# Comparison of Laparoscopic versus Open Surgery after Insertion of Self-Expandable Metallic Stents in Acute Malignant Colorectal Obstruction: A Case-Matched Study

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## ABSTRACT

**Background:** Self-expanding metallic stents (SEMS) have been acknowledged in management of acute colorectal obstruction. The surgical approach after SEMS insertion varies from open approach to laparoscopic-assisted approach. The primary objective of this study was to compare the outcomes of laparoscopic approach and open approach after SEMS insertion.
**Methods:** From January 2007 to December 2010, cross-sectional medical records reviewed a total of 76 patients who underwent colorectal stenting with SEMS. Patients and tumor characteristics, complications, morbidity and mortality were obtained.
**Results:** Forty-three patients underwent SEMS placement as a bridge to surgery. Laparoscopic-assisted surgery (LS) was performed in 24 patients (55.8%), and open surgery (OS) was performed in 19 patients (44.2%). All clinicopathological parameters were matched. The technical success of SEMS was found in 42 patients (97.7%), and the clinical stent success was 100%. LS had a higher chance of primary anastomosis than OS (p=0.012; Odd ratio 2.717; 95%CI: 1.79-4.012). LS had a lower permanent ostomy rate (p=0.031; Odd ratio 0.385; 95%CI: 0.259-0.572) and lower estimated blood loss (p=0.024; Odd ratio 0.23; 95%CI: 0.006-0.086). The post-operative complications, mortality rate, recurrence rate, disease free status, and overall survival rates between the two groups were non-significant.
**Conclusion:** Colonic stent is an effective treatment of acute malignant colonic obstruction. The authors suggest the advantage of laparoscopic approach resection after colonic stenting results in a higher primary anastomosis rate, and lower blood loss than open surgery.

**Keywords:** Self-expanding metallic stent (SEMS); malignant colorectal obstruction; laparoscopic; bridge to surgery; primary anastomosis; ostomy (Siriraj Med J 2017;69: 57-64)

## INTRODUCTION

Colorectal cancer is a highly prevalent cancer worldwide. Early screening and cancer detection has offered satisfying outcomes. However, many patients presenting with acute colorectal obstruction require emergency surgical procedures which have higher morbidity and mortality. During the past few decades, since the introduction of using a self-expanding metallic stent (SEMS) to relieve colorectal obstruction since the 1990s[1], colonic stenting has been widely used for relieving malignant colorectal obstruction while avoiding stoma formation in palliative cases, and to assist in bowel decompression and preparation as a bridge-to-surgery in resectable cases. Three recently published systematic reviews and meta-analyses comparing colonic stenting as a bridge to surgery versus emergency surgery[2-4] have favored the colonic stenting in having a higher primary anastomosis rate and lower overall stoma rate with no significant difference in complications or mortality.

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In the recent decade, colonic stenting with SEMS has increased in popularity as a bridge to surgery. The comparisons on the surgical approaches after colonic stentings have rarely been defined. We have collected the various cases of colorectal obstruction that underwent colonic stenting as a bridge to surgery. The patients were matched to compare the results of laparoscopic approach versus open surgical resection. The objective of this study was to compare the feasibility and oncologic outcomes between laparoscopic and open surgery after placement of SEMS for acute malignant colorectal obstruction.

## MATERIALS AND METHODS

### Patients

A total of 76 Thai patients underwent colorectal stenting with SEMS for acute colorectal obstruction from January 2007 to December 2012. The patients' data and medical records were cross-sectionally reviewed from a tertiary medical center, Siriraj Hospital, Mahidol University and approved by the Ethical Committee of Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University. The mean age of the patients was 68 years (range 15-108 years). Palliative stents were placed in 24 patients, which were excluded for the study. Of the 52 patients that underwent a bridge to surgery with the intention of SEMS placement; 9 patients were excluded due to refusal of surgery and unfit for surgery. Finally the remaining 43 patients underwent surgery (Fig 1). The clinicopathological parameters between laparoscopic surgery (LS) group and open surgery (OS) group were matched (Table 1). The colon and rectum cancer staging was according to the NCCN guidelines Version 4.2013. Acute colorectal obstruction was diagnosed by typical clinically signs and symptoms and imaging study such as plain abdominal series, barium enema (BE), or computed tomography (CT). The SEMS technical success was defined as good complete stent deployment at the obstructing lesion. The SEMS clinical success was defined as alleviation of clinical colonic obstruction via flatus or defecation within 72 hours of stent placement. The complications were defined as "early" if they occurred within 7 days after stent deployment, and as "late" if they occurred more than 7 days after stent deployment.

### Operative procedures

*SEMS placement*

An experienced surgeon performed all colonoscopies with SEMS placement at the Siriraj GI Endoscopy Center, Siriraj Hospital, Mahidol University, Bangkok, Thailand. Uncovered self-expandable metallic stents (WallFlex™ Colonic Stent; Boston Scientific, Natick, MA) were mostly used. The endoscopy utilized was a one-channel endoscopy (CF-1T140L, Olympus Co., Japan). SEMS placement was performed using Through-the-Scope technique (TTS) and guidewire was introduced through the lesion followed by contrast injection via sphincterotome catheter to evaluate upper border of the lesion. The technique of SEMS deployment has been described in 4 steps as in a previous publication (Fig 2). A routine post-operative plain abdominal x-ray was obtained within 24 hours after the stent deployment.

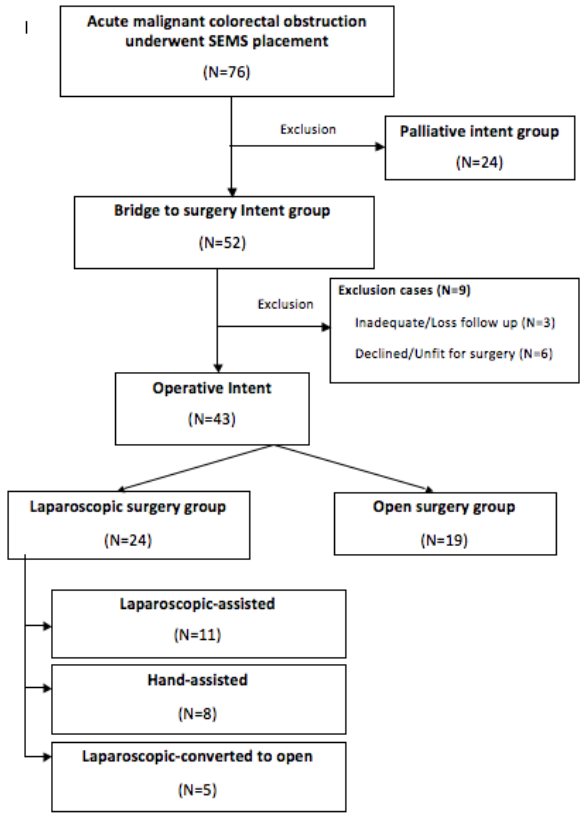



Fig 1. Study design and management of acute malignant colorectal obstruction.

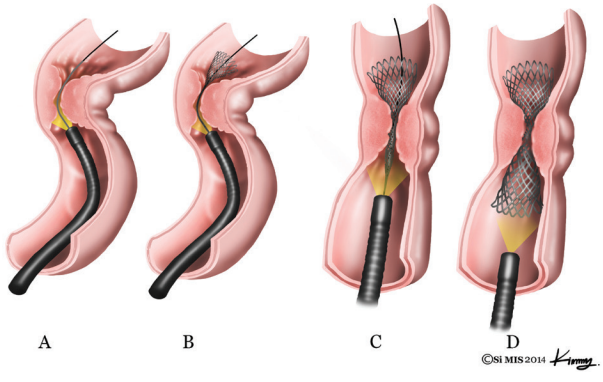



Fig 2. Technique of SEMS placements in acute colorectal obstruction. **A:** Passing stent and guide wire through lesion with contrast injection. **B:** Partial stent deployment. **C:** Pull back stent and scope until fair part of stent reach upper border. **D:** Fully deployment of SEMS.

**Abbreviation:** SEMS = Self-expanding metallic stents

**TABLE 1.** Clinicopathological data of the laparoscopic and open surgery group.

| Factors | Operative approach (Intention to treat) N=43 Frequency (%) | | P value |
|---|---|---|---|
| | Laparoscopic (N=24) | Open (N=19) | |
| Age (years) | Mean 66<br>range 3-90 | Mean 65<br>range 45-68 | 0.893 |
| Sex | | | 0.965 |
| Male | 15 (63.2) | 12 (62.5) | |
| Female | 9 (36.8) | 7 (27.5) | |
| BMI | Mean 21.9<br>range 16-28 | Mean 23<br>range 17-33 | 1.000 |
| ASA classification | | | 0.102 |
| I | 9 (37.5) | 4 (21.1) | |
| II | 15 (62.5) | 12 (63.2) | |
| III | 0 | 3 (15.8) | |
| CCI score | Mean 2.5<br>range 2-5 | Mean 3.1<br>range 2-9 | 0.668 |
| CEA (ng/ml) | Mean 31.9<br>range 0.78-388 | Mean 64.9<br>range 1.13-530 | 0.922 |
| Albumin (ng/ml) | Mean 3.5<br>range 2.7-4.5 | Mean 3.4<br>range 1.6-4.3 | 0.797 |
| Clinical bowel obstruction | | | 0.501 |
| Complete | 18 (75) | 12 (63.1) | |
| Partial | 6 (25) | 7 (36.9) | |
| Tumor location | | | 1.000 |
| Proximal to splenic flexure | 1 (4.2) | 1 (5.3) | |
| Distal to splenic flexure/Rectosigmoid | 21 (87.5) | 17 (89.4) | |
| Rectum | 2 (8.3) | 1 (5.3) | |
| Tumor distance (cm) | Mean 27<br>range 12-118 | Mean 36<br>range 9-70 | 0.171 |
| Stent technical success | 23 (95.8) | 19 (100) | 1.00 |
| Stent clinical success | 23 (100) | 19 (100) | *** |
| Stent early complications | 1 (4.2) | 3 (15.8) | 0.313 |
| Minor perforation | 1 | | |
| Major perforation | | 1 | |
| Obstruction | | 1 | |
| Migration | | 1 | |
| Stent Late complications | 0 | 2 (10.5) | 1.99 |
| Pain/tenesmus | | 1 | |
| Respiratory complication | | 1 | |
| Re-endoscopy | 0 | 2 (10.5) | 0.189 |

| Factors | Operative approach (Intention to treat) N=43 Frequency (%) | | P value |
|---|---|---|---|
| | Laparoscopic (N=24) | Open (N=19) | |
| Stent time to surgery | | | 0.423 |
| <2 weeks | 19 (79.2) | 13 (68.4) | |
| >2 weeks | 5 (20.8) | 6 (31.6) | |
| Overall time to surgery (days) | Mean 13, | range 4-69 | |
| pTumor differentiation | | | 1.000 |
| Well | 1 (4.2) | 1 (5.3) | |
| Moderate | 20 (83.3) | 16 (84.2) | |
| Poor | 3 (12.5) | 2 (10.5) | |
| pTumor staging | | | 0.876 |
| T2 | 3 (12.5) | 2 (10.5) | |
| T3 | 17 (70.8) | 14 (73.7) | |
| T4 | 4 (16.7) | 3 (15.8) | |
| pNode positive | 16 (66.7) | 13 (68.5) | 0.876 |
| Number of positive nodes | Mean 3.31 | Mean 1.8 | 0.653 |
| | range 0-15 | range 0-5 | |
| Number of total nodes | Mean 27.4 | Mean 23.4 | 0.134 |
| | range 10-51 | range 6-41 | |
| LVI positive | 9 (37.5) | 13 (68.5) | 0.080 |
| PNI positive | 11 (45.3) | 12 (63.1) | 0.435 |
| CRM positive | 0 | 0 | |
| Staging | | | 0.653 |
| I | 2 (8.3) | 2 (10.5) | |
| II | 5 (21.7) | 5 (26.3) | |
| III | 13 (53.3) | 11 (57.9) | |
| IV | 4 (16.7) | 1 (5.3) | |

***Not valid due to stent clinical success was a constant factor

*Definite Surgery*

A definite surgery was carried out after SEMS placement as a bridge to surgery intent by the experienced laparoscopic surgeons from the Minimally Invasive Surgery Unit, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University. The timing of surgery depended on the patient's clinical status and the operating theater availability after preoperative evaluation and mechanical bowel preparation were applied. The surgical approach was laparoscopy preferred to open approach if possible. Whether to perform 1-stage, 2-stage, or diverting stoma relied on the intra-operative findings and surgeon's preference.

**Follow-up**

In patients with either technical or clinical failure, an emergency intervention was performed. For the patients who required adjuvant treatment, both oncologist and radiologist were consulted. The follow up investigations were according to the NCCN guidelines Version 4.2013. Medical records were reviewed for post-operative complications up to December 2013.

The primary outcomes were the successful primary anastomosis rate and the overall permanent stoma rate. The secondary outcomes were 30-day mortality, cancer-specific and all-cause mortality, oncologic outcomes, and the long-term survival between the two groups.

### Statistical analysis

Statistical analysis was performed using SPSS statistical software, version 18.0; SPSS, Inc., Chicago, IL, USA. For categorical variables, the Fisher's exact test was applied. Mann-Whitney U test was calculated for each association between continuous variables. Kaplan-Meier curve was used to calculate the survival rate.

## RESULTS

A total of 43 patients after SEMS placement as a bridge to surgery underwent definite surgery. The matched clinicopathological parameters between each group are demonstrated (Table 1). Technical failure was found in one patient. He underwent emergency surgery with laparoscopic anterior resection and primary anastomosis. The clinical stent success was found in all patients (100%). A total of four patients had early complications of SEMS, which were: 1 stent obstruction, 1 minor perforation, 1 major perforation, and 1 stent migration. The patient with minor perforation underwent laparoscopic approach, but was converted to open surgery due to the tumor invasion to the uterus. This patient had low anterior resection with primary anastomosis performed along with hysterectomy. The patient with major perforation preceded to emergency laparotomy and underwent tumor resection with end-colostomy (Hartmann's operation). The patients that had obstruction and stent migration underwent re-endoscopic procedures with additional successful SEMS deployment which was then followed by elective surgery. Two patients had late complications, which were: 1 pain/tenesmus from stent and 1 respiratory complication. The patient who complained of severe pain/tenesmus from the stent had the stent removed and underwent urgent exploratory laparotomy with low-anterior resection and end colostomy. One patient had pulmonary infection after SEMS placement and after the infection subsided, she underwent left hemicolectomy with end-colostomy.

The operative approaches and the complications of the two groups are demonstrated (Table 2). All patients

**TABLE 2.** Operative approaches and complications between the laparoscopic and open surgery group.

| Factors | Operative approach (Intention to treat) N=43 Frequency (%) | | P value |
|---|---|---|---|
| | Laparoscopic (N=24) | Open (N=19) | |
| Operative procedure | | | 0.212 |
| Extended right hemicolectomy | 0 | 1 (5.3) | |
| Left hemicolectomy | 10 (41.7) | 7 (36.8) | |
| Sigmoidectomy | 3 (12.5) | 7 (36.8) | |
| Anterior resection | 5 (20.8) | 3 (15.8) | |
| Low anterior resection | 5 (20.8) | 1 (5.3) | |
| Subtotal colectomy | 1 (4.2) | 0 | |
| Primary anastomosis | 24 (100) | 14 (73.7) | 0.012 |
| Estimated blood loss (ml) | Mean 213.4 range 10-800 | Mean 215.26 range 20-400 | 0.024 |
| Operative time (min) | Mean 220 range 90-42 | Mean 157.6 range 45-270 | 0.432 |
| Post operative complications | 3 (12.5) | 3 (15.8) | 1.00 |
| Anastomosis leakage | 1 | 1 | |
| Wound infection | 0 | 1 | |
| Respiratory/cardiovascular | 2 | 1 | |
| Re-operation | 1 (4.2) | 1 (5.3) | 0.694 |
| Re-admission | 1 (4.2) | 2 (10.5) | 0.575 |
| Permanent ostomy | 0 | 4 (21.1) | 0.031 |
| Adjuvant treatment | 7 (29.2) | 6 (31.5) | 0.370 |
| Length of hospital stay (days) | Mean 5 Range 3-14 | Mean 7 Range 4-20 | 0.468 |

(100%) in LS group had primary anastomosis performed, but only 73.3% in OS group (p=0.012). Five patients underwent open surgery with surgical resection and proximal end colostomy. Only one patient received additional surgery for Hartmann closure, while the remaining 4 had permanent ostomy. There was significantly less blood loss in LS group (p=0.024). Of the total of 43 patients, half of them were disease free (Table 3). The significant comparing factors between the LS and OS groups were the primary anastomosis and estimated blood loss (Table 4).

The patients in LS group had a significantly higher chance of primary anastomosis compared to OS group (OR 2.7; 95%CI 1.79-4.02; p=0.012). The rate of permanent ostomy was lower in LS group (OR 0.39; 95%CI 0.259-0.572; p=0.031). The estimated blood loss was less than open surgery (OR 0.23; 95%CI 0.06-0.86; p=0.024). The 30-day and all cause mortality rate, recurrence rate, and disease free survival were non-significantly different in both groups. The survival rates were found to be comparable in both short-term and long-term survival.

**TABLE 3.** Status, recurrence, and survival rates between the laparoscopic and open surgery group.

| Factors | Operative approach (Intention to treat) N=43 Frequency (percent) | | P value |
|---|---|---|---|
| | Laparoscopic (N=24) | Open (N=19) | |
| Recurrence | | | 0.455 |
| Yes | 6 (25) | 3 (15.8) | |
| No | 13 (54.2) | 10 (52.6) | |
| Never disease free | 5 (20.8) | 6 (31.6) | |
| Recurrence site | | | 0.083 |
| Regional | 0 | 1 | |
| Distant | 6 | 1 | |
| Both | 0 | 1 | |
| Time to recurrence (weeks) | Mean 83 range 7-259 | Mean 107 range 6-323 | 0.737 |
| Status | | | 0.543 |
| Alive disease free | 12 (50) | 7 (36.8) | |
| Alive with disease | 8 (33.3) | 5 (26.3) | |
| Death from disease | 3 (12.5) | 4 (21.1) | |
| Death from other cause | 1 (4.2) | 3 (15.8) | |
| Disease free status | | | 0.468 |
| Disease free | 13 (54.2) | 10 (52.6) | |
| Recurrence/Never disease free | 11 (45.8) | 9 (47.4) | |
| Follow up time (weeks) | Mean 90 range 2-271 | Mean 100 range 4-323 | 0.691 |
| Survival rate (%) | | | 0.279 |
| 1 year survival rate | 95 | 88.5 | |
| 3 years survival rate | 64.7 | 59 | |
| 5 years survival rate | 52.1 | 49.2 | |
| Overall survival in months | Mean 55 , range (43.5-67) | | |

**TABLE 4.** Analysis of comparing factors between laparoscopic and open surgery group.

| Factors | Odd Ratio (OR) | 95% CI | P value |
|---|---|---|---|
| Primary anastomosis rate | 2.717 | 1.79-4.012 | 0.012 |
| Permanent ostomy rate | 0.385 | 0.259-0.572 | 0.031 |
| Estimate blood loss | 0.23 | 0.06-0.86 | 0.024 |
| Mortality rate | | | |
| 30-day mortality | 1.69 | 0.901-3.194 | 0.170 |
| All cause mortality | 2.915 | 0.703-12.05 | 0.132 |
| Recurrence rate | 0.650 | 0.129-3.257 | 0.511 |
| Disease free survival | 2.19 | 0.514-9.345 | 0.468 |

**Abbreviations:** OR= odd ratio, CI=confidence interval

## DISCUSSION

Since the introduction of colonic stents in application to relieve colonic obstruction in both a palliative and as a bridge to surgery intent, many published systemic reviews and randomized control trials have acknowledged the usefulness of colonic stents.[3-10] Kavanah et al[11] reported the short and median-term outcomes compared between emergent surgery and colonic stenting as a bridge to surgery in acute malignant colonic obstruction. The results concurred with the research that stenting had no impact either on cancer-specific survival or the overall survival. There was also no difference in stoma rate, primary anastomosis, and postoperative mortality. Another comparative study by Dastur et al[12] on the short and long-term outcomes between SEMS and emergency surgery concluded that there was no difference in the long-term (3-year) survival (p=0.54) between the two groups. Meta-analysis of 2 RCTs and 6 retrospective reviews have concluded that stent placement before elective surgery did not adversely affect mortality and long-term survival.[4] The SEMS complications that occurred in the authors' study were comparable to the Cochrane review. It is implied that SEMS is an acceptable treatment of acute malignant colorectal obstruction as a bridge to surgery.

The placement of SEMS is acknowledged to relieve obstruction and act as a bridge to surgery to avoid a stoma formation. Three systematic reviews and meta-analyses have favored a higher rate of primary anastomosis in the stent group compared to the emergency surgery group.[2-4] However, the group of patients who underwent surgery after stent placement has not been analyzed. Other studies[13-15] and RCTs[16] have concurred with the role of laparoscopic surgery which can be safely performed after placement of SEMS. However, the results between laparoscopic and open surgery after colonic stenting have rarely been compared. A prospective review by Law et al[17] was the only study to compare the methods of colorectal resection after colonic stent placement. They reported a total of 36 patients with colonic stenting and half underwent laparoscopic surgery and the other half underwent open surgery. The results suggested the combined endoscopic and laparoscopic procedure provided a less invasive alternative to the multistage open operations. However, in this study, there was the largest population and a longer mean follow up time which found a higher chance of primary anastomosis in LS group compared to OS group (p=0.012; OR 2.717; 95%CI 1.79-4.12), similar to Law et al. The higher primary anastomosis rate in the laparoscopic group may have contributed to selection bias among surgeons performing open surgery and Hartmann's procedure. Further randomized-control trial is advised to concur the significance. The overall survival, recurrence and disease free status between laparoscopic and open approach after SEMS were not different. This result suggests an advantage of a laparoscopic approach after colonic stenting since it indicates higher primary anastomosis, lower blood loss, while achieving similar oncologic outcomes in complications, morbidity, mortality, and survival as open surgery. The laparoscopic approach also has the advantage of the improved quality of life with lower ostomy rate and fewer hospital stays. However, further randomized controlled trials between these two groups and a larger population would provide further promising results.

## CONCLUSION

Colonic stents are established as an effective treatment of acute malignant colonic obstruction in a bridge to surgery approach. This study, not only confirms the efficacy and safety of the colonic SEMS, but also long-term outcomes, recurrence and survival are comparable to conventional open surgery, and in addition it supports the use of laparoscopic approach in treatment of malignant colonic obstruction.

**Disclosures of Potential Conflicts of Interest:** The authors declare that they have no conflicts of interest.

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