REVIEW

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CLINICAL ENDOSCOPY

Colon stenting as a bridge to surgery in obstructive colorectal cancer management

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Colonic stent placement is a commonly used bridging strategy for surgery in patients with obstructive colorectal cancer. The procedure involves the placement of a self-expandable metallic stent (SEMS) across the obstructive lesion to restore intestinal patency and alleviate the symptoms of obstruction. By allowing patients to receive surgery in a planned and staged manner with time for preoperative optimization and bowel preparation, stent placement may reduce the need for emergency surgery, which is associated with higher complication rates and poorer outcomes. This review focuses on the role of colon stenting as a bridge to surgery in the management of obstructive colorectal cancer. SEMS as a bridge to surgery for left-sided colon cancer has been demonstrated to be particularly useful; however, further research is needed for its application in cases of right-sided colon cancer. Colon stent placement also has limitations and potential complications including stent migration, re-obstruction, and perforation. However, the timing of curative surgery after SEMS placement remains inconclusive. Considering the literature to date, performing surgery at an interval of approximately 2 weeks is considered appropriate. Therefore, colonic stent placement may be an effective strategy as a bridge to surgery in patients with obstructive colorectal cancer.

Keywords: Colonic neoplasms; Colorectal surgery; Intestinal obstruction; Self-expandable metallic stents

INTRODUCTION

Colorectal cancer is one of the most common malignancies worldwide, and its prevalence is gradually increasing.[1,2] Large bowel obstruction caused by colorectal cancer occurs in 7% to 29% of patients with this cancer.[3-5] Conventionally, patients with obstructive colorectal cancer are treated with emergency surgery, which is associated with high morbidity and mortality rates of 40% to 50% and 15% to 20%, respectively.[6-8] Moreover, many patients who have undergone emergency surgery are left with a permanent colostomy,[9,10] resulting in a markedly lower health-related quality of life than those without a colostomy.[11,12] These patients experience worse outcomes because of higher morbidity and mortality rates than those who receive surgery electively.[13-15]

Colon stenting is a minimally invasive procedure that involves the insertion of a self-expandable metallic stent (SEMS) into the colon to relieve obstruction caused by a malignant tumor. Since the introduction of metallic stents in 1991 by Dohmoto,[16] SEMSs have been widely applied as a palliative treatment for malignant colorectal obstruction in patients with incurable diseases.[17] Colon stenting can be used as an alternative to emergency surgery in patients with colonic obstruction caused by malignant tumors. SEMS insertion relieves obstruction and allows the resumption of normal bowel function.

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During this time, the stent serves as a "bridge" to allow the patient to recover from the acute symptoms of the obstruction and prepare for elective surgery for curative intent. Tejero et al.[18] first reported SEMS as a bridge to surgery (BTS) for malignant colorectal obstruction in 1994. Since then, several studies have demonstrated stent placement before elective surgery as a safe alternative to conventional emergent surgical management of malignant obstruction of the colon.[10,19] Preoperative SEMS placement can prevent high-risk emergency surgery, increase primary anastomosis, and decrease stoma formation.[20] Additionally, SEMS use allows physicians to perform medical resuscitation, bowel preparation, optimization of comorbidities, and stage workup for colon cancer.[19,21] This review describes the role of colon stenting as a BTS strategy in the management of obstructive colorectal cancer.

CURRENT MANAGEMENT OF MALIGNANT LEFT-SIDED COLONIC OBSTRUCTION

Clinical guidelines

Several clinical guidelines have addressed the issue of selecting between SEMS and emergency surgery in the management of left-sided malignant colonic obstruction.[22-25] Recent guidelines have expanded the role of SEMS as a BTS in the curative treatment of left malignant colonic obstruction. In 2014, the European Society of Gastrointestinal Endoscopy (ESGE) guidelines regarding SEMS placement for malignant obstructions did not recommend colonic SEMS placement as a bridge to elective surgery for the standard treatment of symptomatic left-sided malignant colonic obstruction.[26] This recommendation was strong and supported by high-quality evidence. SEMS use was only considered an alternative to emergency surgery in patients who were at high risk for postoperative morbidity and mortality. However, the ESGE guidelines from 2014 were updated in 2020.[22] The new guidelines now support SEMS use as a valid alternative to emergency resection for managing symptomatic left-sided malignant colonic obstructions. The guidelines emphasize the importance of a shared decision-making process with patients, considering technical factors, as well as short- and long-term outcomes. Stenting is not recommended as a prophylactic procedure for an anticipated obstruction.

The guidelines of the American Society of Colon and Rectal Surgeons (ASCRS) for 2022 state that the choice between SEMS use and emergency resection should be individualized based on patient factors and the local expertise of the institution, thus aligning with the ESGE 2020 guidelines.[23] The guidelines also recommend that a diverting colostomy may be an alternative to stenting. The European Society for Medical Oncology 2020 guidelines[24] state that colonic stenting can be used as a bridge to elective surgery, particularly in expert centers, for patients likely to have higher rates of postoperative complications after emergency surgery, such as those aged >70 years and/or those with an American Society of Anesthesiologists classification >II. According to the National Comprehensive Cancer Network 2021 guidelines,[25] one-stage colectomy with *en bloc* removal of the regional lymph nodes, resection with diversion, and diversion or stenting followed by colectomy are all possible options for managing resectable colon cancer with obstruction. Stents are generally considered in cases of distal cancer where a stent can facilitate decompression of the proximal colon, allowing for elective colectomy with a primary anastomosis at a later stage. Table 1 summarizes the guidelines for each type of colorectal stenting used as a BTS.

Comparison of outcomes between SEMS use vs. emergency surgery

In a recent meta-analysis that compared SEMS use and emergency surgery, 27 relevant studies with approximately 4,000 patients were included.[27] Only randomized controlled trials (RCTs) or high-quality non-randomized comparative studies were considered to ensure reliability and robustness. The meta-analysis indicated that SEMS use resulted in improved surgical and short-term survival outcomes compared with emergency surgery. These included a higher primary anastomosis rate, lower overall complication rate, increased lymph node harvest, shorter intensive care unit and hospital stays, and reduced 30-day mortality rates. However, the long-term oncological outcomes, presented as 3- and 5-year disease-free and overall survival rates afforded by SEMS use and emergency surgery, were similar.

In recent RCTs, the multicenter Enteral Stents for Colonic Obstruction (ESCO) trial conducted in Europe has demonstrated no statistically significant differences in overall survival, time to progression, and disease-free survival between stenting as a BTS and emergency surgery.[28] These findings were based on a median follow-up period of 37 months in the ESCO trial. An RCT conducted in the United Kingdom, the ColoRectal Endoscopic Stenting Trial, also demonstrated similar results between stenting and emergency surgery in terms of the 30-day postoperative mortality rate and duration of hospital stay. Furthermore, the stenting group in the RCT had significantly lower

Table 1. Summary of the latest guidelines for each situation in colorectal stenting as a BTS

Situation	Recommendations from various guidelines
Management of left-sided colonic obstruction	SEMS use as a valid alternative to emergency resection for managing symptomatic left-sided malignant colonic obstruction, emphasize the importance of a shared decision-making process with patients, considering technical factors as well as short- and long-term outcomes (ESGE 2020)
	Stenting is not recommended as a prophylactic procedure for anticipated obstructions (ESGE 2020)
	Choice between SEMS use and emergency resection should be individualized based on patient factors and the local expertise of the institution (ASCRS 2022)
	Colonic stenting can be used as a bridge to elective surgery, particularly in expert centers, for patients likely to have higher rates of postoperative complications after emergency surgery, such as those who aged >70 years and/or with an American Society of Anesthesiologists classification of >II (ESMO 2020)
	One-stage colectomy with *en bloc* removal of regional lymph nodes, resection with diversion, and diversion or stenting followed by colectomy are all possible options for the management of resectable colon cancer with obstruction (NCCN 2021)
Management of right-sided colonic obstruction	SEMS use can be considered a BTS even in the treatment of malignant right-sided colonic obstruction (ESGE 2020)
	Both the initial colectomy and initial endoscopic stent decompression with subsequent interval colectomy could be considered treatment options for patients with obstructing right or transverse colon cancer and curable disease (ASCRS 2022)
Perforation	Emergency resection should be considered in patients with stent-related perforation (ESGE 2020)
Migration	Even if migration occurs, early surgery should be performed without attempting stent re-insertion in the BTS group (ESGE 2020)
Stent re-obstruction	Early surgery rather than repeat colonic stenting when stent obstruction occurs in the BTS group (ESGE 2020)
Optimal timing of surgery after colon stenting	Performing elective surgery with a time interval of approximately 2 weeks after SEMS insertion (EGSE 2020)

BTS, bridge to surgery; SEMS, self-expandable metallic stent; ESGE, European Society of Gastrointestinal Endoscopy; ASCRS, American Society of Colon and Rectal Surgeons; ESMO, European Society for Medical Oncology; NCCN, National Comprehensive Cancer Network.

stoma formation rates than the emergency surgery group.[29]

A major concern associated with SEMS use is the risk of perforation. Perforation can have a marked impact on the oncological outcomes of affected patients, leading to worse outcomes. In an RCT conducted by Sloothaak et al.,[30] SEMS use was associated with a higher 5-year overall recurrence rate than emergency surgery. This finding was attributed to patients with stent perforation who had significantly higher overall recurrence rates than those without stent perforation (83% vs. 34%, $p<0.01$) as well as a higher 5-year cumulative incidence of locoregional recurrence (50% vs. 10%, $p=0.053$). Two RCTs conducted in the Netherlands that compared SEMS use and emergency surgery were stopped prematurely because of the unexpectedly high perforation rate.[31,32]

CURRENT MANAGEMENT OF MALIGNANT RIGHT-SIDED COLONIC OBSTRUCTION

Clinical guidelines

Decompression procedures for proximal colonic obstruction are less common than those for distal obstruction. This can be attributed to several factors. First, the technical success rate for right-sided obstruction has been reported to be slightly lower than that for left-sided obstruction.[33,34] Second, the long distance from the anus and the tortuosity of the bowel make proximal colonic stenting considerably more challenging than distal colonic stenting. Furthermore, more time and experience are required to achieve successful outcomes.[35]

Segmental resection with ileocolic anastomosis is considered a safe surgical approach for managing malignant right-sided colonic obstruction and has been performed in most cases.[36] Hence, most studies evaluating stenting as a BTS have primarily focused on left-sided obstructions. However, a previous population-based study has reported that a bridging strategy involving SEMS use or diverting loop ileostomy was associated with lower mortality rates than primary resection in cases of malignant right-sided colonic obstruction.[37] Subsequently, SEMS use has been increasingly implemented in the management of malignant right-sided colonic obstruction. Recently, guidelines have been established for SEMS use in this context.

The ESGE 2014 guidelines recommend surgical resection as the preferred treatment option for malignant obstruction of the

proximal colon, and stenting is not widely recommended for right-sided obstruction owing to limited evidence.[26] However, in the ESGE 2020 guidelines, the status of SEMS use has been upgraded, and it is specified that SEMS use can be considered a BTS strategy even in the treatment of malignant right-sided colonic obstruction.[22] This indicates that the evidence and recommendations for SEMS use in cases of right-sided obstruction have evolved, and SEMS use is now recognized as a potential treatment option in this context.

The most recent ASCRS 2022 guidelines for the management of colon cancer acknowledge that both initial colectomy and initial endoscopic stent decompression with subsequent interval colectomy could be considered treatment options for patients with obstructing right or transverse colon cancer and curable disease.[23] Evolving guidelines, such as the ESGE 2020 and ASCRS 2022 guidelines, reflect the increasing acceptance and recognition of SEMS use as a BTS in cases of malignant right-sided colon obstruction. These changes are based on accumulating evidence from studies and clinical experience, suggesting that SEMS placement can be a safe and effective approach for managing malignant right-sided colonic obstruction in selected patients. Clinicians need to stay updated on the latest guidelines to inform their clinical decision-making and provide optimal care to patients with this condition.

Comparison of outcomes between SEMS use and emergency surgery

Several retrospective studies have compared SEMS placement with emergency surgery in terms of short-term treatment outcomes and long-term oncological and survival outcomes. A nationwide database study conducted in Japan investigated perioperative outcomes in 1,500 matched patients who underwent emergency right colectomy or SEMS use.[38] The study has reported that SEMS use afforded more favorable perioperative outcomes, including a higher rate of laparoscopic utilization, fewer stomas, and shorter length of hospital stay. A previous systematic review of procedure-related morbidity and mortality has demonstrated that stent placement and elective resection were associated with lower major morbidity and mortality rates as well as fewer anastomotic leakages and permanent ileostomies.[39] Another recent systematic review has also demonstrated that staged treatment by decompression or stenting was associated with lower mortality rates, fewer complications, and fewer anastomotic leaks and stoma creations than emergency resection.[40]

CLINICAL OUTCOMES OF SEMS USE

Technical and clinical success

Technical success was defined as successful stent placement across an obstructed colonic segment. Clinical success refers to the effectiveness of the stent in relieving the symptoms of colonic obstruction and improving bowel function.[41] Technical success rates of 81% to 100% have been reported in observational studies. The clinical success rate for colon stenting has been reported to be 65% to 100%.[41-49] This indicates that in the vast majority of cases, colorectal stents could be placed in the correct position and fully expanded to relieve obstruction. Most patients experience symptom improvement after stent placement, such as relief from abdominal pain and resumption of normal bowel movements. Some studies have reported higher technical and clinical success rates when a stent is inserted by an operator with experience in performing at least 10 colon stent procedures.[50] Meanwhile, a lesion length of >5 cm and the presence of curved lesions are associated with a low clinical success rate.[49]

Complications

The major complications associated with colon stenting include perforation, migration, and re-obstruction. In addition, complications, such as ulceration, hematochezia, infection/fever, and tenesmus, can occur. The overall complication rate associated with SEMS use as a BTS has been reported to be 7% to 23%.[51,52] Complete obstruction, a stent diameter of ≤22 mm, and operator experience are significant factors affecting the complication risk associated with SEMS use as a BTS.[51]

Perforations may also occur during stent insertion or expansion. Stent migration may lead to obstruction or perforation if the stent moves or is dislodged after placement. Bowel re-obstruction may occur due to ingrowth or overgrowth of the tumor into the stent lumen or stool impaction within the stent lumen. The risk of infection, especially bacteremia, may increase with stent insertion, particularly in cases of complete obstruction.[51] However, in one RCT, the use of prophylactic antibiotics was not effective in preventing infections associated with SEMS use.[53]

1) Perforation

Perforation is a potential complication of colonic stent insertion. It occurs when the stent causes a tear or hole in the colonic wall. Perforation can be a serious complication when it results in the

development of peritonitis or sepsis.[52] Stent-related perforation may result from guidewire or catheter malpositioning, stricture dilation, and proximal colonic distension because of inadequate colonic decompression or excessive air insufflation.[52,54,55] Old age, long segment involvement, and angulated strictures have been identified as risk factors for perforation.[49,56,57] A previous prospective study and systematic review have reported perforation rates of 3% to 5%.[19,48,52,58-60] Meanwhile, some studies have reported high perforation rates of 10% to 13%.[31,61] In a meta-analysis of 4,086 patients, an overall perforation rate of 7.4% was reported.[62] "Silent" microperforations, which are perforations that can be detected only by a pathologic examination, were also identified in 1% to 20% of cases.[31,52,61,63] The rates may vary depending on whether the pathologist actively searches for microperforations.[52,64]

Stent-related perforation can lead to poor oncological outcomes. According to a recent meta-analysis on stenting as a BTS,[65] the occurrence of stent-related perforation was associated with an increased risk of local tumor recurrence, whereas no significant difference was observed in terms of systemic recurrence. In terms of survival, several reports have indicated that stent-related perforation is associated with high mortality rates.[48,66,67] However, when considering only the BTS setting, even if perforation occurred, no significant differences were observed in 3- and 5-year overall survival rates between the groups with and without stent-related perforations.[65] The ESGE guidelines recommend considering emergency resection in patients with stent-related perforation.[22]

2) Migration

Several studies have reported an SEMS migration rate of 1% to 20%.[19,44,47,48,63,64,68-72] Migration is another potential complication of colon stent insertion and occurs when the SEMS moves out of its intended position in the colon. In two meta-analyses, the risk of SEMS migration was lower in the uncovered stent group than in the covered stent group.[73,74] The use of stents of inappropriate sizes (e.g., an SEMS that is too small) or incorrect stent placement, such as SEMS placement in a tortuous portion of the colon, are factors that could result in more frequent SEMS migration.[44,64,75] According to the ESGE guidelines, even if stent migration occurs, early surgery without attempting stent re-insertion is recommended in the BTS group.[22] However, no well-designed comparative studies on early surgery and stent re-insertion have been conducted.

3) Stent re-obstruction

Stent re-obstruction is a potential complication of colonic stent insertion and occurs when the stent is blocked or occluded again after successful initial placement. Several studies have reported rates of SEMS re-obstruction of 3% to 18%.[47,76,77] Stent occlusion occurs because of the overgrowth of malignant tissue, fecal impaction, or tumor ingrowth.[47,78] Longer follow-up duration is a risk factor for stent re-obstruction.[47,76,79,80] In cases in which stenting is a BTS, stent re-obstruction is less frequent than that in cases of palliative stenting because the period of stent maintenance is relatively short.[51] Uncovered stents have been reported to be more prone to tumor ingrowth, whereas covered stents were associated with higher risks of stent migration and tumor overgrowth.[81]

Re-obstruction can be managed using stent replacement or stent-in-stent techniques in instances of palliative stenting.[82,83] However, in the BTS group, the surgery was typically performed before the occurrence of re-obstruction due to tumor ingrowth. Therefore, in the context of stenting as a BTS, ensuring proper stent expansion during insertion and preventing migration would be better than being concerned regarding stent ingrowth. The ESGE guidelines recommend early surgery rather than repeat colonic stenting when stent obstruction occurs in the BTS group.[22]

OPTIMAL TIMING OF SURGERY AFTER COLON STENTING

Current guidelines

The optimal timing of surgery after colonic stent insertion remains debatable, and no clear consensus on the ideal interval between stent placement and surgical intervention has been established. Changes were made to the ESGE guidelines. The 2014 ESGE guidelines recommend elective surgery within 5 to 10 days after SEMS insertion.[26] However, the 2020 ESGE guidelines recommend performing elective surgery within a time interval of approximately 2 weeks after SEMS insertion.[22] The time interval for surgery after colonic stenting has been discussed and analyzed depending on the balance between surgery-related adverse events and tumoral systemic and local recurrences owing to delays.

Recent study results

Many studies have been conducted to determine the appropriate timing for surgery after SEMS use. Broholm et al.[84] have

reported that delayed elective surgery (≥18 days) after SEMS insertion could increase the risk of metastasis. Abdussamet Bozkurt et al.[85] suggested that an interval of 7 to 9 days after SEMS insertion is sufficient, because extending this duration could increase the risk of re-obstruction and emergency surgery. Kye et al.[86] conducted a study by dividing the interval between stenting and surgery into three groups: within 7 days, 8 to 14 days, and 15 days later. In this study, disease-free and overall survival was superior in the within 7 days group, whereas the rates of short-term postoperative complications were similar among the three groups.

However, some studies have suggested that slightly delaying the surgery is better. Matsuda et al.[87] have reported that an operation interval of >15 days reduced operation-related complications such as anastomosis site leakage and *Clostridioides difficile*-associated colitis. Another report has stated that the risk of anastomotic leakage significantly reduced when surgery was delayed for ≥10 days.[88] de Roos et al.[89] divided two groups by the interval between SEMS use and surgery: <4 weeks and ≥4 weeks. The later operation group demonstrated better 5-year recurrence-free survival (82.1% vs. 63.2%) and 5-year overall survival (75% vs. 51.4%). Recently, Oh et al.[90] formed three groups based on the interval between SEMS use and operation (group 1 [≤2 weeks], group 2 [2–3 weeks], and group 3 [>3 weeks]). In this study, the bridging interval did not affect SEMS-related complications, resection-related complications, 90-day mortality, permanent stoma formation, 3-year disease-free survival, or 3-year overall survival. Laparoscopic surgery rates were significantly higher in groups 2 and 3 than in group 1 (83.7% and 81.0%, respectively, vs. 53.2%). Furthermore, the rate of stoma formation directly after resection was significantly higher in group 1 than in groups 2 and 3 (21.3% vs. 2.3% and 6.9%, respectively). Because these studies demonstrated conflicting results, further studies are needed to confirm these findings and establish clear guidelines for the optimal timing of surgery after colon stent insertion.

CONCLUSIONS

As a treatment for intestinal obstruction caused by a malignant tumor, colonic stent insertion can be an effective strategy as a BTS in patients with obstructive colorectal cancer. Recently, various studies have reported that preoperative SEMS insertion affords superior treatment results compared to emergency surgery, and its indications are gradually expanding. Therefore, clearly understanding the indications and methods of stent implantation before surgery is necessary to improve patient prognosis and reduce complications.

Conflicts of Interest

The authors have no potential conflicts of interest.

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Author Contributions

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