Stent as bridge to surgery for left-sided malignant colonic obstruction reduces adverse events and stoma rate compared with emergency surgery: results of a systematic review and meta-analysis of randomized controlled trials

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Stent as bridge to surgery for left-sided malignant colonic obstruction reduces adverse events and stoma rate compared with emergency surgery: results of a systematic review and meta-analysis of randomized controlled trials

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Background and Aims

Twenty years after the first description of the technique, the debate is still open on the role of self-expandable metallic stent (SEMS) placement as a bridge to elective surgery for symptomatic left-sided malignant colonic obstruction. The aim was to compare morbidity rates after colonic stenting bridge to surgery (SBTS) versus emergency surgery (ES) for left-sided malignant obstruction.

Methods

We performed a systematic review and meta-analysis of randomized controlled trials (RCTs) on SBTS or ES for acute symptomatic malignant left-sided large bowel obstruction. The primary outcome was overall morbidity within 60 days after surgery.

Results

The meta-analysis included 8 RCTs and 497 patients. Overall mortality within 60 days after surgery was 9.6% in SBTS-treated patients and 9.9% in ES-treated patients (relative risk [RR], 0.99; $P = .97$). Overall morbidity within 60 days after surgery was 33.9% in SBTS-treated patients and 51.2% in ES-treated patients (RR, 0.59; $P = .023$). The temporary stoma rate was 33.9% after SBTS and 51.4% after ES (RR, 0.67; $P < .001$). The permanent stoma rate was 22.2% after SBTS and 35.2% after ES (RR, 0.66; $P = .003$). Primary anastomosis was successful in 70.0% of SBTS-treated patients and 54.1% of ES-treated patients (RR, 1.29; $P = .043$).

Conclusions

SBTS was associated with lower short-term overall morbidity and lower rates of temporary and permanent stoma. Depending on multiple factors such as local expertise, clinical status including level of obstruction, and level of certainty of diagnosis, SBTS does offer some advantages with less risk than ES for left-sided malignant colonic obstruction in the short term.

Abbreviations

CI
confidence interval
ES
emergency surgery
MD
mean difference
RCT
randomized controlled trial
RR
relative risk
SBTS
stenting bridge to surgery
SD
standard deviation
SEMS
self-expandable metallic stent

Introduction

Symptomatic left-sided malignant colonic obstruction is a medical and surgical emergency. Emergency surgery (ES) is burdened by a high rate of anastomotic leak, assessed at between 18% and 33%.[1-4] Performing intraoperative colonic lavage, subtotal colectomy, or temporary bowel stoma with or without primary anastomosis may help to minimize this risk, but these procedures carry disadvantages.

Twenty years ago, Tejero et al[5] first described the technique of self-expandable metallic stent (SEMS) placement as a bridge to elective surgery. Since then, its use has produced conflicting results.[6] In 2014, the European Society for Gastrointestinal Endoscopy stated that SEMS placement as a bridge to elective surgery is not recommended as a standard treatment of symptomatic left-sided malignant colonic obstruction.[7] Moreover, concern has been expressed regarding the effect of colonic stenting on short-term adverse events, as well as on long-term survival in patients whose disease is potentially curable, because of the possible risk of both local progression of the cancer and metastatic spread.[8,9]

We performed a systematic review of the literature comparing colonic stenting as bridge to surgery (SBTS) and emergency surgery (ES) and a meta-analysis to determine whether the SBTS strategy confers clinically relevant short-term advantages in terms of morbidity over ES in the treatment of symptomatic left-sided malignant colonic obstruction.

Methods

The analysis and generation of inclusion criteria were based on Cochrane Collaboration guidelines[10] and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations.[11] The study methods have been documented in a protocol registered and accessible at http://www.crd.york.ac.uk/prospero/ (registration number: CRD42017054700).

Criteria for identifying studies and eligibility

According to population, interventions, comparators, outcome measures, and setting (PICOS) criteria, we included only patients from randomized studies that directly compared SBTS and ES for the treatment of acute symptomatic malignant left-sided large bowel obstruction. Emergency resective surgery of any kind was considered, including intraoperative colonic lavage, subtotal colectomy, or temporary bowel stoma with or without primary anastomosis.

Outcomes

Primary outcomes were overall mortality within 60 days after surgery and overall morbidity defined as any diagnosed morbidity related to the endoscopic or surgical technique within 60 days after surgery. Morbidity was defined as the occurrence of any adverse event directly or indirectly related to endoscopy and/or surgery. Secondary endpoints were the success of stent positioning, its safety, ie, postprocedural adverse events including bleeding and perforation, the need for surgery to manage adverse events, need for a stoma, operative time, hospital length of stay, cost analysis, oncologic outcome, and quality of life.

Search strategy

We systematically searched the electronic databases for literature published in English as of December 10, 2016, and listed in PubMed using the string ''(((((("Colorectal Neoplasms"[Mesh]) OR ((colorect* OR rect* OR colon*) AND (neoplas* OR carcinoma* OR tumor* OR tumour* OR cancer* OR malignan* OR oncol*))))) AND ((("Stents"[Mesh] OR stent*)) OR (prosthesis OR endoprosthesis OR SEMS OR "self-expanding metal"))) AND ("surgery" [Subheading] OR surgery OR bridge))) AND ("Randomized Controlled Trial" [Publication Type] OR random*)" and in EMBASE using the string '''colorectal cancer'/exp OR (colorect* OR rect* OR colon* AND (neoplas* OR carcinoma* OR tumor* OR tumour* OR cancer* OR malignan* OR oncol*)) AND ('stent'/exp OR stent* OR prosthesis OR endoprosthesis OR sems OR 'self-expanding metal') AND (surgery:lnk OR 'surgery'/exp OR surgery OR bridge) AND ('randomized controlled trial'/exp OR random*).''

Study selection criteria

Titles were screened by 2 authors (G.L.S. and M.V.). When the same data published by a single research group were reported in multiple publications, only the study reporting on the largest cohort was included. A third investigator (A.A.) arbitrated in the event of lack of agreement. Only randomized controlled trials (RCTs) were selected for inclusion.

The reviewers independently collected the following data when available: (1) year of publication, (2) prospective or retrospective study design, (3) enrollment period, (4) number of patients included, (5) mean age, (6) gender distribution, (7) indication for treatment, (8) technical success of stent positioning, (9) clinical success of stent positioning, (10) adverse events related to stent positioning, (11) mean operating time, (12) R0 resection rate, (13) mean number of lymph nodes harvested, (14) overall adverse events rate, (15) rate of surgery because of adverse events, (16) hospital length of stay, (17) temporary stoma, (18) permanent stoma, (19) successful primary anastomosis defined as primary anastomosis with no related anastomotic adverse events, (20) recurrence rate, (21) overall survival, (22) progression-free survival, (23) quality of life, and (24) costs.

Quality assessment

The methodological quality and risk of bias of each study were evaluated by 3 reviewers (A.A., M.V., and G.L.S.) according to the Cochrane Collaboration guidelines[10] for RCTs.

Statistical analysis

All analyses were performed according to the original treatment allocation (intention-to-treat analysis). For binary outcome data, the relative risks (RR) and 95% confidence intervals (CIs) were estimated using the Mantel-Haenszel method. For continuous outcome data, the mean differences (MD) and 95% CIs were estimated using inverse variance weighting; when means and/or standard deviations (SDs) were not reported, they were estimated from the reported medians, ranges, and sample size as described by Hozo et al.[12] A fixed-effects model was used in all meta-analyses, and the same analyses were redone in a random-effects model. Heterogeneity was assessed by the I^2 measure of inconsistency and deemed statistically significant if I^2 was >50%.

Potential sources of heterogeneity were explored using different sensitivity analyses: comparing fixed-effects versus random-effects models (thus incorporating heterogeneity using the second method), checking the results of cumulative (sequentially including studies by date of publication) and influence meta-analyses (calculating pooled estimates by omitting one study at a time). Publication bias was assessed by generating a funnel plot and performing a linear regression test for funnel plot asymmetry. All analyses were performed using the R 3.3.1 package meta.[13]

Results

A total of 373 studies were retrieved (Fig. 1), 8 of which,[14-21] all RCTs, met the inclusion criteria and included a total of 497 patients: 251 in the SBTS group and 246 in the ES group (Table 1). In all cases, the indication for either SBTS or ES was symptomatic left-sided malignant colonic obstruction. Table 2 presents the patients' characteristics.
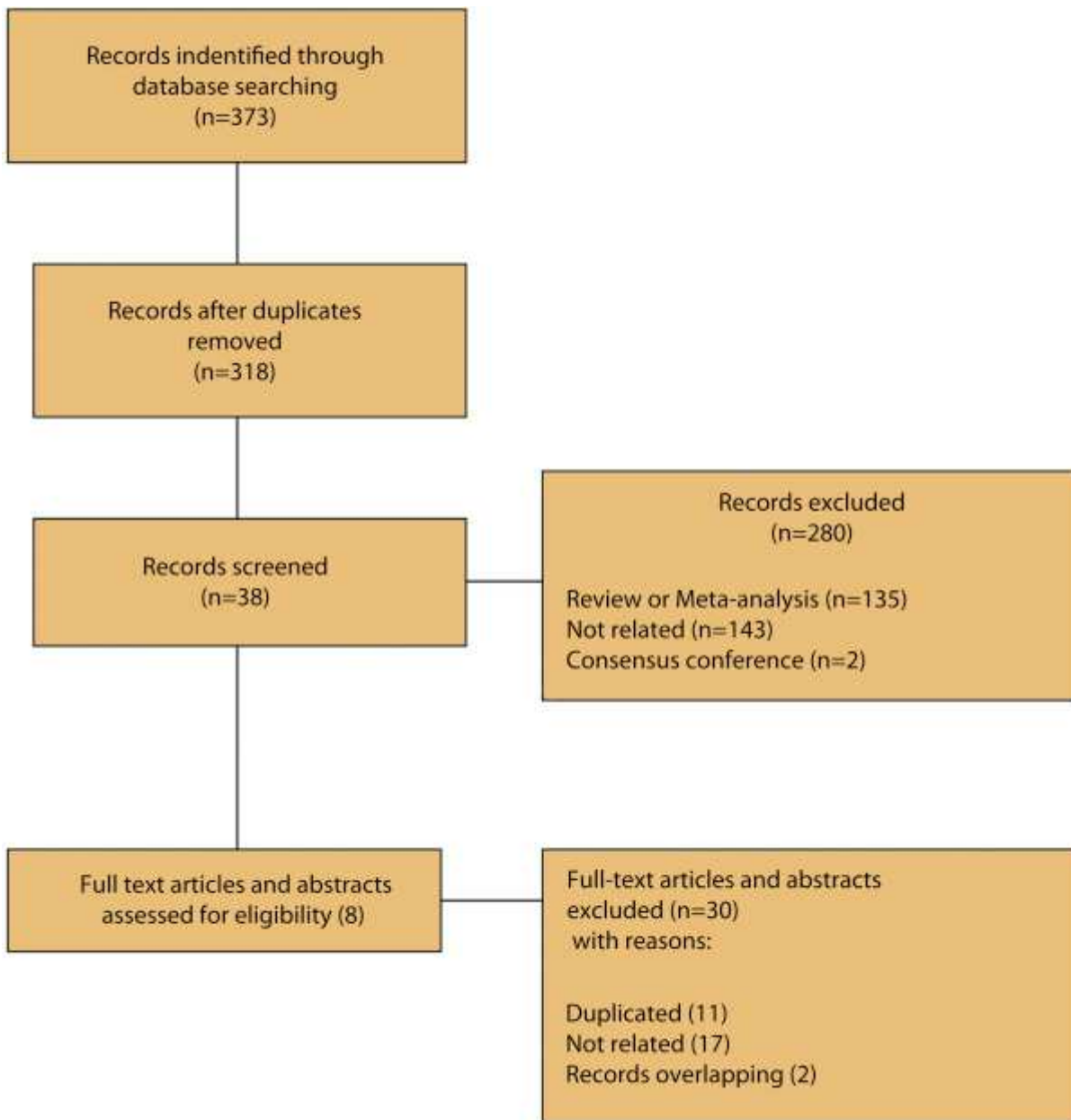
Figure 1. Flowchart illustrating the systematic literature search and study selection strategy.

Table 1. Characteristics of the studies and the principal outcomes

Reference	Country	Type of publication	Recruitment	Type of surgery	Stent type*	Time from SEMS to surgery	Significant difference	No significant difference	Notes
Cheung et al, 2009[15]	China	Single center; RCT	Jan 2002 to May 2005	SBTS and laparotomy vs ES open	Wallstent	<2 weeks	Blood loss, pain, wound infection, anastomotic leak	–	–

Reference	Country	Type of publication	Recruitment	Type of surgery	Stent type*	Time from SEMS to surgery	Significant difference	No significant difference	Notes
							rates, stoma rate		
Alcántara et al, 2011[19]	Spain	Single center; RCT	Feb 2004 to Dec 2006	SBTS and laparotomy vs open ES	NA	<10 days	Blood loss, permanent stoma pain, postoperative complications	–	Trial included 2 SBTS groups, operated at 3 or at 10 days, showing higher 1-stage treatment and lower conversion rate
Cui et al, 2011[14]	China	Single center; RCT	–	SBTS and open vs open ES with IOCL	Wallstent	5-7 days	Overall morbidity and anastomotic leak	SSI, hospital stay, mortality	Trial stopped as emergency surgery group had significantly increased rate of anastomotic leak
Van Hooft et al, 2011[18]	Netherlands	Multicenter; RCT	Mar 2007 to Aug 2009	SBTS and open surgery vs open ES	Wallstent/WallFlex	<4 weeks	Initial stoma rates	Mean global health status, mortality, morbidity, stoma rates	Trial stopped as SBTS group had increased absolute risk of 30-day morbidity on interim analysis

Reference	Country	Type of publication	Recruitment	Type of surgery	Stent type*	Time from SEMS to surgery	Significant difference	No significant difference	Notes
Pirlet et al, 2011[17]	France	Multicenter; RCT	Dec 2002 to Oct 2006	SBTS and open surgery vs open ES	Bard	NA	–	Stoma, colonic resection, in-hospital mortality, surgical and medical morbidity rates	Trial stopped owing to 3 colonic perforations during stent placement and a high rate of technical failure of stent placement (16 of 30)
Ho et al, 2012[16]	Singapore	Single center; RCT	Oct 2004 to Feb 2008	SBTS and surgery vs ES	WallFlex	1-2 weeks	Shorter hospital stay	Stoma, overall complications, mortality	12 IOCL and 7 STC in ES group
Ghazal et al, 2013[20]	Egypt	Single center; RCT	Jan 2009 to May 2012	SBTS and surgery vs subtotal colectomy	NA	<10 days	Postoperative complications, bowel movements	-	30 TACIR in ES group
Arezzo et al, 2016[21]	Italy; Spain	Multicenter; RCT	Mar 2008 to Nov 2015	SBTS and surgery vs ES	WallFlex/Hanaro	<4 weeks	Initial stoma rates (pro SBTS), hospital stay (pro ES)	Morbidity, mortality, blood transfusion, relapse, OS and PFS curves	13% misdiagnosis at CT

SEMS, self-expandable metallic stents; *RCT*, randomized controlled trial; *SBTS*, stent bridge to surgery; *ES*, emergency surgery; *NA*, not available; *IOCL*, intraoperative colonic lavage; *SSI*, surgical site infection; *TACIR*, total abdominal colectomy and ileorectal anastomosis; *OS*, overall survival; *PFS*, progression-free survival; *CT*, computed tomography.

Table 2. Characteristics of the patients

Author	No. of patients randomized	Group	No. of patients analyzed	Male/female	Mean age, years (SD or range)	BMI, kg/m^2 (SD or range)	ASA score (I/II/III/IV)	POSSUM score	Mean follow-up, months (SD or range)
Cheung et al, 2009[15]	50	SBTS	24	14/10	64.5 (39-68)	23.8 (17.5-27.2)	–	–	65 (18-139)
		ES	24	12/12	68.5 (27-86)	24 (17.4-30.3)	–	–	32 (4-118)
Alcántara et al, 2011[19]	28	SBTS	15	5/10	71.9 (8,96)	–	–/5/8/2	17.13	37.6 (16.08) *
		ES	13	7/6	71.15 (9)	–	–/1/9/3	19.15	
Cui et al, 2011[14]	49	SBTS	29	16/13	64	22.3	–	–	–
		ES	20	9/11	67.5	23.7	-	–	
Van Hooft et al, 2011[18]	98	SBTS	47	24/23	70.4 (11.9)	–	16/24/6/0	–	6
		ES	51	27/24	71.4 (9.7)	–	17/27/6/0	–	
Pirlet et al, 2011[17]	67	SBTS	30	16/14	70.4 (10.3)	24.2 (5.1)	–	24.2 (7.6)	–
		ES	30	13/17	74.7 (11.3)	23.3 (4.2)	–	21 (5.2)	
Ho et al, 2012[16]	40	SBTS	20	13/7	68 (51-85)	–	–	–	–
		ES	19	9/10	65 (49-84)	–	–	–	
Ghazal et al, 2013[20]	60	SBTS	30	12/18	52 (37-68)	–	–	–	18 (6-40)

Author	No. of patients randomized	Group	No. of patients analyzed	Male/female	Mean age, years (SD or range)	BMI, kg/m^2 (SD or range)	ASA score (I/II/III/IV)	POSSUM score	Mean follow-up, months (SD or range)
		ES	30	11/19	51 (35-66)	–	–	–	
Arezzo et al, 2016[21]	144	SBTS	56	28/28	72 (43-90)	24.8 (19.5-40.2)	12/27/14/3	–	36 (16-38)
		ES	59	32/27	71 (44-94)	24.5 (18-35)	11/28/16/4	–	
Total	536	SBTS	251	128/123					
		ES	246	120126					

SD, standard deviation; *BMI*, body mass index; *ASA*, American Society of Anesthesiologists; *POSSUM*, Physiological and Operative Severity Score for the enUmeration of Mortality and Morbidity; *SBTS*, stent bridge to surgery; *ES*, emergency surgery.

*

  Mean + SD.

Risk of bias of the studies

Assessment of quality according to the Cochrane Collaboration guidelines[10] for RCTs is reported in Table 3. A L'Abbé plot for overall adverse events reporting the potential sources of heterogeneity within all studies showed a homogeneous distribution of studies (Fig. 2).

Table 3. The Cochrane Collaboration tool for assessing risk of bias

Reference	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other source of bias
Cheung et al, 2009[15]	Low	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Alcántara et al, 2011[19]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Cui et al, 2011[14]	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear	Unclear
Van Hooft	Low	Low	Low	Low	Low	Unclear	Unclear

| Reference	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other source of bias
et al, 2011[18]							
Pirlet et al, 2011[17]	Low	Low	Unclear	Unclear	Unclear	Unclear	Unclear
Ho et al, 2012[16]	Low	Low	Unclear	Unclear	Unclear	Unclear	Unclear
Ghazal et al, 2013[20]	Low	Low	Unclear	Unclear	Unclear	Unclear	Unclear
Arezzo et al, 2016[21]	Low	Low	Unclear	Unclear	Unclear	Unclear	Unclear
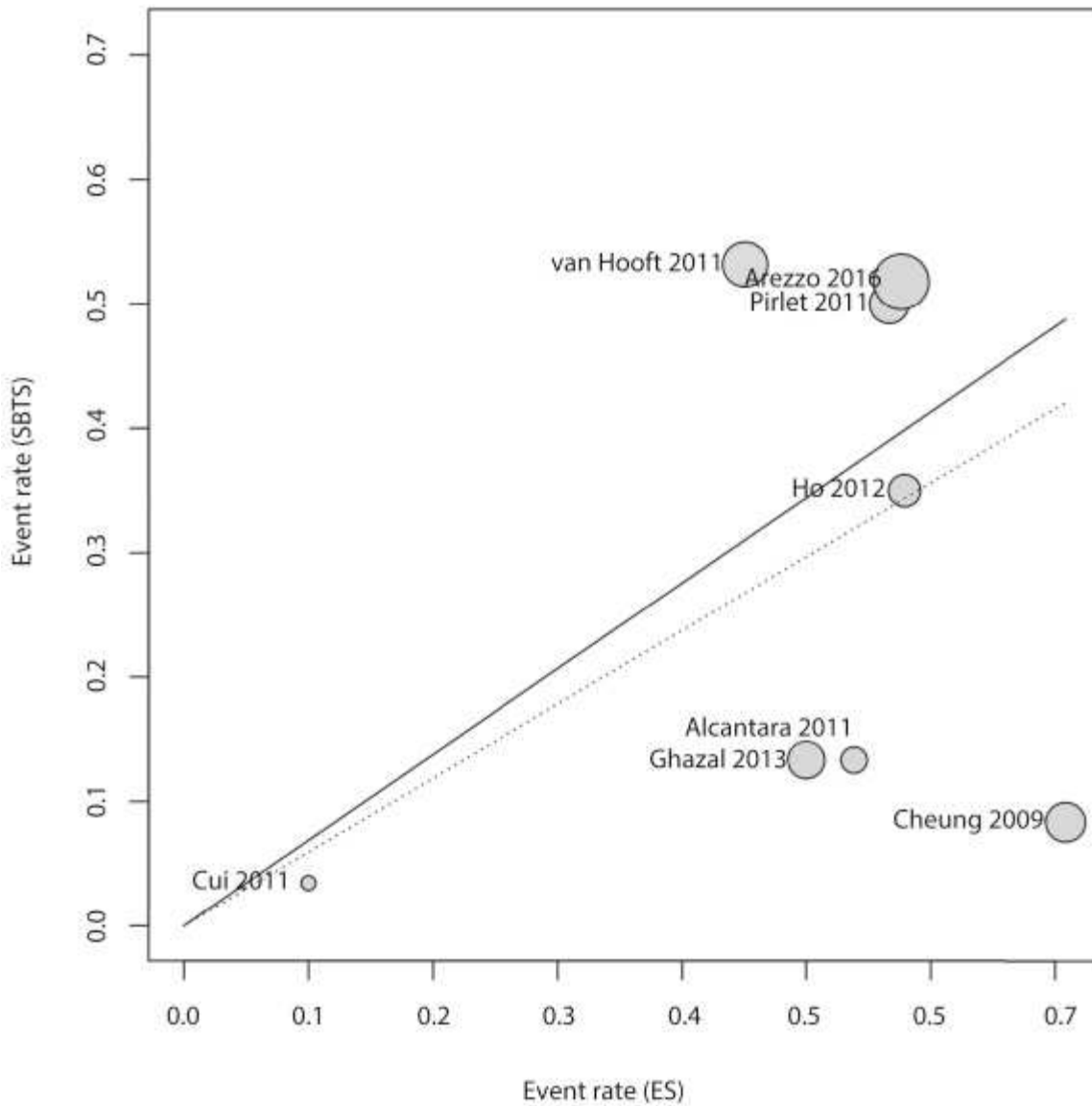
Figure 2. L'Abbé plot for the overall morbidity rate.

Primary outcomes

The meta-analysis investigated the overall mortality (Fig. 3) and morbidity rates within 60 days (Fig. 4) as primary outcomes.
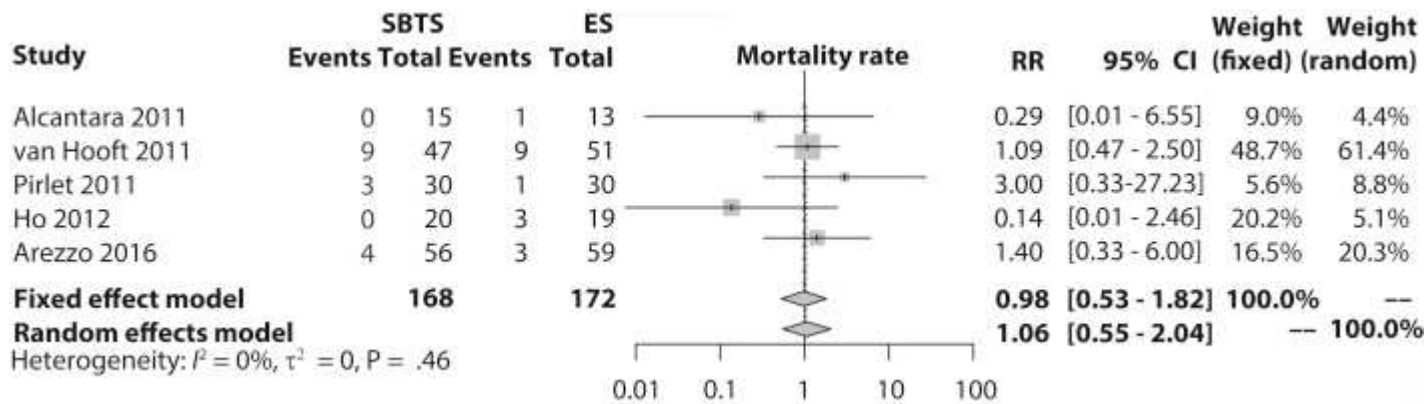

	SBTS		ES		Mortality rate	RR	95% CI	Weight (fixed)	Weight (random)
Study	Events	Total	Events	Total					
Alcantara 2011	0	15	1	13		0.29	[0.01 - 6.55]	9.0%	4.4%
van Hooft 2011	9	47	9	51		1.09	[0.47 - 2.50]	48.7%	61.4%
Pirlet 2011	3	30	1	30		3.00	[0.33 - 27.23]	5.6%	8.8%
Ho 2012	0	20	3	19		0.14	[0.01 - 2.46]	20.2%	5.1%
Arezzo 2016	4	56	3	59		1.40	[0.33 - 6.00]	16.5%	20.3%
Fixed effect model		168		172		0.98	[0.53 - 1.82]	100.0%	--
Random effects model						1.06	[0.55 - 2.04]	--	100.0%
Heterogeneity: $I^2 = 0\%$, $\tau^2 = 0$, $P = .46$									

Figure 3. Forest plot for the overall mortality rate within 60 days.

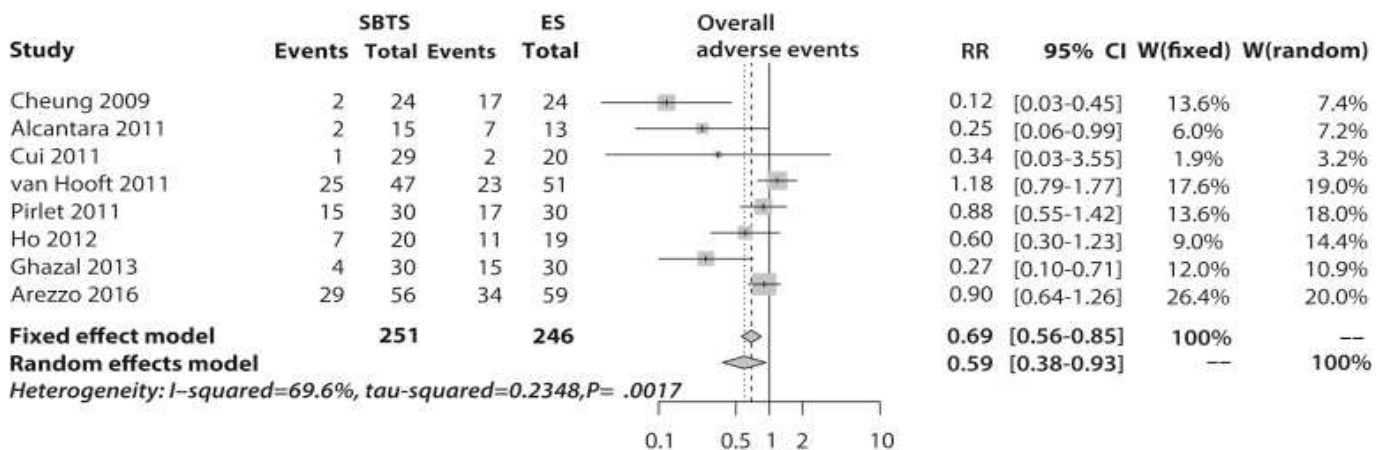|	SBTS		ES		Overall adverse events	RR	95% CI	W(fixed)	W(random)
Study	Events	Total	Events	Total					
Cheung 2009	2	24	17	24		0.12	[0.03-0.45]	13.6%	7.4%
Alcantara 2011	2	15	7	13		0.25	[0.06-0.99]	6.0%	7.2%
Cui 2011	1	29	2	20		0.34	[0.03-3.55]	1.9%	3.2%
van Hooft 2011	25	47	23	51		1.18	[0.79-1.77]	17.6%	19.0%
Pirlet 2011	15	30	17	30		0.88	[0.55-1.42]	13.6%	18.0%
Ho 2012	7	20	11	19		0.60	[0.30-1.23]	9.0%	14.4%
Ghazal 2013	4	30	15	30		0.27	[0.10-0.71]	12.0%	10.9%
Arezzo 2016	29	56	34	59		0.90	[0.64-1.26]	26.4%	20.0%
Fixed effect model		251		246		0.69	[0.56-0.85]	100%	--
Random effects model						0.59	[0.38-0.93]	--	100%
Heterogeneity: I-squared=69.6%, tau-squared=0.2348, P= .0017									

Figure 4. Forest plot for the overall morbidity rate within 60 days.

Mortality was reported in 5 studies. The overall mortality rate was 9.6% in the SBTS group and 9.9% in the ES group. As no heterogeneity was observed, the fixed-effects model was used, which showed an overall RR of 0.98 (95% CI, 0.53-1.82; $P = .955$). In the cumulative meta-analysis, RR notably ranged from 0.29 to 1.14; in the influence meta-analysis, no study added heterogeneity, with the RR ranging only from 0.86 to 1.20.

Morbidity was reported in 8 studies. The overall morbidity rate was 33.9% in the SBTS group and 51.2% in the ES group. Because of consistent heterogeneity ($I^2 = 69.6\%$), the random-effects model was used, which showed an overall RR of 0.59 (95% CI, 0.38-0.93; $P = .023$); a notable publication bias was detected ($P = .009$). In the cumulative meta-analysis, RR increased progressively over time from 0.12 to 0.59 (the van Hooft et al[18] trial introduced heterogeneity); in the influence meta-analysis, the RR varied from 0.49 (after omitting either the van Hooft et al[18] trial [$P = .009$] or the Arezzo et al[21] trial [$P = .02$]) to 0.73 (after omitting the Cheung et al[15] trial [$P = .09$]).

Secondary outcomes

The temporary <u>stoma</u> rate was reported in 7 studies; the rate was 33.9% in the SBTS group and 51.4% in the ES group, with an overall RR of 0.67 (95% CI, 0.54-0.83; $P < .001$; $I^2 = 14.1\%$), and no clear evidence of publication bias ($P = .101$) (<u>Fig. 5</u>). In the cumulative meta-analysis, the RR increased over time starting from 0.53, but it was quite constant in the influence meta-analysis.

Study	SBTS Events	Total	ES Events	Total		RR	95% CI	W(fixed)	W(random)
Cheung 2009	8	24	15	24		0.53	[0.28-1.02]	13.6%	12.3%
Alcantara 2011	1	15	4	13		0.22	[0.03-1.70]	3.9%	1.4%
Cui 2011	11	29	7	20		1.08	[0.51-2.31]	7.5%	9.2%
van Hooft 2011	29	47	39	51		0.81	[0.61-1.06]	33.8%	43.4%
Pirlet 2011	13	30	17	30		0.76	[0.46-1.28]	15.4%	17.9%
Ho 2012	2	20	6	19		0.32	[0.07-1.38]	5.6%	2.6%
Arezzo 2016	11	56	23	59		0.50	[0.27-0.94]	20.3%	13.2%
Fixed effect model		221		216		0.67	[0.54-0.83]	100%	--
Random effects model						0.70	[0.55-0.90]	--	100%

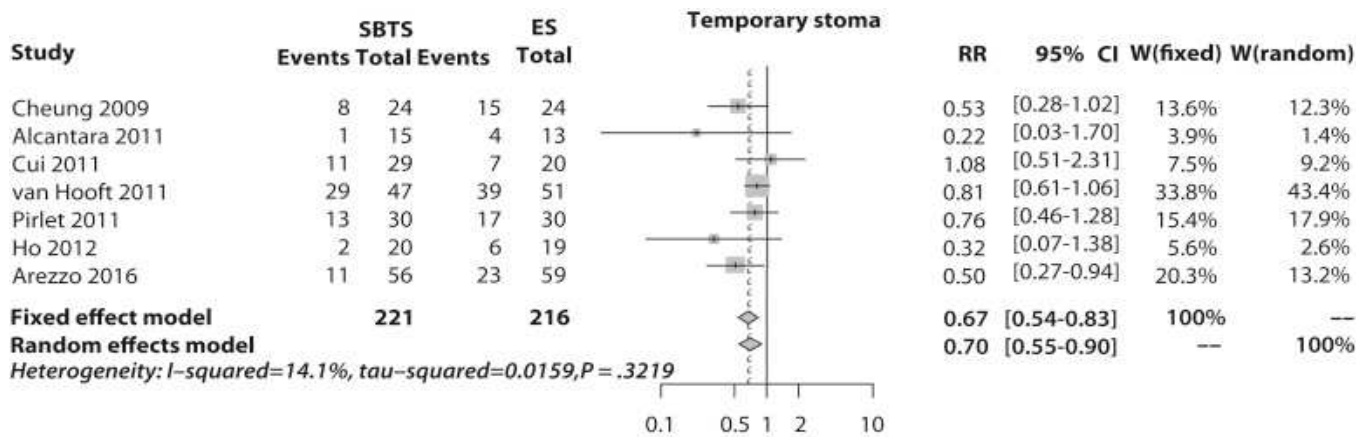Heterogeneity: I-squared=14.1%, tau-squared=0.0159, P = .3219

Figure 5. <u>Forest plot</u> for the temporary <u>stoma</u> rate.

The permanent stoma rate was reported in 8 studies; the rate was 22.2% in the SBTS group and 35.2% in the ES group, with an overall RR of 0.66 (95% CI, 0.50-0.87; $P = .003$; $I^2 = 43.0\%$) and a notable publication bias ($P = .040$) (<u>Fig. 6</u>). In the cumulative meta-analysis, the RR showed 2 different patterns (RR, ~0.15 up to 2011; RR around the final value after 2011) but it was almost constant in the influence meta-analysis.

Study	SBTS Events	Total	ES Events	Total		PR	95% CI	W(fixed)	W(random)
Cheung 2009	0	24	6	24		0.08	[0.00-1.29]	8.5%	3.1%
Alcantara 2011	1	15	4	13		0.22	[0.03-1.70]	5.6%	5.4%
Cui 2011	2	29	7	20		0.20	[0.05-0.85]	10.9%	9.4%
van Hooft 2011	27	47	34	51		0.86	[0.63-1.18]	42.7%	35.4%
Pirlet 2011	9	30	8	30		1.12	[0.50-2.52]	10.5%	20.3%
Ho 2012	1	20	2	19		0.48	[0.05-4.82]	2.7%	4.4%
Arezzo 2016	9	56	15	59		0.63	[0.30-1.33]	19.1%	22.0%
Fixed effect model		221		216		0.66	[0.50-0.87]	100%	--
Random effects model						0.62	[0.37-1.04]	--	100%

Heterogeneity: I-squared=43%, tau-squared=0.1678, P = .1043
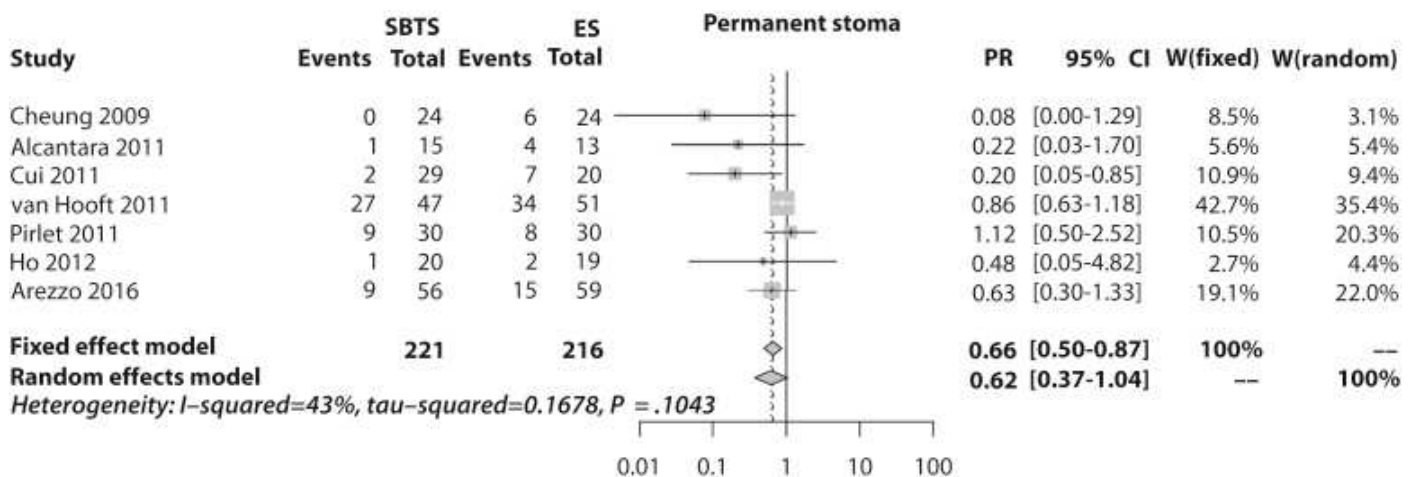
Figure 6. <u>Forest plot</u> for the permanent <u>stoma</u> rate.

The primary <u>anastomosis</u> success rate was reported in 8 studies; the rate was 70.0% in the SBTS group and 54.1% in the ES group, with an overall RR of 1.29 (95% CI, 1.01-1.66; $P = .043$; $I^2 = 90.3\%$) and an extreme publication bias ($P = .001$) (<u>Fig. 7</u>). In the cumulative meta-analysis, the RR decreased progressively over time from 1.82 to 1.29, and it was stable over time in the influence meta-analysis.
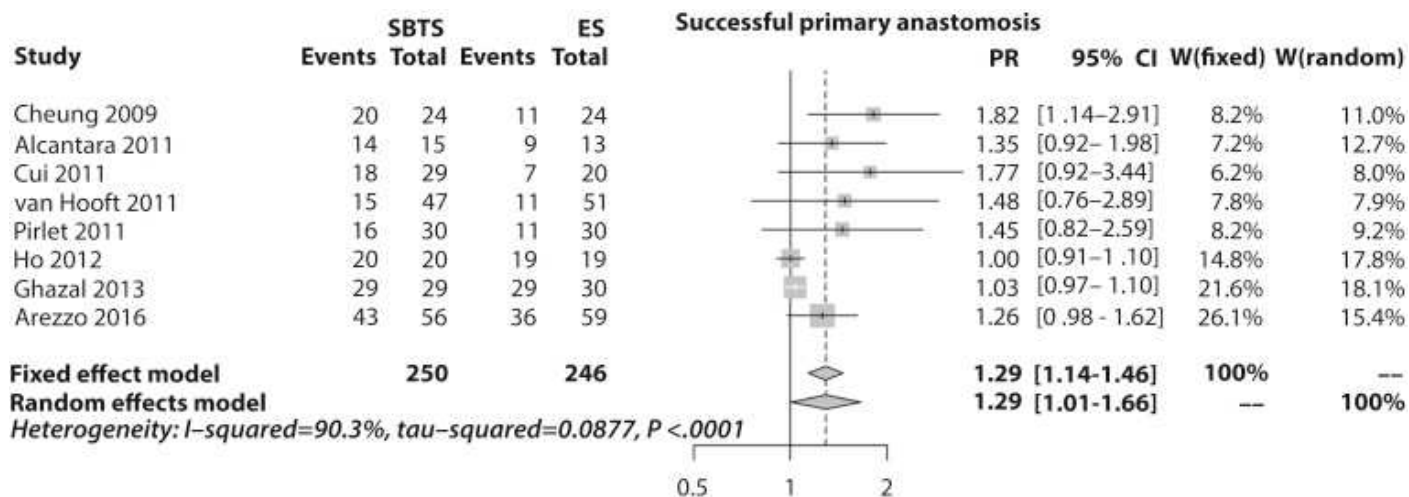
Figure 7. Forest plot for the primary anastomosis success rate.

The surgery for adverse events rate was reported in 6 studies; the rate was 10.9% in the SBTS group and 8.7% in the ES group, with an overall RR of 1.23 (95% CI, 0.68-2.24; $P = .487$; $I^2 = 8.7\%$), and no publication bias ($P = .643$). In both the cumulative and the influence meta-analyses, the RR was constant only after 2011.

The operative time was reported in 5 studies; the mean duration was 146 min in the SBTS group and 172 minutes in the ES group, with an overall MD of -20 minutes (95% CI, -38 to -1; $P = .039$; $I^2 = 54.7\%$), and no publication bias ($P = .531$). In the cumulative meta-analysis, the MD decreased from -40 minutes (up to 2011) to -20 minutes (from 2012 to the present), and it was constant in the influence analysis (range, -15 to -27 min).

The hospital length of stay was reported in 4 studies; the mean duration was 15.5 days in the SBTS group and 14.5 days in the ES group, with an overall MD of $+0.5$ days (95% CI, -4.4 to 5.3; $P = .039$; $I^2 = 54.7\%$), and no publication bias ($P = .241$). In the cumulative meta-analysis, the MD progressively decreased from -6.9 to 0.5 days and it was quite unstable in the influence analysis (range, -4.4 to 5.3 days).

The tumor recurrence rate was reported in 4 studies, with a median follow-up period ranging from 18 to 65 months; the rate was 40.5% in the SBTS group and 26.6% in the ES group, with an overall RR of 1.80 (95% CI, 0.91-3.54; $P = .09$; $I^2 = 61.1\%$); publication bias could not be estimated because of the low number of available trials (Fig. 8). In the cumulative meta-analysis, the RR decreased progressively over time from 3.67 to 1.80 in the influence meta-analysis; all trials except for Arezzo et al[21] increased heterogeneity, and RR varied from 1.48 to 2.31.
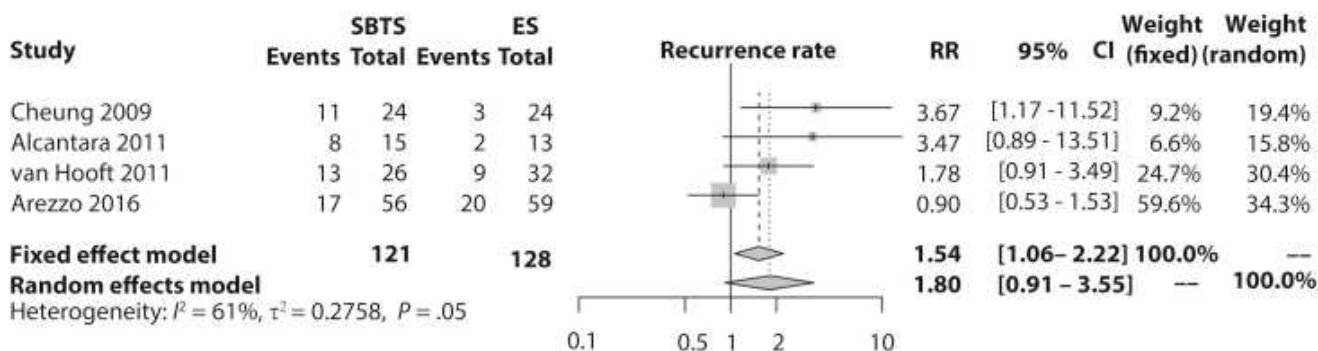
Figure 8. Forest plot for the tumour recurrence rate.

Data on overall survival and progression-free survival, as well as quality of life and cost analysis, were insufficient for inferential analysis.

Discussion

Twenty years after the first description of the technique, the debate remains open on the role of SEMS placement as a bridge to elective surgery for symptomatic left-sided malignant colonic obstruction. Conflicting results from different series and comparative studies are fueling the controversy. Ideally, a meta-analysis of only RCTs would avoid the major limitation of meta-analyzing data potentially confounded by a systematic difference in patient characteristics between the 2 treatment groups. For this reason, we intentionally excluded data originating from case-control and cohort studies. Our decision is supported by a recent meta-analysis that showed a 20% difference in the reported technical and clinical success rates of stent positioning between RCTs and prospective cohort studies.[22]

Since 1994, 8 RCTs[14-21] comparing SBTS and ES for symptomatic left-sided malignant colonic obstruction have been published and included only 497 cases. Nevertheless, statistical analysis showed an acceptable level of evidence, as confirmed by risk of bias analysis and heterogeneity tests. The sensitivity analyses showed that no study had an influential effect on RR.

The fundamental hypotheses driving the growing interest in SEMS placement are that it can convert ES into elective surgery, thus reducing preoperative morbidity. Furthermore, restoring bowel function was thought to reduce the need for creating a stoma, which is often definitive rather than temporary and significantly burdens quality of life. However, while trying to investigate the superiority of the SBTS strategy over ES, 3 of the 8 RCTs were stopped prematurely,[17-19] and, curiously, this happened for contrasting reasons.

The primary outcome in the van Hooft et al[18] study was mean global health status, as assessed with the QL2 subscale of the European Organization for Research and Treatment of Cancer quality-of-life questionnaire, during a 6-month follow-up. The trial was stopped when an interim analysis showed an increase in absolute risk of 30-day morbidity in the SEMS group, mainly because of a high perforation rate (13%) combined with a high leak rate of primary anastomosis in the SBTS group. It was later admitted that this might have resulted from limited operator experience in deploying stents at some of the study centers, which explains in part why the guidewire could not be passed across the lesion in up to 17% of cases. In the study by Pirlet et al,[17] the primary outcome was the decreased need for a stoma in the SBTS group compared with the ES group. No significant difference in the stoma rate was noted because of the low technical success rate of stent insertion (47%), again stemming from the inability to pass the guidewire across the lesion, and again probably because of limited endoscopic expertise. In contrast, Alcántara et al[19] had to close their study prematurely because of the high morbidity rate in the ES group, primarily because of the high incidence of anastomotic leakage. Notably, all patients in the ES group had undergone intraoperative colonic lavage before hemicolectomy and anastomosis.

Despite these conflicting results, our meta-analysis confirms that the rate of overall adverse events within 60 days after surgery is significantly reduced in patients undergoing SBTS. This finding is in line with the results of Mabardy et al[23] analyzing the Nationwide Inpatient Sample database and Huang et al[24] analyzing data of RCT studies only. On the other hand, SBTS does not confer an advantage in terms of short-term mortality, as previously shown by Ferrada et al.[25] The safe use of stents had already been shown by Atukorale et al[26] in a recent systematic review, although this

included patients treated both with SBTS and palliative strategies, with only 3.4% risk of perforation and 0.5% risk of major bleeding. In addition, in our analysis, the risk of a temporary or permanent stoma was found to be significantly lower in the SBTS group. Although the main focus of studies involving patients with cancer is the oncologic outcome after treatment, there is a considerable risk of the need for colostomy after ES. Minimizing this risk may ensure that the quality of life of such patients is not impaired. Unfortunately, we were unable to directly measure quality of life because of lack of data. Nevertheless, our findings based uniquely on a meta-analysis of RCT data, suggest that SBTS does offer some advantages with less risk than ES in the short term.

A major concern has been raised regarding oncologic outcomes after SBTS following increased reporting of disease spread, particularly of liver metastases. Sabbagh et al[9] showed that overall survival was significantly lower in the SBTS group (25% vs 62%, $P = .0003$) and when only patients with no perforation and no metastasis on diagnosis were considered. The studies by Alcántara et al,[19] Tung et al,[27] and Arezzo et al[21] did not confirm these data, however; the meta-analysis by Matsuda et al[28] also showed no significant difference between SBTS and ES in terms of overall survival, disease-free survival, and recurrence. Sloothaak et al,[29] in their analysis of the long-term results of the Stent-in-2 trial, reported that stent placement was associated with a higher risk of recurrence but that the numbers were too small to draw a definitive conclusion. On subgroup analysis, a higher recurrence rate was observed among patients who had experienced a perforation during SEMS positioning. Since its publication, the study has been criticized because it was biased by varied operator experience levels at the participating centers, which would explain the high rate of perforations compared with previously published data. As a result, surgeons in the Netherlands must demonstrate sufficient expertise in colonic stenting before they can perform these procedures. To minimize the risk of inadvertent perforation, many studies have recommended that stenting should be performed only in units where experienced endoscopists are available.[6,30-32] As we did not have access to the individual participant data or the hazard ratios of the single studies, we were unable to compare the global overall survival and the global progression-free survival curves of the series included in this study. Nevertheless, we analyzed data regarding recurrence rate between the 2 groups, which shows a clear tendency to favor ES compared with SBTS (26% vs 40%), although it is not statistically significant. Further long-term oncologic data are awaited to clarify the oncologic outcome.

Unfortunately, we were unable to collect sufficient specific data for quality-of-life and cost analyses. What can be said is that although SBTS is associated with a lower rate of temporary and permanent stomas, in-hospital length of stay after SBTS is prolonged until normal bowel function is restored. This is true, and especially so in hospitals that do not have an early discharge program after stenting. In this context, a future area of focus would be to optimize and standardize protocols for post-stent care during in-hospital stay and for proper bowel preparation.

Our meta-analysis has several limitations mainly as a result of the heterogeneity of the studies included. First, ES encompasses a variety of different procedures (intraoperative colonic lavage, subtotal colectomy, or temporary bowel stoma with or without primary anastomosis) that were not differentiated in most studies; however, our results were unchanged when the analysis was limited to the studies that defined overall adverse events as the primary endpoint. Second, although we included studies with the best methodological quality, ie, RCTs, because the surgeons were not blinded to the allocation group, this may have influenced their perioperative management of the patients. Nevertheless, our meta-analysis showed that the prevalence of overall adverse events was consistent with, if not higher than, that reported in the current literature. This, in turn, argues against a selection bias and supports the applicability of our results to the general population of patients with symptomatic left-sided malignant colonic obstruction. Furthermore, the sensitivity analysis

and the absence of publication bias enhance the reliability of our results. Finally, we did not have access to individual data. Using summary data precluded an analysis of overall and progression-free survival curves, so that an exact determination of the oncologic results was not possible. It is also likely that local expertise in stent placement plays a role in the success rate of the SBTS technique, but we did not investigate the role of expertise on the outcomes among the different studies. Taken singularly, the data reported in some of the RCTs suggest that the results in the 2 groups are comparable. Further studies are needed to answer this question.

Conclusions

A lower short-term overall morbidity and a lower rate of temporary and permanent stoma, with its possible positive effects on quality of life, suggest that depending on local expertise, SBTS has some benefits compared with ES for left-sided malignant colonic obstruction in the short term. The analysis of the data regarding tumour recurrence rate raises concerns about the oncologic safety of stenting. Until more long-term oncologic data become available, SBTS cannot be established as preferred or as the standard of care.

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