Chapter 13
Management of Patients with Acute Large Bowel Obstruction from Colon Cancer

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Introduction

Although colorectal cancer remains the third most common malignancy worldwide [1], it is highly treatable in its early stages. Unfortunately, 10–29 % of patients with colorectal cancer will present with a large bowel obstruction [2–5]. This poses a challenging clinical dilemma for patients and physicians alike.

Bowel obstruction is highly morbid condition. Intervention to relieve the obstruction is appropriate for the large majority of patients. Patients with newly diagnosed colorectal cancer will benefit from relief of the obstruction, allowing time to adequately evaluate comorbidities and complete tumor staging. Modern systemic chemotherapy may afford patients with metastatic disease up to 2 years survival [6]. Therefore palliative procedures to relieve obstruction are an important component of the management of obstructed colorectal cancer patients, even in the setting of stage IV disease.

Surgery has traditionally been the primary treatment of malignant large bowel obstruction. More recently, endoscopic stenting has become a viable alternative and has grown in popularity. Endoscopic insertion of a self-expanding metallic stent (SEMS) to relieve the obstruction was first described as a palliative procedure, but was quickly adopted as a bridge to surgery. An endoscopic palliative procedure is an attractive option if it relieves the obstruction, with a low morbidity and requirement for stoma. Similarly, stents as a bridge to surgery allow for conversion of an emergency operation to a safer, elective, one-stage operation (Table 13.1).

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Table 13.1 PICO table

P (patients)	I (intervention)	C (comparator)	O (outcomes)
Patients with obstructing colorectal cancer	Surgery	Self expanding metallic stents	Technical success, morbidity, bridging to surgery, oncologic outcomes, survival

Methods: Search Strategy

This review is based on the results of a search of the English language literature published in databases including PubMed, Ovid, Google Scholar, and the Cochrane Library. Publications were included from inception through December 2015. Search terms included "stent," "stenting," "colon," "rectum," "colorectal cancer," "obstruction," "prospective," "palliation," "randomized," and "review." Relevant completed and ongoing trials cited on www.clinicaltrials.gov were also reviewed. Emphasis was placed on publications since 2010, so as to provide the most relevant practices and up to date information. Systematic reviews, randomized trials, and prospective comparative trials were reviewed in detail, and summarized in the Results Table. Level of evidence and strength of recommendation according to the GRADE system were assigned to each [7]. Case series and technical reports were reviewed and referenced as needed.

Results

Emergency surgery has long been the standard treatment for obstructing colorectal cancers, despite the high risk of mortality and complication rates approaching 50 % [4, 8–16]. Long-term survival for patients undergoing emergency operations for malignant obstruction is inferior to those undergoing elective operations [17, 18] This is likely due to a combination of both patient specific factors related to the emergency nature of the operation, as well as more advanced stage tumors tending to present with obstruction [12, 19–21].

Even in the setting of advanced pathology, medically suitable patients may benefit from resection of the primary tumor. In addition to relieving the obstruction, palliative resection appears to convey a survival benefit in patients with metastatic disease [21–24]. The absolute survival advantage is modest, but may be important to a patient with a limited life expectancy.

After resection, a decision must be made between primary anastomosis and creation of an intestinal stoma. A large number of patients treated with a "temporary" stoma will never undergo stoma closure. Further, primary reconstruction avoids the hidden costs of a stoma to the patient, such as appliances, new clothing, and loss of work [25].

Surgeons must honestly counsel patients and families that in the setting of cancer, especially metastatic, that there is a 20–50 % likelihood of the stoma being permanent [26–29]. For this reason, surgeons should construct every stoma with the same attention to detail as if it were a permanent stoma. Emergent colostomies are well known to carry a high rate of stoma specific complications [30].

Self-Expanding Metal Stents (SEMS)

Endoscopically deployed self-expanding metal stents can be used to restore intestinal continuity in patients with obstructing colon tumors. First introduced as a palliative treatment for unresectable malignancies in the early 1990s, [31] the practice rapidly evolved into a bridge towards one stage curative resections. The purported benefits include transformation from an emergent to an elective operation with reduced morbidity, mortality, length of stay, cost, rate of stoma formation, and increased minimally invasive techniques and survival [32–34].

Multiple case reports and institutional series have demonstrated the safety and efficacy of self-expanding metal stents to treat obstructing colorectal tumors. The large majority of treated tumors are left sided or rectal tumors. These tend to obstruct more often than right sided tumors, which are more commonly treated with right colectomy. Rectal tumors can be stented, however stents placed into the distal rectum are at risk of causing pain, tenesmus, or prolapsing through the anus. Most endoscopists can achieve a very high degree of technical success, on the order of 90–95 % [35, 36]. Success is dependent upon tumor size and location, but also the skill and experience of the endoscopist. Some authors have suggested a learning curve of 20–30 procedures [37–39]. Common procedural complications include perforation, migration, and late occlusion due to tumor in growth or stool impaction. A recent review of over 4000 procedures documented a perforation rate of 7.4 % [35]. Covered stents are more resistant to tumor in growth and late obstruction, while uncovered stents carry a lower rate of migration.

Stenting has grown in popularity as it provides a less invasive treatment for obstruction. Biagi et al. [40] demonstrated that the time to initiation of adjuvant chemotherapy effects survival, and stents have at least the theoretical benefit of enabling a far more expeditious initiation of treatment. Two general strategies have developed from the early experience: stenting as definitive palliation, and stenting as a bridge to surgery [41]. The minimally invasive nature of stenting makes it an attractive option for either goal, but this must be balanced by the effectiveness, morbidity, mortality, cost, rate of stomas, etc. A large number of publications have addressed these issues. The largest numbers of these are single center experiences and retrospective reviews. There are few high quality prospective or comparative trials. For this reason, systematic reviews and meta-analyses are useful approaches to evaluation of the relative value of stenting versus surgery.

Stenting as Palliation

The data supporting the safety and effectiveness of stenting to relieve obstruction is plentiful, however this is mostly low quality data in the form of small case series and retrospective reviews. Few authors have directly compared palliative stenting to surgical resection. There are no randomized controlled trials to support colectomy for right sided cancers, but this remains the widely accepted standard of care. Stenting of right sided lesions is technically feasible, [42–45] and may be considered for palliation. This review will primarily consider data regarding stenting of left sided lesions. There have been several recently published systematic reviews specifically examining stenting compared to surgery in the palliative setting.

In 2011, Lee et al. [46] reported the long term outcomes of palliative stenting in patients with incurable obstructing cancers by conducting a retrospective review of 71 patients treated with stents and 73 patients treated with palliative surgery during 2000–2008. Stenting was as successful as surgery in relieving the obstruction (96 vs 100 %; $p = 0.12$). Fewer early complications occurred in patients treated with stents (16 vs 33 %; $p = 0.015$), which included a 5.6 % perforation rate with stenting. Primary patency of the stents was shorter than surgery, but patency after a second endoscopic intervention was comparable to surgery (patency 229 vs 268 days; $p = 0.239$). There were more late complications in the stenting group, but there were similar rates of major complications ($p = .07$). The number of patients requiring stomas was reduced in the stent group (18 vs 51 %; $p < 0.001$). The time to chemotherapy was significantly reduced in the stented patients (16 vs 31 days; $p < 0.001$). Overall survival was similar between groups. The authors concluded that stenting is an effective therapy for initial palliation, reduces time to chemotherapy and stoma requirements, with comparable longer term efficacy.

Young et al. [47] recently published an Australian randomized controlled trial of stenting vs surgical decompression in patients specifically diagnosed with malignant, incurable colon obstruction. The primary outcome measure was change in quality of life. 52 patients (26 each arm) were enrolled. Stenting was technically successful in 73 % of patients, with a 79 % rate of clinical success, and zero perforations. The quality of life scores (QLQ-CR29) were reduced in both groups, however there was less reduction in quality of life scores in the stent group from baseline to 12 months ($p = 0.01$). Mortality and median survival were similar (5.2 vs 5.5 months). The rate of stomas in the stent group was drastically reduced (27 vs 92 %). The stented patients also enjoyed a shorter length of stay and return of bowel function. The rate of patients proceeding to chemotherapy was the same in both groups (42 %). The morbidity was similar between groups (38 vs 54 %).

Due to the relative lack of high quality prospective or comparative data, multiple authors have written systematic reviews and performed meta-analyses combining multiple small cohort studies. In 2012, Zhang et al. [48] performed a meta-analysis including eight trials evaluating stenting vs surgery for palliative treatment of incurable disease. Outcomes of 601 patients (232 stent, 369 surgery) were detailed. There were fewer stomas created in the patients undergoing stenting compared to surgery (34 vs 51 %; $p = 0.04$). Mortality (6 vs 5 %; $p = 0.47$) and permanent stoma rate (17 vs 26 %; $p = 0.52$) were similar between groups. Complications were lower in the stent group (21 vs 50 %; $p = 0.001$). There were no significant differences in recurrence or survival (57 vs 56 %; $p = 0.39$).

Zhao et al. [49] published a meta-analysis in 2013 which reviewed 13 trials, including 3 randomized controlled trials (RCTs) comparing palliative stenting to surgery. These trials included 837 patients with 404 stented and 433 undergoing surgery. The 30-day mortality favored stenting (4.2 vs 10.5 %; $p = 0.01$). Early complications also favored stenting (14 vs 34 %; $p = 0.03$-stent perforation rate was 10.1 %). However, late complications were lower with surgery (32 vs 13 %; $p < 0.0001$). Clinical relief of obstruction was similar (93 vs 99.8 %; =0.0009). The post procedure length of stay (LOS) favored stenting (9.6 vs 18.8 days; $p < 0.00001$). The requirement for stoma significantly was reduced by stenting (13 vs 54 %; p<0.00001). The time to postoperative chemotherapy also was improved by stenting compared to surgery (15.5 vs 33.4 days). Survival time was similar (7.6 vs 7.9 months; p>0.05). The authors concluded that stenting provided similar survival in the palliative setting, with reduced 30-day mortality, LOS, need for stomas, and time to chemotherapy.

In 2014, Liang et al. [50] published a similar systematic review and meta-analysis, but included 9 studies (3 RCT) including 410 total patients (195 stented, 215 surgery). The technical success of stenting was 94 %, with clinical success at 94 %. The stent related perforation rate was 3.7 %. The mortality (7.1 vs 11.6 %; p=0.22) and short term complications were similar (26 vs 35 %; p=0.22). Stenting again demonstrated a higher long rate of complications (OR 2.34; p=0.03).

Takahashi et al. [51] recently reviewed the available data from controlled trials of stenting vs surgery as palliation for unresectable cancers. This review included 10 studies, with 793 patients (stenting 375, surgery 418). Similar outcomes to the previous reviews were noted for mortality (2.1 vs 8.6 %; p<0.01) and stoma creation (11 vs 41 %; p<0.01). Stenting did improve early complications (12.3 vs 29.7 %; p<0.01), and longer term survival. Stenting complications included perforations (7.4 %), migration (8.4 %), and obstruction (13 %). Stenting caused a higher rate of total late complications (24 vs 14 %; p=0.03).

Stenting as a Bridge to Surgery

Early reports [52] of stenting as a bridge to surgery offered patients an opportunity for a safe one stage operation, with a significantly lower rate of colostomy formation. Multiple European centers began to adopt and refine this treatment strategy. In 2011, Jimenez-Perez et al. [53] detailed the experience of 182 patients prospectively enrolled into two large European multinational registries. Procedural success was achieved in a remarkable 98 % of patients. Clinical success with resolution of obstructive symptoms was realized in 94 % of patients. Perforation occurred in 1.7 % of patients, and overall stent complications were observed in 7.8 % Elective surgery was performed in 90 % of patients at a median of 14 days later. A stoma was required at the time of surgery in only 6 % of surgical patients. This experience detailed the successful application of the bridge to surgery strategy, with a high degree of technical success, and a low rate of stoma formation. It did not however describe oncologic results or long term outcomes of these patients.

Meisner et al., [54] also in 2011, similarly documented the short term safety and efficacy of stenting as a bridge to surgery. They examined 447 patients enrolled prospectively in 2 registries at 39 hospitals. In this cohort, the technical success of stenting was 95 %, with clinical success (relief of obstruction) in 91 %. Perforations occurred in 3.9 %. Successful procedures led to elective surgery in 90 % of patients at a mean of 16 days after stenting. Stomas were created in only 6 % of these patients. Thirty day mortality was 9 %, primarily due to perforation and cancer-related death. This growing experience continued to suggest that stenting as a bridge to surgery was reasonably safe in patients with obstructing colon tumors.

The first prospective randomized controlled trial comparing stenting as a bridge to surgery vs immediate surgery was published in 2011 by Pirlet et al. [55]. The primary outcome measure was the need for a stoma for any reason. This trial was performed at nine centers. Only 30 patients were enrolled in each group. Surprisingly, 43 % of the stented patients required a stoma compared to 57 % of the immediate surgery patients ($p=0.30$). Both groups had similar morbidity, mortality, and length of stay. A bridging stent did not reduce the need for stoma, however the technical success of stenting in this trial was only 47 % (perforation rate was 6.7 %), considerably lower than most other prospective groups. In fact, of the patients that underwent a technically and clinically successful stenting, none required a stoma at the time of surgery. Therefore, this trial can be interpreted to suggest that if endoscopic stenting is successful, then the need for stoma is eliminated. But the rate of perforation was much higher and the rate of successful stenting was much lower than in other contemporary studies, suggesting a lower level of experience and expertise or possibly patient selection bias.

Despite early concern for perforations, the Dutch continued to examine stenting as a bridge to surgery. A cooperative trial at 25 hospitals randomizing 98 patients to stenting (47) or surgery (51) was reported in 2011 [56]. Enrollment in this trial was suspended due to increased morbidity in the stenting group at interim analysis. Stoma rates at latest follow up were similar (69 vs 60 %), although the initial stoma rate was lower in the stent group (51 vs 75 %). The initial trend of increased morbidity in stoma patients was not confirmed in 98 patients with long-term follow up.

In 2013, Kavanagh et al. [57] published described the short and medium term results of a retrospective review of patients who underwent either stenting as a bridge to surgery or immediate surgery between 2005 and 2011. The final analysis included 22 patients in the bridging group and 26 in the emergent surgery group. Initial stoma rates were similar (48 vs 42 %; $p=0.23$). The permanent stoma rates were also similar. There were no early mortalities and early morbidity was similar (59 vs 65 %). Stenting was successful in 91 % of attempts with a 5 % perforation rate. The rate of patients starting chemotherapy within 8 weeks was similar in each group (22 vs 15 %; $p=0.13$). The cancer specific survival and overall survival were also similar between groups. The authors concluded that stenting is an effective bridge to surgery, resulting in a similar stoma rate, primary anastomosis rate, morbidity, and mortality.

In 2013, Ghazal et al. [58] published a prospective randomized trial comparing stenting as a bridge to surgery compared to immediate total abdominal colectomy with ileorectal anastomosis. Sixty patients were randomized. The rate of technical success for the stent group was 97 %, and was followed by elective resection 7–10 days later. Morbidity was reduced in the stent group (13 vs 50 %; $p=0.012$). Anastomotic leak was 3.3 % in the subtotal colectomy group. There were no mortalities. The subtotal colectomy patients experienced more frequent bowel movements postoperatively. Cancer recurrence was similar between groups (17 vs 13 %; $p=0.228$). In this study, the authors concluded that stenting as a bridge to segmental resection was safer, with fewer bowel movements postoperatively.

Gianotti et al. [28] published their results from 134 prospectively evaluated patients with malignant obstruction. They were treated with either stenting as a bridge to surgery ($n=49$), stents as palliation ($n=34$), or with immediate surgery ($n=51$). Here the technical success of stenting was again quite high at 95 % with a clinical success in

98 % of patients. Perforation rate was a remarkably low 1 %. Complications were significantly reduced in stented patients compared to surgical patients (33 vs 61 %; $p=0.005$), as was length of stay (10 vs 15 days; $p=0.001$). Mortality was 2 % in both groups. The rate of stoma formation was significantly reduced in the stented patients (6 vs 22 %; $p=0.01$). Interestingly, the stented patients had improved overall survival.

Although prospective, randomized comparative data on stenting remains sparse, additional studies with larger cohorts have recently been published. In 2015, Saito et al from Japan described a prospective cohort of 518 patients stented from 2012 to 2013 [59]. Stenting as a bridge to surgery was performed in 312 of these patients. The technical and clinical success rates were 98 and 92 %. Perforation identified during stenting was 1.6 %, and an additional 1.3 % perforations were identified at the time of surgery, yielding an overall perforation rate of 3.8 %. Surgery was electively performed in 297 (95 %) patients, with a median time to surgery of 16 days. The primary anastomosis rate was 92 %, and the overall stoma rate was 10 %. Mortality was 0.7 %, and postoperative morbidity was 16 % (including a 4 % anastomotic leak rate). This is the largest multicenter prospective cohort of patients managed with stenting as a bridge to elective surgery. The vast majority of patients were successfully stented and subsequently underwent a one stage operation with low morbidity.

Because there are relatively few prospective trials evaluating stenting as a bridge to surgery, multiple authors have performed systematic reviews in the last 5 years in an effort to draw meaningful conclusions from pooled data. In 2011, Sagar et al. [60] provided a Cochrane review with a meta-analysis including 5 RCT trials with 207 patients. The primary objective was to evaluate the clinical success rate of stents compared to emergency surgery. Surgery offered a higher rate of relief of obstruction, but stenting offered a shorter length of stay. There were similar rates of complications. However, the included trials had several different definitions of return of GI function and resolution of obstruction.

In 2012, Tan et al. [61] performed a meta-analysis of 4 RCT which included a total of 234 patients. Summarized technical and clinical success rates for stenting were 71 and 69 %, with a perforation rate of 6.9 %. Stenting as a bridge to surgery resulted in a significantly higher rate of primary anastomoses (RR 1.58, 95 %CI 1.22–2.04; $p<0.001$), and lower overall stoma rate (RR 0.71; $p=0.004$). There were no differences in the rates of permanent stomas, mortality, anastomotic leak, or surgical site infection. It should be noted that 3 of the included trials were terminated early due to complications (2 in their stenting group, and 1 in their surgery group).

Cirocchi [62] published a meta-analysis in 2013 of 3 RCTs specifically comparing stenting as a bridge to surgery vs immediate surgery for left colon and rectal cancers. The clinical success rates were 53 % for stenting vs 99 % for surgery. Mortality was similar between groups (8 vs 9 %). Overall complications were similar (48 vs 51 %), but the stented patients had a somewhat lower rate of stoma formation (45 vs 62 %).

In 2014, Huang [63] performed a systematic review of 7 RCTs which included 382 patients (stenting 195, surgery 187). The technical success of stenting was 77 %. There were no differences in mortality (11 vs 12 %), but the stented patients experienced fewer complications (33 vs 54 %; $p=0.03$). Also, there was a higher rate of primary anastomoses (67 vs 55 %; $p<0.01$) and lower permanent stoma rates with stenting as a bridge to surgery (9 vs 27 %; $p<0.01$).

Most recently, in 2015 Matsuda described the effect of stenting on long term oncologic outcomes in a systematic review, [64] which included 11 studies. These were a combination of prospective, retrospective, and RCTs with a total of 1136 patients (432 stents as bridge to surgery, and 704 emergency surgeries). Overall survival, disease free survival, and recurrence rates were similar between groups. Five year overall survival was available in eight reports, with generally similar results between groups (57 vs 67 %, P = 0.66), however the data was heterogeneous. Five year disease free survival reported in 5 trials was also not significantly different between groups (48 vs 59 %; p = 0.43). Eight trials reported recurrence rates, with no significant differences. The authors concluded that stenting as a bridge to surgery was oncologically comparable to emergency surgery with respect to overall survival, disease free survival, and recurrence.

This issue of oncologic safety has been specifically addressed by several authors who focused on defining the oncologic risks of stenting as bridge to surgery compared to immediate resection. It is possible that a delay in surgery, procedure related perforation, or occult perforation may lead to increased tumor recurrence. A 2015 Danish study [65] sought to clarify if self-expanding metal stents used specifically as a bridge to surgery were safe and useful by examining a population-based database with procedures performed from 2005 to 2010. Patients that survived 30 days postoperatively were analyzed (581 stent, 3333 resection). Five-year survival was improved in the stented patients (49 vs 40 %; adjusted mortality ratio 0.98, 95 %CI 0.90–1.07), however the 5-year recurrence was greater (39 vs 30 %; adjusted incidence rate ratio 1.12, 95 % CI 0.99–1.28). The authors concluded that stenting and emergent resection have similar 5-year survival, but stenting may cause increased recurrence. Other authors have suggested that there may be an increased rate of tumor spillage from stent perforations, and that there may be a higher rate of metastatic disease or shorter survival if a perforation occurs [66–68].

Conclusions

Review of this literature seems to indicate that although it may be possible that stent perforation can increase recurrence or metastatic disease, it is much clearer that stenting as a bridge to surgery significantly reduces perioperative complications. A reduction in complications, in turn, has been correlated with improved survival in a recent analysis of more than 12,000 patients [69]. Therefore, patients with a high risk of perioperative complications may be best suited for stenting as a bridge [70, 71]. To be efficacious and maintain a reasonable level of safety, institutional rates of successful stent placement should be 90 % or better, and the rates of stent-related perforation should be 5–7 % or lower.

It is unlikely that a large scale RCT comparing stenting as a bridge to surgery will be conducted due the requirement of a very large sample size, difficulty with technical standardizations, and need for long-term cancer follow up. It would also be very difficult to standardize the surgical arm of such a trial – segmental resection vs Hartmann's procedure vs total colectomy, stoma, etc. Therefore, meta-analyses, as imperfect as they are, may be the best source of data and recommendations.

The American Society of Colon and Rectal Surgeons (ASCRS) 2013 Practice Parameters for the Management of Rectal Cancer [72] addresses the issue of stenting. The authors reiterate that stenting should not be considered in the setting of perforation, massive bleeding, or lack of technical expertise. Technical success may be achievable, but is at risk for failure due to migration, pain, and incontinence when placed in the rectum. The authors do conclude that a stent may function as a bridge to surgery, and facilitate a primary anastomosis, or as a component of palliative treatment in the setting of metastatic disease. Surgeons were cautioned about the limited duration of patency of stents in light of the improving survival of patients on modern palliative chemotherapy. The recommendation was graded as a strong recommendation in favor of stenting based on low quality evidence.

Currently, trials of stenting versus surgery are being conducted at Nanfang Hospital in southern China, and at the Chinese University of Hong Kong (www.clinicaltrials.gov). In addition, other trials in progress are comparing devices such as covered versus uncovered stents.

The Approach to the Patient with Obstructing Colon Cancer

When a patient with an obstructing colorectal cancer presents, the first decision that must addressed is the goals of care. Some patients may prefer to seek hospice care with comfort measures only, especially in the setting of metastatic disease. If the patient elects to pursue treatment, then the next decision is how to acutely manage the obstruction. The primary options are stenting or surgery. Most right-sided colon lesions are treated with right colectomy. These patients should undergo a brief period of resuscitation and optimization, followed by right colectomy with either primary anastomosis, ileostomy and mucous fistula, or anastomosis with proximal loop ileostomy, depending on the condition of the patient and the colon.

For left-sided colon lesions, endoscopic stenting is an attractive option. If the endoscopist has experience with stenting and there are no compelling reasons to proceed immediately to the operating room, such as perforation, then stenting should be considered. If successful, a thorough metastatic workup and medical optimization can proceed. If the patient has incurable disease, the stent may serve as definitive palliation. Patency can be expected for many months and may be repeated if needed. Occasionally, resection may be performed subsequently if the metastatic disease is stabilized and the primary tumor is symptomatic. If the patient appears to have potentially curable disease, stenting is also a good initial approach. Stenting as a bridge to surgery does appear to reduce the need for a stoma and reduces the rate of postoperative complications. Although not all stents are technically successful and there is a 5–7 % rate of perforation, stenting has the distinct advantage of conversion of an emergency operation into an elective operation with the ability to stage and stabilize the patient. Patients and their families should clearly understand that stenting is not universally successful, that there are complications, and that, if unsuccessful, immediate surgery would be necessary, as would have been offered otherwise.

Published data of stenting compared to surgery (2010–2015)

Publication	Design	Patients	Technical success of stenting	Stenting results		Surgery results		Quality of evidence (GRADE)
Palliative stenting – prospective trials								
Young (2015) [47]	RCT	26 Stent 26 Surgery	73 %	Mortality	8 %	Mortality	15 %	High
				Morbidity	28 %	Morbidity	54 %	
				Perforation	0	Perforation	0	
				LOS	7 days	LOS	11 days	
				Stoma	27 %	Stoma	92 %	
				Postop chemotx	42 %	Postop chemotx	42 %	
				Survival	5.2 months	Survival	5.5 months	
Palliative stenting – systemic reviews								
Takahashi (2015) [51]	Meta-analysis	10 trials 375 stent 418 surgery	95 %	Mortality	2 %	Mortality	9 %	High
				Morbidity	12 %	Morbidity	30 %	
				Perforation	7 %	Stoma	41 %	
				Stoma	11 %	Late complications	14 %	
				Late complications	24 %			
				Survival	improved			
Liang (2014) [50]	Meta-analysis	9 trials 195 stent 215 surgery	94 %	Mortality	7 %	Mortality	12 %	High
				Morbidity	26 %	Morbidity	35 %	
				Perforation	3.7 %			
Zhao (2013) [49]	Meta-analysis	13 trials 404 stent 433 Surgery	93 %	Mortality	4 %	Mortality	11 %	High
				Morbidity	14 %	Morbidity	34 %	
				Perforation	10 %	Perforation	–	
				LOS	10 days	LOS	19 days	
				Stoma	13 %	Stoma	54 %	
				Time to Chemotx	16d	Time to Chemotx	33 d	
				Survival	7.6 months	Survival	7.9 months	

Stenting as a bridge to surgery – prospective trials								
Saito (2015) [59]	Prospective cohort	312 stent	98 %	Mortality	0.7 %			Moderate
				Morbidity	16 %			
				Perforation	3.8 %			
				Initial stoma	8 %			
				Final stoma	10 %			
				Bridged to surgery	95 %			
Erichsen (2015) [65]	Prospective cohort	581 stent 3333 surgery		5-year survival	49 %	5-year survival	40 %	Moderate
				Recurrence	39 %	Recurrence	30 %	
Ghazal (2013) [58]	RCT	30 stent bridge to segmental colectomy 30 subtotal colectomy with ileorectal	97 %	Mortality	0	Mortality	0	Moderate
				Morbidity	1 %	Morbidity	50 %	
				LOS	13 days	LOS	8 days	
				Recurrence	17 %	Recurrence	13 %	
						More frequent bowel movements		
Gianotti (2013) [27]	Prospective cohort	49 stent as bridge; 34 stent as palliation 51 surgery	95 %	Mortality	2 %	Mortality	2 %	Moderate
				Morbidity	33 %	Morbidity	61 %	
				Perforation	1 %	LOS	15 days	
				LOS	10 days	Stoma	22 %	
				Stoma	6 %	5 year survival	55 %	
				5 year survival	80 %			
Gorissen (2013) [73]	Prospective cohort	62 stent 43 surgery	90 %	Morbidity	8 %	Morbidly	21 %	Moderate
				Mortality	3 %	Mortality	9 %	
				Stoma	23 %	Stoma	37 %	
				5-year survival	71 %	5-year survival	56 %	
				Chemo	42 %	Chemo	26 %	

(continued)

Published data of stenting compared to surgery (2010–2015)

Publication	Design	Patients	Technical success of stenting	Stenting results		Surgery results		Quality of evidence (GRADE)
Alcantara (2011) [74]	RCT	15 stent 13 surgery	100 %	Morbidity	13 %	Mortality	8 %	Moderate
				Mortality	0	Morbidity	54 %	
				Perforation	0	Anastomotic leak	31 %	
				Stoma	7 %	Stoma	0	
				5-year survival	57 %	5-year survival	69 %	
				LOS	13 days	LOS	10 days	
Pirlet (2011) [55]	RCT	30 stent 30 surgery	47 %	Mortality	9 %	Mortality	4 %	High
				Morbidity	49 %	Morbidity	53 %	
				Perforation	7 %	Stoma	57 %	
				Stoma	43 % (0 % in patients successfully bridged with stent)			
Van Hooft (2011) [56]	RCT	47 stent 51 surgery	70 %	Mortality	11 %	Mortality	10 %	Moderate
				Morbidity	53 %	Morbidity	45 %	
				Perforation	13 %	Initial stoma	75 %	
				Initial stoma	51 %	Final stoma	60 %	
				Final stoma	69 %			
				Bridge to surgery	94 %			
Ho (2012) [75]	RCT	20 stent 19 surgery	75 %	Morbidity	35	Morbidity	58	Moderate
				Mortality	0	Mortality	16	
				Perforation	0	Stoma	32 %	
				Stoma	10 %	LOS	13	
				LOS	14			

Stenting as a bridge to surgery – systematic reviews								
Matsuda (2015) [64]	Meta-analysis	11 trials 432 stent 704 surgery		5 year survival	57 %	5 year survival	67 %	Moderate
				Recurrence	31 %	Recurrence	27 %	
Huang (2014) [63]	Meta-analysis	195 stent 187 surgery	77 %	Mortality	11 %s	Mortality	12 %	High
				Morbidity	33 %	Morbidity	54 %	
				Permanent stoma	9 %	Permanent stoma	27 %	
Cennamo (2013) [76]	Meta-analysis	178 stent 175 surgery	74 %	Mortality	8.4 %	Mortality	8 %	High
				Morbidity	36 %	Morbidity	46 %	
				Perforations	8 %	Stoma	48 %	
				Stoma	25 %			
Tung (2013) [77]	RCT	24 stent 24 surgery	83 %	Mortality	0	Morality	0	Moderate
				Morbidity	8 %	Morbidity	33 %	
				Stoma	0	Stoma	25 %	
				5 years survival	48 %	5 years survival	27 %	
				Chemotx	75 %	Chemotx	54 %	
Cirocchi (2013) [62]	Meta-analysis	3 trials 97 stent 100 surgery		Mortality	8.2 %	Mortality	9 %	Moderate
				Complications	48 %	Complications	51 %	
				Stoma	45 %	Stoma	62 %	
				Clinical success	53 %	Clinical success	99 %	
Zhang (2012) [48]	Meta-analysis	8 trials 232 stent 369 surgery	87 %	Mortalitys	6 %	Mortality	5 %	Moderate
				Morbidity	21 %	Morbidity	50 %	
				Primary anastomosis	78 %	Primary anastomosis	43 %	
				Stoma	34 %	Stoma	51 %	
				Permanent stoma	17 %	Permanent stoma	26 %	
				5 year survival	57 %	5 year survival	56 %	

(continued)

Published data of stenting compared to surgery (2010–2015)

Publication	Design	Patients	Technical success of stenting	Stenting results		Surgery results		Quality of evidence (GRADE)
Tan (2012) [61]	Meta-analysis	4 trials 116 Stent 118 Surgery	71 %	Mortality	7 %	Mortality	6 %	Moderate
				Perforation	6.9 %	Primary anastomosis	44 %	
				Primary anastomosis	66 %	Stoma	64 %	
				Stoma	44 %	Permanent stoma	44 %	
				Permanent stoma	32 %			
Sagar (2011) [60]	Cochrane/ Meta-analysis	5 RCT 102 stent 105 surgery	86 %	Mortality	2.3 %	Mortality	2.3 %	High
				Morbidity	39 %	Morbidity	46 %	
				Perforation	5.9 %	LOS	17 days	
				LOS	11.5 days	Relief of obstruction	99 %	
				Relief of obstruction	78 %			

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