resection surgery was thought to delay the surgery and increase the rate of recurrence and survival in the study by Broholm[20], although further larger study is needed to confirm the results. Postoperative adverse effects, especially infectious complications, were associated with poorer survival in patients after colorectal cancer resection[29]. SEMS insertion was also reported to be associated with increased perineural invasion[30], which is a known prognostic factor in CRCs and correlates with the findings in our study. Many clinical factors could influence the prognosis of obstructing CRCs and overall survival. An analysis by Rodrigues et al. suggests pTMN stage IV, number of lymph nodes harvested, adjuvant therapy and surgery-related complications could influence overall survival[2]. In our study, stenting along with surgical adverse effects and pTNM stage were associated with overall survival by multivariate analysis of propensity score matched patients.

The present study had several limitations. First, its retrospective nature may bring a selection bias and affect the results. Second, because the population after propensity score matching was relatively small, analysis of some variables showed a wide range. The effect of SEMS as BTS should be cautiously interpreted. Third, although the medical records were carefully reviewed and follow-up studies were thoroughly carried out, the causes of death were difficult to confirm in some cases and the disease-free survival was lacking. Strengths of our studies are the homogeneity between groups, due to the use of PSM analysis, and long follow-up period.

In conclusion, SEMS placement was associated with a high technical and clinical success, similarly to ES, as demonstrated by the higher primary anastomosis rate and lower stoma rates, with its possible positive effects on quality of life. However, SEMS placement as a BTS, compared to ES, leads to more perineural invasion, higher recurrence rate and worse long-term overall survival. These results suggest SEMS placement should not be routinely performed in patients with potentially cured AMLCOs.

Declarations

Ethics approval and consent to participate

The current study was approved by Tongji University Affiliated Shanghai Tongji Hospital.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

Conception and design: BG and QH; Acquisition of data: YC, QC, ZN, FW, CH, JZ, SZ; Analysis and interpretation of data: YC, QC, ZN and QH; Writing, review and revision of the manuscript: YC, QC and QH; Funding: QH; All authors reviewed and approved the manuscript

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Figures

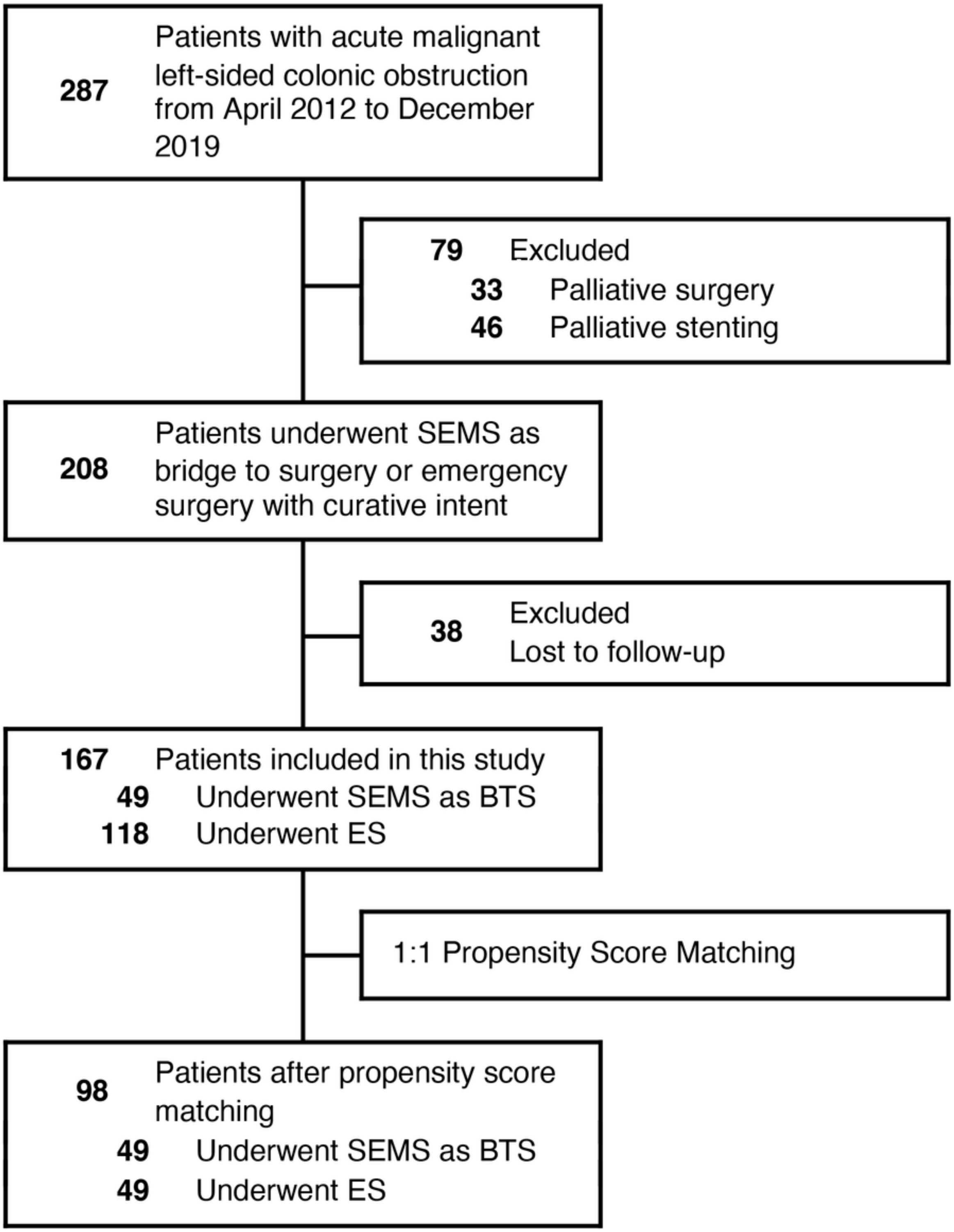
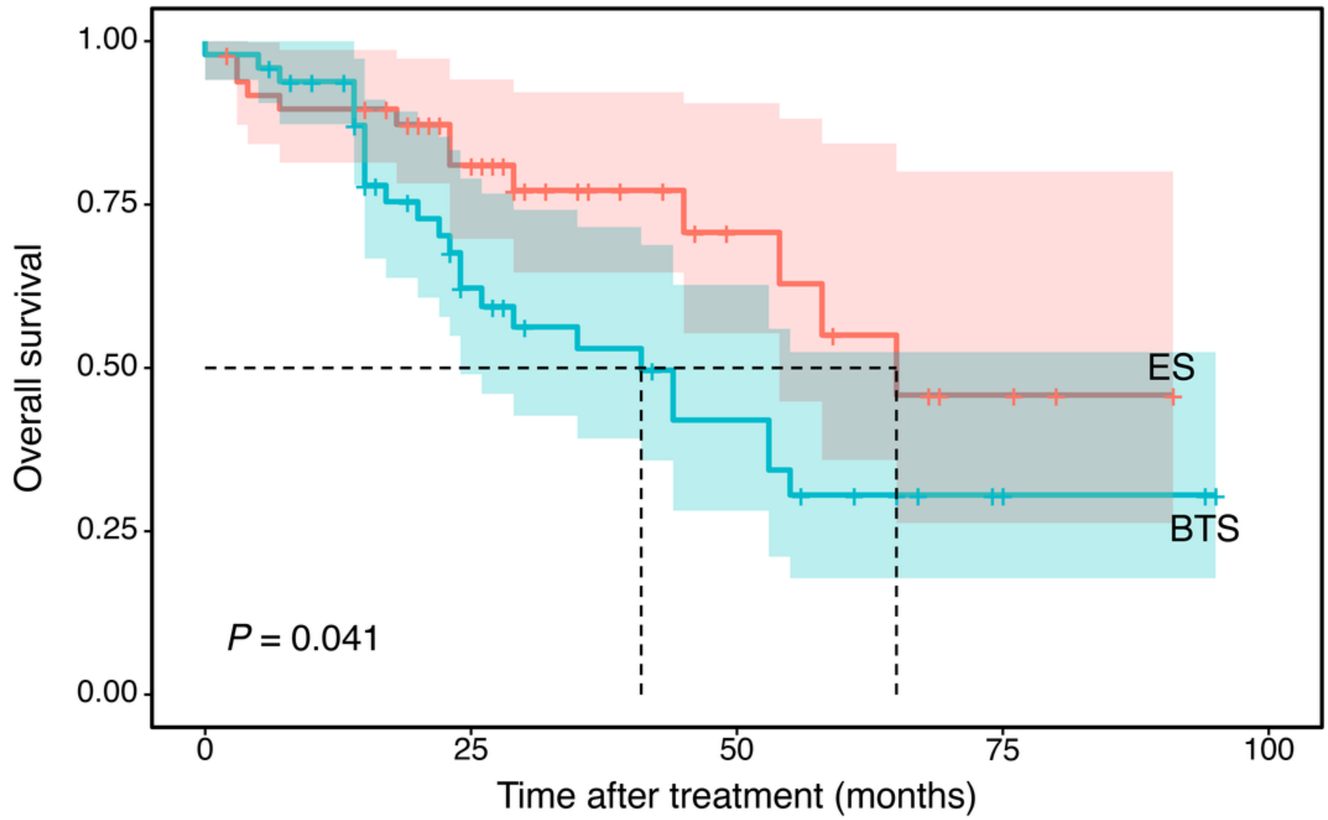


Figure 1

Flowchart of patient selection



No. at risk

BTS	49	26	9	3	0
ES	49	22	11	3	0

Figure 2

Survival curves for Bridge to Surgery (BTS) vs Emergency Surgery (ES) (Propensity Score Matched Patients)