

Preoperative Colonoscopy for Detection of Synchronous Neoplasms after Insertion of Self-Expandable Metal Stents in Occlusive Colorectal Cancer: Comparison of Covered and Uncovered Stents

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Background/Aims: In patients with occlusive colorectal cancers, a complete preoperative evaluation of the colon proximal to the obstruction is often impossible. We aimed to evaluate the feasibility of preoperative colonoscopy after stent placement and to determine whether the success rate of colonoscopy differs between covered and uncovered stents.

Methods: Seventy-three patients with malignant colorectal obstruction were enrolled prospectively. In patients with a resectable cancer, a preoperative colonoscopy was performed after insertion of a self-expandable metal stent (SEMS). The success rate of complete preoperative colonoscopy was compared between covered and uncovered stents. **Results:** Forty-five of 73 patients who underwent stent placement had a resectable cancer (61.6%). A complete preoperative colonoscopy was possible in 40 of 45 patients (88.9%). The success rate of complete preoperative colonoscopy was significantly lower in the covered-stent group when the obstructing mass lesion was located in the sigmoid colon ($p=0.024$). Synchronous cancer was detected in one patient (2.2%). Stent migration was observed in four patients with a covered stent. **Conclusions:** A preoperative complete colonoscopy after SEMS placement was feasible and safe in most patients with malignant colorectal obstruction. Uncovered stents seem to have more advantages than covered stents in preoperative colonoscopy proximal to the obstruction. (*Gut Liver* 2013;7:311-316)

Key Words: Colorectal neoplasms; Stents; Colonoscopy; Neoplasms, multiple primary

INTRODUCTION

It is important to identify the presence of synchronous colon cancers preoperatively, because their presence could influence decisions about the extent and method of surgical resection.¹ In nonocclusive colon cancers, preoperative complete evaluation using colonoscopy can usually be performed without complications, but it is often impossible in patients with stenosing colorectal cancers. Self-expandable metal stents (SEMSs) are widely used to decompress malignant colorectal obstruction and enable one-stage elective surgery.^{2,3} However, reports on preoperative colonoscopy after SEMS placement are limited. There is a previous study demonstrating that after SEMS placement, colonoscopic navigation to the proximal part of the obstruction is feasible in a majority of patients.⁴ However, the feasibility and safety of preoperative colonoscopy in patients with malignant colorectal obstruction may be affected by the type of stent used and the features of the lesion. Thus, the aims of this study were to evaluate the feasibility and the safety of preoperative evaluation using colonoscopy to detect synchronous neoplastic lesions and to determine whether the type of SEMSs (covered or uncovered) influenced the rates of preoperative complete colonoscopy in patients with malignant colorectal obstruction.

MATERIALS AND METHODS

1. Patients

Seventy-three patients with malignant colorectal obstruction were enrolled consecutively between February 2009 and September 2011. Patients were eligible for the study if the initial diagnostic colonoscopy failed due to occlusive colorectal cancer

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with or without clinical signs and symptoms of obstruction. Exclusion criteria included colonic perforation and clinical situations in which an endoscopic procedure was impossible due to comorbidity or systemic illness. Informed consent for all procedures was obtained from all patients and this study was approved by the Institutional Review Board of Ajou University Hospital.

2. SEMS placement

SEMS placement was required based on clinical and radiologic information, while the type of SEMS, covered or uncovered, was randomly decided by alternate assignment. SEMS placement was performed on patients under conscious sedation with intravenous midazolam and propofol. The SEMS was inserted under endoscopic and fluoroscopic guidance within 24 hours of diagnosis of malignant colorectal obstruction. Colonoscopic examination was performed in the left decubitus position. If the colonoscope (12.2 mm outer diameter, Evis Lucera Colonovideoscope CF-Q260AL/I; Olympus, Tokyo, Japan) reached an area of obstruction, water-soluble contrast medium (Iohexol; GE Healthcare, Buckinghamshire, UK) was injected through a 5 Fr biliary catheter to identify the stenotic lesion and measure the length of the obstruction. The length of the stent was determined to cover the entire lesion and extend at least an additional 1 to 2 cm longer on each side of the obstruction. After the jag guide wire was inserted through the area of obstruction, the delivery system of the stent was advanced to the obstruction through the working channel. A covered or uncovered SEMS was placed under fluoroscopic and endoscopic control (delivery system diameter 10 Fr, 6 to 12 cm long and 22 mm diameter, BONASTENT Colo-Rectal Covered; Sewoon Medical, Cheonan, Korea; and delivery system diameter 10 Fr, 6 to 12 cm long and 24 mm diameter, Niti-S Enteral Colonic Uncovered Stent; Taewoong Medical, Gimpo, Korea). All endoscopic procedures were performed by two expert gastroenterologists (S.G.L. and K.J.L.) with extensive colonoscopy experience ($\geq 2,000$ cases). Plain abdominal radiographs were obtained after the procedure to evaluate placement and expansion of the stent and to check for perforation.

3. Preoperative colonoscopy

Patients who recovered from obstruction after stent insertion underwent staging work-up. Patients who were considered candidates for curative resection underwent a standard bowel preparation with a 4 L polyethylene glycol-electrolyte lavage solution at least 3 days after SEMS insertion because it took at least 48 to 72 hours for SEMS to be fully expanded. On the following day, complete preoperative colonoscopy to cecum using a relatively thin colonoscope (11.3 mm outer diameter, Evis Lucera colonovideoscope PCF-Q260JL/I; Olympus) was performed without fluoroscopic guidance (Fig. 1). The premedications, pethidine, and cimetropium bromide, were injected intrave-



Fig. 1. The abdominal X-ray of a patient with occlusive rectal cancer receiving complete preoperative colonoscopy to the cecum after self-expandable metal stent placement.

nously before the procedure. Intravenous midazolam and/or propofol were administered for standard conscious sedation as needed. Patients in whom preoperative colonoscopy could not be performed completely after SEMS placement underwent an intraoperative colonoscopy to detect synchronous lesions. Any synchronous polyps and/or cancers detected during preoperative colonoscopy were removed or biopsied, and the tissue was evaluated histopathologically.

4. Data assessment

Primary endpoint was the success rate of preoperative complete colonoscopy; the success rates of the covered and uncovered SEMS groups were compared. Secondary endpoints were technical success rate of SEMS placement and complication rates such as bleeding, perforation and stent migration during or after colonoscopy. In addition, the characteristics of synchronous lesions (histopathology, location, and number) were recorded. Technical success was defined as the correct position of the stent across the entire length of the stenosis with an established patency, which was confirmed by endoscopy or fluoroscopy. The quality of bowel preparation was determined by the endoscopists with the following scale: 1, poor (large amounts of stool, unacceptable); 2, fair (moderate amounts of stool); 3, good (small amounts of stool); and 4, excellent (almost no stool). Immediately after colonoscopic examination, we examined the colonoscope for mechanical damage due to passage through the stent.

5. Statistical analysis

Categorical variables were compared with chi-square tests. While continuous variables were expressed as means with standard deviation (SD) and analyzed using Mann-Whitney U test.

A p-value <0.05 was considered statistically significant. Statistical analysis was performed using the SPSS version 13.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

1. Baseline characteristics

Covered and uncovered SEMs were placed in 73 consecutive patients with malignant colorectal obstruction. This study group comprised 42 males and 31 females. The mean age was 64.8 ± 13.4 (mean \pm SD). Twenty-eight patients were diagnosed with an unresectable or metastatic cancer during their preoperative staging work-up; consequently they were excluded from this study. Preoperative colonoscopy after the stent insertion was performed to detect synchronous lesions in the remaining 45 patients. Among those patients, covered and uncovered SEMs were placed in 20 and 25 patients, respectively (Fig. 2A

and B). Demographic data and characteristics of the lesion in these two groups did not differ significantly. The sigmoid colon was the most frequent site of obstruction (28 of 45 patients, 62.2%), followed by the rectum (11 of 45 patients, 24.4%). In the covered SEM group, there were four cases with a history of previous abdominal surgery (one laparoscopic cholecystectomy, one hysterectomy, and two Cesarean sections) and there were two cases in the uncovered SEM group (one laparoscopic cholecystectomy and one small bowel resection) (Table 1).

2. Stent insertion outcomes

The overall technical success rate was 100% (73/73). Major complications, such as perforation and bleeding, did not occur. Although the stent was migrated in four cases of the covered SEM group (one case due to the bowel preparation solution and three cases due to colonoscopy), the migration did not affect the performance of colonoscopy (Fig. 2C).

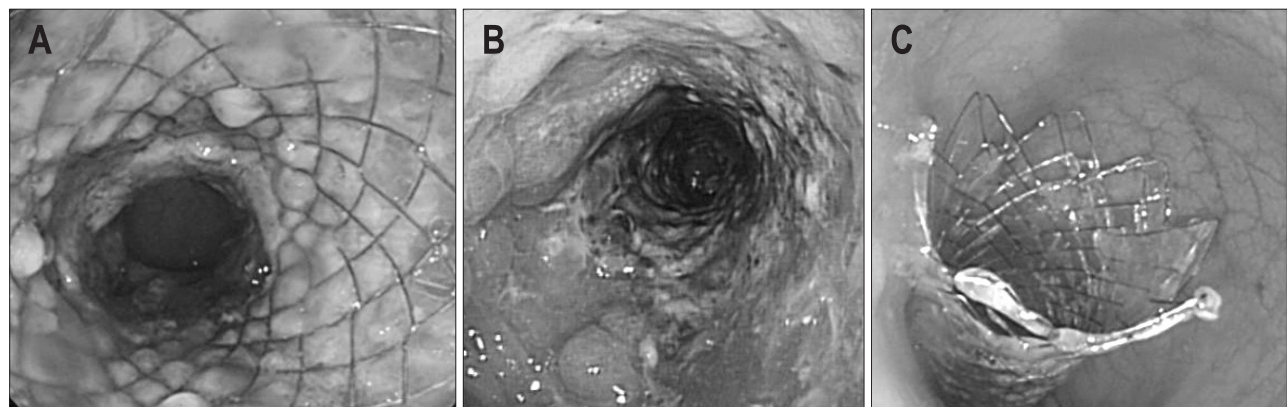


Fig. 2. Endoscopic view after stent placement. (A) Covered stent. (B) Uncovered stent. (C) Migration of the stent during colonoscopy.

Table 1. Clinical Characteristics of Covered and Uncovered SEMS Groups

Characteristic	Covered SEMS group (n=20)	Uncovered SEMS group (n=25)	p-value
Age, yr	63.4 \pm 13.98	63.4 \pm 14.64	0.869
Male	11 (55.0)	15 (60.0)	0.773
BMI, kg/m ²	22.4 \pm 5.86	22.9 \pm 3.19	0.271
Tumor characteristics			
Location			1.000
Rectum	5 (25.0)	6 (24.0)	
Sigmoid colon	12 (60.0)	16 (64.0)	
Descending colon	2 (10.0)	2 (8.0)	
Transverse colon	1 (5.0)	1 (4.0)	
Length of obstruction, cm	4.8 \pm 1.06	4.8 \pm 1.32	0.768
Length of stent, cm	9.5 \pm 1.93	9.0 \pm 2.01	0.443
Previous operation history on abdomen	4 (20.0)	2 (8.0)	0.382

Data are presented as mean \pm SD or number (%). All data were analyzed by Fisher's exact test except age, BMI, length of obstruction, and length of stent, which were analyzed using Mann-Whitney U test. SEMS, self-expandable metal stent; BMI, body mass index.

3. Preoperative colonoscopy following SEMS placement

A complete colonoscopic examination was possible in 40 of the 45 patients (88.9%). Colonoscopy was performed an average of 4.8 days after SEMS placement. The mean time required to reach the cecum and to examine the colon completely in the cases of successful complete colonoscopy was 12.5 and 25.1 minutes, respectively. The mean insertion time was not significantly different between covered and uncovered SEMS groups. The success rate of complete colonoscopy in the uncovered SEMS group was higher than that in the covered SEMS group (96.0% [24 of 25 patients] vs 80.0% [16 of 20 patients]), but this difference was not statistically significant ($p=0.154$). When the analysis of complete colonoscopy was stratified by the location of the lesion, in patients with sigmoid colon cancer, the success rate of complete colonoscopy in the covered SEMS group was significantly lower than that in the uncovered SEMS group (66.7% vs 100%, $p=0.021$) (Table 2).

With respect to the five patients in whom the complete colonoscopic examination failed, the colonoscope reached the hepatic flexure in one case, transverse colon in two cases, and sigmoid colon in two cases. Their sites of obstruction were sigmoid colon (four cases) and rectum (one case). In these patients, an intraoperative colonoscopy was performed, but a synchronous lesion was not found. The colonoscope was not damaged mechanically by the passage through any of the stents. The status of bowel preparation was excellent in eight (17.8%), good in 25 (55.5%), and fair in 12 (26.7%) patients.

Thirty-five synchronous lesions were identified in 20 patients by preoperative colonoscopy. Among these lesions, 34 adenomas were found in 19 patients (42.2%); high grade dysplasia was found in one case; 27 adenomas were proximal to the stent and seven adenomas were distal to the stent. There was one case of intramucosal carcinoma (2.2%) that was removed completely by endoscopic mucosal resection (Table 3). After identifying

the histopathology of the synchronous lesions, all 45 patients underwent surgical resection without a change of their surgical plan.

DISCUSSION

In patients with malignant colorectal obstruction, a SEMS offers several important clinical benefits. Recent studies reported that elective surgical resection after placing SEMS over the ste-

Table 3. Preoperative Colonoscopic Findings: Location and Number of Synchronous Lesions

Tumor location	Synchronous lesions, n/location	
	Adenoma	Cancer
Rectum	2/descending	0
	1/transverse	
	1/ascending	
Sigmoid colon	1/rectum	1/ascending
	5/sigmoid	
	1/SD junction	
	5/descending	
	1/SF	
Descending colon	5/transverse	
	5/ascending	
	1/sigmoid	0
	1/SF	
	2/HF	
Transverse colon	2/HF	
	1/ascending	
	0	0
Sum, no.	34	1

SD, sigmoid-descending; SF, splenic flexure; HF, hepatic flexure.

Table 2. Comparison of Success Rates for Complete Colonoscopy and Complications of Stent Insertion between the Covered SEMS Group and the Uncovered SEMS Group

Characteristic	Covered SEMS group (n=20)	Uncovered SEMS group (n=25)	p-value
Success rates according to tumor location			
Rectum	5/5 (100.0)	5/6 (83.3)	1.000
Sigmoid colon	8/12 (66.7)	16/16 (100.0)	0.023
Descending colon	2/2 (100.0)	2/2 (100.0)	
Transverse colon	1/1 (100.0)	1/1 (100.0)	
In total	16/20 (80.0)	24/25 (96.0)	0.152
Complications			
Perforation	0/20 (0)	0/25 (0)	1.000
Migration	4/20 (20.0)	0/25 (0)	0.037
Bleeding	0/20 (0)	0/25 (0)	1.000

Data are presented as number (%). All data were analyzed by Fisher's exact test. SEMS, self-expandable metal stent.

nosing site was superior to emergency surgery in terms of morbidity, mortality, duration of hospital stay, and the frequency of colostomy.⁵⁻⁸ Colonic decompression using a SEMS allows time for clinical recovery, bowel cleansing, and preoperative staging work-up.^{8,9} Moreover, after staging work-up, SEMS placement at the malignant obstruction can facilitate the detection of synchronous lesions. Recently, two valuable diagnostic modalities for detecting the synchronous lesions were reported: 1) preoperative complete colonoscopy after SEMS placement; and 2) imaging modalities such as computer tomography (CT) colonography, magnetic resonance colonography and integrated positron emission tomography/CT colonography.^{4,10-13}

Preoperative complete colonoscopy has been regarded as the reference standard, particularly in studies evaluating the feasibility of the imaging modalities. In patients with nonocclusive colorectal cancers, preoperative colonoscopy is usually uncomplicated. However, in patients with malignant colorectal obstruction, a preoperative colonoscopy that reaches the cecum is often impossible. In such cases, the colonoscopic examination should be postponed until the malignant stenosis has been resolved after SEMS placement. Vitale *et al.*⁴ demonstrated the feasibility of preoperative complete colonoscopy after decompression of acute malignant obstruction with SEMSs for the first time. However, it was a small scale nonrandomized prospective study. There were no major complications related to SEMS placement or the colonoscopic examination. In most cases, a bowel preparation was adequate to allow a search for synchronous lesions proximal to the obstruction. The present study demonstrated that a preoperative complete colonoscopic examination was possible in a majority of patients (overall success rate was 88.9%) and safe; no major complications, such as massive bleeding and perforation, occurred.

Although the previous study was similar to the present study, there are several important differences. First, we performed all the colonoscopic examinations without fluoroscopic guidance. In the previous study, colonoscopy was performed with fluoroscopic control to detect all the changes of the stent during the passage of the endoscope or any scope impact to the stent. In the present study, preoperative colonoscopy following SEMS placement was successful in 40 of 45 patients. In the five patients in whom complete colonoscopy failed, the second colonoscopy was performed with fluoroscopic guidance. Despite these efforts, a complete preoperative colonoscopy was not possible in any of these five patients. This result raises the question of whether fluoroscopic guidance is necessary during colonoscopy after SEMS placement in such patients. Our findings showed the efficacy of preoperative colonoscopy after SEMS placement without fluoroscopic guidance. Preoperative colonoscopy after SEMS placement without fluoroscopic guidance has the advantage of avoiding exposure to radiation. Second, we evaluated the effect of the covering membrane of SEMS on the completion of colonoscopy. In the present study, the success

rate of complete colonoscopy, in which the colonoscope reached the cecum, was higher in the uncovered SEMS group than that in the covered SEMS group (96% vs 80%). In particular, our results showed that the location of the obstruction influenced on the success rate of complete colonoscopy. The sigmoid segment of colon is freely movable, therefore loops develop easily during colonoscopy. Accordingly, if a resistant force is present in the sigmoid colon, colonoscopy would be very difficult due to excessive loop formation. The finding that the success rate of complete colonoscopy was significantly lower in patients with obstructing sigmoid colon cancer in the covered SEMS group makes it possible to assume that the covering membrane of the stent could be a cause for a failure of complete colonoscopy. We speculate that the frictional force between the colonoscope and the membrane of covered SEMSs may contribute to greater resistance through the obstruction and thereby hinder the removal of a loop at the sigmoid colon.

The other factors to be considered are the diameter of the stent, the diameter of the colonoscope and the dimensions of the tumor mass. The diameter of covered SEMSs was smaller than that of uncovered SEMSs in the present study (22 mm vs 24 mm). However the effect of this difference is probably irrelevant, because the diameter of the colonoscope used in the present study was relatively thin (diameter of a colonoscope, 11.3 mm) and the lumen at the SEMS placement site is sufficiently wide for the passage of a colonoscope. The factors associated with a tumor lesion itself, such as degree of angulation and severity of stenosis, could also affect the execution of a colonoscopy after SEMS placement. Actually, in one patient in the covered SEMS group, the stent was not fully expanded due to severe stenosis, and a colonoscope could not be passed through the stenosing site. In addition, stent migration occurred in four patients of the covered SEMS group before and during preoperative colonoscopy. Although preoperative colonoscopy was successful in all of these patients with stent migration in the present study, it is clear that stent migration can have a bad influence on performance of colonoscopy and be an important cause of failure of complete colonoscopy. Therefore, uncovered SEMSs seem to have more advantages in performing preoperative complete colonoscopy than covered SEMSs.

The effectiveness of the imaging modalities for preoperative colonic evaluation after SEMS placement in occlusive colorectal cancer has been recently reported.¹¹⁻¹³ However, several issues remain to be determined. 1) Accuracy for lesions smaller than 10 mm and flat or depressed lesions is quite low and variable.¹⁴ 2) Test performance and training requirements for accurate interpretation are not sufficiently standardized, so interobserver variation and the inaccuracy of tests could be problematic.^{14,15} 3) The cost-effectiveness is not fully evaluated. Given that colonoscopy is relatively cheap in Korea, colonoscopy should be considered first for detection of synchronous lesions after SEMS placement in occlusive colorectal cancers. Imaging modalities

are recommended for patients in whom complete colonoscopy failed or colonoscopy was refused by patients.

In conclusion, the present study demonstrated that after SEMS placement, preoperative complete colonoscopy was feasible and safe in a majority of patients with malignant colorectal obstruction without fluoroscopic guidance. The success rate of complete colonoscopy, in which the colonoscope reached the cecum, was significantly lower in the covered SEMS group than in the uncovered SEMS group, especially when the malignant lesions were located in the sigmoid colon. In the future, a large scale randomized, prospective study is required to confirm whether the uncovered SEMS placement has more advantages in the performance of preoperative complete colonoscopy in patients with resectable occlusive colorectal cancers than the covered SEMS placement.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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