International Journal of Colorectal Disease (2019) 34:1933–1943
https://doi.org/10.1007/s00384-019-03413-z

ORIGINAL ARTICLE

# Long-term outcome after one-stage surgery without preoperative decompression for stage II/III malignant colorectal obstruction: a propensity score-matched analysis

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Accepted: 23 September 2019 / Published online: 30 October 2019


## Abstract

**Purpose** Whether malignant colorectal obstruction (MCO) after one-stage curative surgery without preoperative decompression has a poor prognosis remains unclear. We assessed long-term outcomes of one-stage surgery without preoperative decompression for stage II/III MCO.

**Methods** We retrospectively enrolled patients with stage II/III colorectal cancer (CRC) between April 2011 and December 2017. Propensity score-matched (PSM) analysis was used to reduce the possibility of selection bias.

**Results** In total, 464 stage II/III CRC patients were identified, of which 145 (31%) had obstruction (MCO group) and 319 (69%) did not (non-MCO group). In the MCO group, 59 (40.7%) had emergency MCO (E-MCO) and 86 (59.3%) had semi-emergency MCO (SE-MCO). The median follow-up was 37.0 (range 0–86.5) months. The tumor was deeper and larger, and serum carcinoembryonic antigen level was higher ($p < 0.001$, respectively) in the MCO group (including E-MCO and SE-MCO). Venous invasion-positivity rate was significantly higher (MCO and SE-MCO only, $p = 0.003$ and 0.009, respectively) than that in the non-MCO group. Laparoscopic surgery rate was significantly lower (MCO and E-MCO only, $p < 0.001$) than that in the non-MCO group. Before PSM, disease-free survival (DFS) of the SE-MCO patients was worse than that of the non-MCO patients ($p = 0.046$). After PSM, DFS was not significantly different between the non-MCO and MCO, E-MCO, and SE-MCO groups ($p = 0.619$, 0.091, and 0.308, respectively).

**Conclusions** Long-term prognosis in patients with stage II/III MCO after one-stage surgery without preoperative decompression was similar to that in patients without MCO.

**Keywords** One-stage surgery · Malignant colorectal obstruction · Colorectal cancer · Preoperative decompression · Emergency

## Introduction

Preoperative obstruction has been reported to occur in 8–29% of patients with colorectal cancer (CRC) [1]. There are several conflicting reports about the prognostic effect of obstruction, and definitive evidence is lacking [2–4].

Preoperative obstruction, as a high-risk feature (HRF) of stage II CRC, is described in major guidelines such as the National Comprehensive Cancer Network [5] and European Society for Medical Oncology [6], but not in those of the American Society of Clinical Oncology. Many studies have defined obstruction as an HRF as follows: T4 tumors, perforation, lymphovascular invasion, perineural invasion, < 12 lymph nodes examined, high-grade tumors, positive margins, and obstruction [7–10]. However, HRF varies even in the guidelines, and the prognostic effect of obstruction remains unclear. Furthermore, in stage III CRC, fewer reports have analyzed the influence of preoperative obstruction after curative resection [2].

Typically, obstructed CRC is a more advanced disease, so the association between obstruction and many other clinical and clinicopathological parameters may make understanding of the prognostic influence of obstruction difficult [2, 3]. Furthermore, prognostic controversy may arise as a result of variations in study designs, including different stages,

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curability, definition and degree of obstruction, treatment strategy, and adjuvant chemotherapy [2].

Generally, the short-term outcome of preoperative obstruction is worse than without, and a worse short-term outcome could affect the long-term outcome [3, 11, 12]. Treatment of malignant colorectal obstruction (MCO) has traditionally involved two-stage or three-stage surgery because primary resection and anastomosis (PRA) were deemed to contribute to life-threatening postoperative complications [13]. However, the feasibility and safety of PRA have recently been re-evaluated [14, 15].

Few reports have analyzed the long-term prognostic influence of PRA without preoperative decompression for MCO [16]. The objective of this study was to evaluate long-term outcomes of patients with stage II/III MCO after curative one-stage surgery without preoperative decompression by using propensity score-matched (PSM) analysis.

## Methods

### Study design, patients, and data collection

All 471 consecutive sporadic stage II/III CRC patients who had undergone curative resection at Minoh City Hospital between April 2011 and December 2017 were included in this retrospective study. Patient selection is shown in Fig. 1. Patients who had undergone transanal resection without lymph node dissection or preoperative chemotherapy or preoperative decompression were excluded. Of 471, one case was performed preoperative chemotherapy to be participated in another clinical trial, one case was performed transanal resection without lymph node dissection, and five cases were performed preoperative decompression, namely two cases of self-expanding metallic stent (SEMS) placement, two cases of transanal drainage tube placement, and one case of transnasal drainage tube placement. The study protocol was reviewed and approved by the local medical ethics committee. This study complied with the STROBE statement [17]. The study protocol was approved by the Institutional Review Board of Minoh City Hospital (IRB No. R01-B4) and was conducted according to the ethical guidelines of the Declaration of Helsinki.

Patient characteristics were collected from medical records, including tumor characteristics, treatment, surgical variables, short- and long-term outcomes, and postoperative mortality and morbidity. All of the patients were followed up at our institution, and the last update of the follow-up evaluation was April 2019.

### Definition of obstruction and decision of treatment procedure

Obstruction was defined as clinical signs of severe colonic obstruction with dilation of the colon on either plain abdominal radiographs (with typical abnormalities on a Gastrografin® enema study) or contrast-enhanced computed tomography scan [18]. According to the Colonic Stent Safe Procedure Research Group Colorectal Obstruction Scoring System (CROSS) score, we assigned 59 patients who required continuous decompression as emergency MCO (E-MCO) a score of 0–1, and we assigned 86 patients who were able to intake only water as a semi-emergency MCO (SE-MCO; a subobstruction) a score of 2 [19].

Throughout the observation period, our treatment strategic principle was emergency one-stage surgery for E-MCO and semi-emergency one-stage surgery following emergency admission with continuous drip intravenous infusion allowing

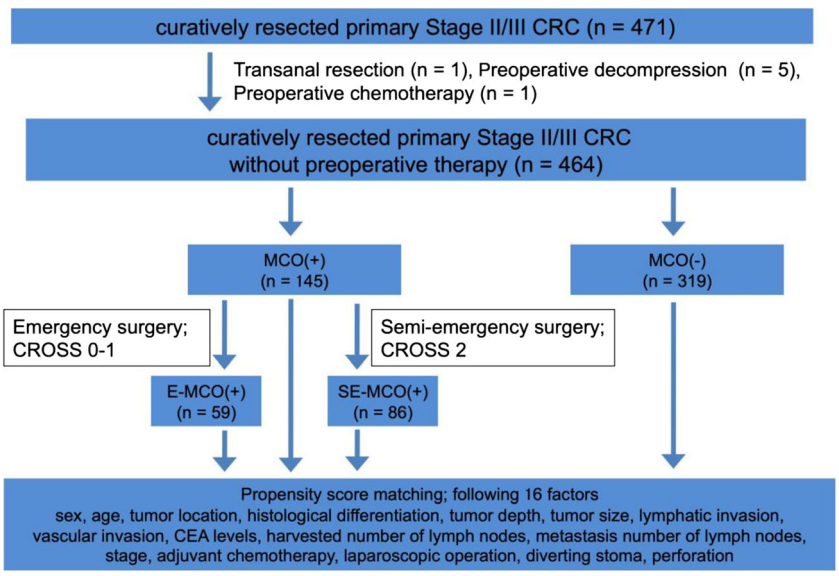


**Fig. 1** Flowchart of this study's experimental design

only water oral intake for SE-MCO (Fig. 1). However, five patients selected emergency decompression and semi-emergency surgery after decompression other than emergency surgery.

### Surgical procedures

Dedicated and experienced colorectal surgeons performed the surgical procedures. In addition, they frequently worked as a team and shared the same principles for treating CRC, including MCO. As we previously reported, throughout the observation period, our treatment policy was curative resection of the primary lesion with sufficient margin and appropriate lymph node dissection [14].

### Follow-up evaluation

Treatment and follow-up were based on the applicable Japanese Society for Cancer of the Colon and Rectum national evidence-based guidelines for diagnosis, treatment, and follow-up of CRC [20].

### Primary endpoint

The primary outcome for this study was disease-free survival (DFS) of stage II/III MCO patients after one-stage curative resection without preoperative decompression.

### Statistical analysis

Propensity score-matched analysis was performed by using a logistic regression model. The following 16 variables were matched: sex, age, tumor location, histological differentiation, tumor depth, tumor size, lymphatic invasion, vascular invasion, serum carcinoembryonic antigen (CEA) levels, harvested number of lymph nodes, metastasis number of lymph nodes, stage, adjuvant chemotherapy, laparoscopic operation, diverting stoma, and perforation. This one-to-one matching was performed by using a caliper width that was 0.20 of the standard deviation of the log of the propensity score.

Continuous variables are expressed as the median and range. The Mann–Whitney *U* test was used to compare continuous variables. Fisher's exact test was used to compare categorized variables. Kaplan–Meier curves analysis and the log-rank test were used to compare DFS. All analyses were performed by using JMP Pro version 11 software (SAS Institute, Cary, NC, USA). $p$ values < 0.05 were considered as indicative of statistical significance.

## Results

### Patient characteristics

A flowchart of the study patients is shown in Fig. 1. The characteristics of the patients are summarized in Table 1. Among these 464 patients, 145 (31%) had colorectal obstruction. Among the 143 MCO patients, 59 (40.7%) were E-MCO and 86 (59.3%) were SE-MCO. The median length of follow-up was 37.0 (range 0–86.5) months. The tumor depths were deeper ($p < 0.001$), tumor sizes were larger ($p < 0.001$), and CEA levels were higher ($p < 0.001$) in the MCO, E-MCO, and SE-MCO groups. The rate of venous invasion positivity was significantly higher in the MCO and SE-MCO groups ($p = 0.003$ and 0.009, respectively) than that in the non-MCO group. The rate of laparoscopic surgery was significantly lower in the MCO and E-MCO groups ($p < 0.001$) than that in the non-MCO group. No significant differences in sex, age, tumor differentiation, lymphatic invasion, number of harvested lymph nodes, number of metastatic lymph nodes, stage, adjuvant chemotherapy, diverting stoma, and perforation were observed between the non-MCO and MCO groups.

### Effects of MCO, E-MCO, and SE-MCO on DFS without adjustment for background

Kaplan–Meier analyses for DFS are shown in Fig. 2. The 3-year DFS rates were 82.6% (non-MCO), 75.9% (MCO), 81.1% (E-MCO), and 72.4% (SE-MCO). Although MCO and E-MCO were not significantly associated with poor prognosis ($p = 0.084$ and 0.583, respectively), SE-MCO was associated with a significantly worse prognosis than that of non-MCO ($p = 0.046$).

### Effects of MCO, E-MCO, and SE-MCO on DFS in colon and rectal cancer

Kaplan–Meier analyses for DFS in colon cancer and rectal cancer patients are shown in Fig. 3 a and b, respectively. In colon cancer patients, the 3-year DFS rates were 83.2% (non-MCO), 79.2% (E-MCO), and 70.7% (SE-MCO). Although E-MCO was not significantly associated with poor prognosis ($p = 0.382$), SE-MCO was associated with a significantly worse prognosis than that of non-MCO ($p = 0.049$). In rectal cancer patients, the 3-year DFS rates were 81.8% (non-MCO), 87.5% (E-MCO), and 75.1% (SE-MCO). E-MCO and SE-MCO were not significantly associated with prognosis ($p = 0.567$ and 0.404, respectively).

**Table 1** Patient characteristics

| | All cases ($n$ = 464) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Non-MCO ($n$ = 319) | MCO ($n$ = 145) | $p$ value | E-MCO ($n$ = 59) | $p$ value | SE-MCO ($n$ = 86) | $p$ value |
| Sex | | | | | | | |
| Male | 161 | 66 | 0.367 | 32 | 0.671 | 34 | 0.071 |
| Female | 158 | 79 | | 27 | | 52 | |
| Age (median, range) (years) | 74 (32–95) | 73 (40–100) | 0.611 | 73 (44–100) | 0.599 | 71 (40–92) | 0.260 |
| Tumor location | | | | | | | |
| Right-sided colon | 87 | 9 | < 0.001 | 8 | < 0.001 | 1 | < 0.001 |
| Transverse colon | 53 | 27 | | 19 | | 8 | |
| Left-sided colon | 51 | 54 | | 21 | | 33 | |
| Rectum | 128 | 55 | | 11 | | 44 | |
| Histological differentiation | | | | | | | |
| tub1 | 73 | 31 | 0.759 | 9 | 0.407 | 22 | 0.465 |
| tub2 | 228 | 108 | | 46 | | 62 | |
| por, muc, scc | 18 | 6 | | 4 | | 2 | |
| Tumor depth | | | | | | | |
| T1 | 9 | 0 | < 0.001 | 0 | < 0.001 | 0 | < 0.001 |
| T2 | 17 | 0 | | 0 | | 0 | |
| T3 | 229 | 69 | | 26 | | 43 | |
| T4a | 44 | 44 | | 14 | | 31 | |
| T4b | 20 | 30 | | 19 | | 12 | |
| Tumor size (median, range) (mm) | 45 (8–150) | 55 (20–120) | < 0.001 | 55 (20–110) | < 0.001 | 55 (25–120) | < 0.001 |
| Lymphatic invasion | | | | | | | |
| Present | 231 | 105 | 1.000 | 37 | 0.159 | 66 | 0.268 |
| Absent | 88 | 40 | | 22 | | 18 | |
| Venous invasion | | | | | | | |
| Present | 168 | 98 | 0.003 | 39 | 0.064 | 59 | 0.009 |
| Absent | 151 | 47 | | 20 | | 27 | |
| Serum CEA levels (median, range) (ng/ml) | 3.6 (0.5–118.2) | 5.9 (1.0–233) | < 0.001 | 5.6 (1.3–77) | < 0.001 | 6.1 (1.0–233) | < 0.001 |
| Harvested number of lymph nodes (median, range) | 20 (2–80) | 23 (7–58) | 0.095 | 22 (7–46) | 0.141 | 23 (7–58) | 0.254 |
| Metastasis number of lymph nodes (median, range) | 0 (0–42) | 0 (0–10) | 0.446 | 0 (0–10) | 0.548 | 0 (0–9) | 0.565 |
| Stage | | | | | | | |
| II | 163 | 80 | 0.424 | 33 | 0.571 | 47 | 0.627 |
| III | 156 | 65 | | 26 | | 39 | |
| Adjuvant chemotherapy | | | | | | | |
| Present | 131 | 71 | 0.129 | 37 | 0.002 | 34 | 0.901 |
| Absent | 188 | 74 | | 22 | | 52 | |
| Laparoscopic operation | | | | | | | |
| Yes | 244 | 12 | < 0.001 | 0 | < 0.001 | 12 | 0.056 |
| No | 75 | 132 | | 59 | | 74 | |
| Diverting stoma | | | | | | | |
| Present | 2 | 0 | 1.000 | 0 | 1.000 | 0 | 1.000 |
| Absent | 317 | 145 | | 59 | | 86 | |
| Perforation | | | | | | | |
| Present | 10 | 1 | 0.185 | 1 | 1.000 | 0 | 0.128 |
| Absent | 309 | 143 | | 57 | | 86 | |

Note: Data are given as median (range) or $n$. $p$ values were determined by the Mann–Whitney test and Fisher's exact test

*MCO* malignant colorectal obstruction, *E-MCO* emergency malignant colorectal obstruction, *SE-MCO* semi-emergency malignant colorectal obstruction, *tub1* well-differentiated tubular adenocarcinoma, *tub2* moderately differentiated tubular adenocarcinoma, *por* poorly differentiated adenocarcinoma, *muc* mucinous adenocarcinoma, *scc* squamous cell carcinoma

## Effects of MCO, E-MCO, and SE-MCO on DFS in stage II and stage III CRC

Kaplan–Meier analyses for DFS in stage II and stage III CRC patients are shown in Fig. 4 a and b, respectively. In stage II patients, the 3-year DFS rates were 88.3% (non-MCO), 93.1% (E-MCO), and 82.0% (SE-MCO). E-MCO and SE-MCO were not significantly associated with prognosis ($p$ = 0.602 and 0.177, respectively). In stage III patients, the 3-year DFS rates were 76.9% (non-MCO), 65.6% (E-MCO), and 62.7% (SE-MCO). E-MCO and SE-MCO were not significantly associated with prognosis ($p$ = 0.133 and 0.11, respectively).

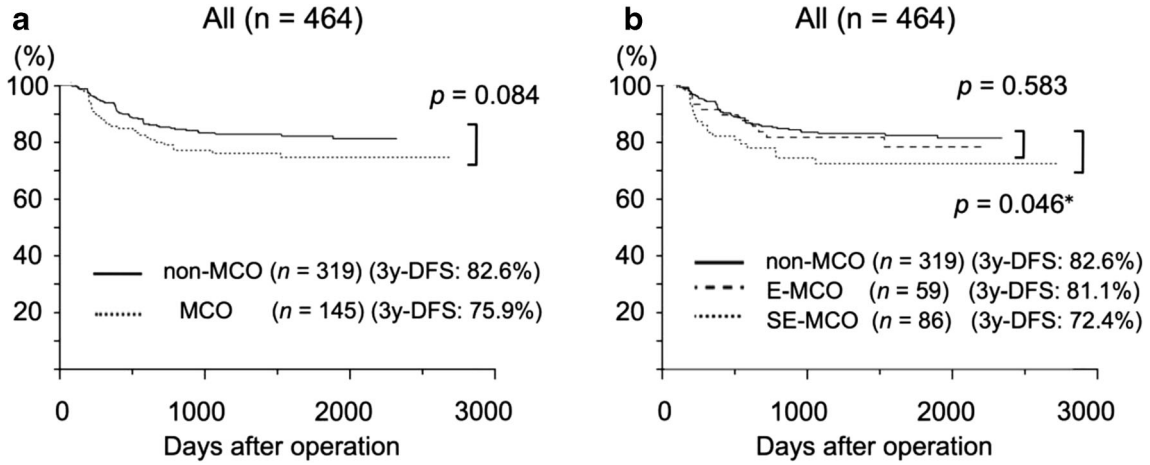


**Fig. 2** Kaplan–Meier analysis of DFS according to preoperative obstruction in patients with stage II/III CRC without adjustment for background. **a** Between non-MCO ($n$ = 319) and MCO ($n$ = 145). **b** Between non-MCO ($n$ = 319), E-MCO ($n$ = 59), and SE-MCO ($n$ = 86)

## Effects of MCO, E-MCO, and SE-MCO on DFS after propensity score matching

The characteristics of the CRC patients after matching with PSM are summarized in Table 2. After PSM, there were no significant differences in the patient characteristics. The Kaplan–Meier analyses for DFS are shown in Fig. 5. The 3-year DFS rates were 82.8–89.2% (non-MCO), 79.4% (MCO), 78.1% (E-MCO), and 73.5% (SE-MCO). MCO, E-MCO, and SE-MCO were not significantly associated with poor prognosis ($p$ = 0.619, 0.091, and 0.308, respectively).

## Sites of recurrent disease

There was no significant difference in either the sites or types of recurrence. The recurrence rates were similar in the E-MCO groups ($p$ = 0.703; Table 3) and tended to be slightly higher in the MCO and SE-MCO groups ($p$ = 0.152 and 0.112, respectively; Table 3) than those in the non-MCO group. Distant metastasis was more common in all groups ($n$ = 75; 89.2%). The most common sites of metastasis were the liver ($n$ = 34; 40.5%), lung ($n$ = 28; 33.3%), and peritoneum ($n$ = 14; 16.7%). Fourteen patients developed peritoneal recurrences, of which 9 were in the non-MCO group and 5 were in the E-MCO group, whereas no patient developed recurrence in the SE-MCO group.

## Discussion

In this study, we evaluated the long-term prognosis in patients with stage II/III CRC with obstruction after one-stage surgery using PSM. Before PSM, Kaplan–Meier analysis revealed that the long-term prognosis of patients with SE-MCO after one-stage surgery was significantly worse and that of patients

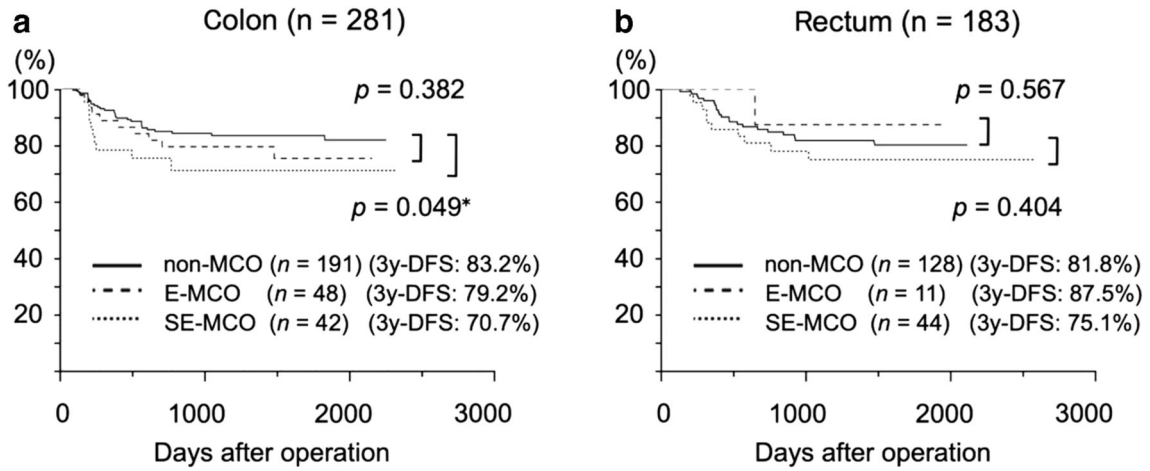


**Fig. 3** Kaplan–Meier analysis of DFS according to preoperative obstruction in patients with stage II/III CRC in the colon and rectum. **a** In colon cancer patients ($n$ = 281), between non-MCO ($n$ = 191), E-MCO ($n$ = 48), and SE-MCO ($n$ = 42). **b** In rectal cancer patients ($n$ = 183), between non-MCO ($n$ = 128), E-MCO ($n$ = 11), and SE-MCO ($n$ = 44)

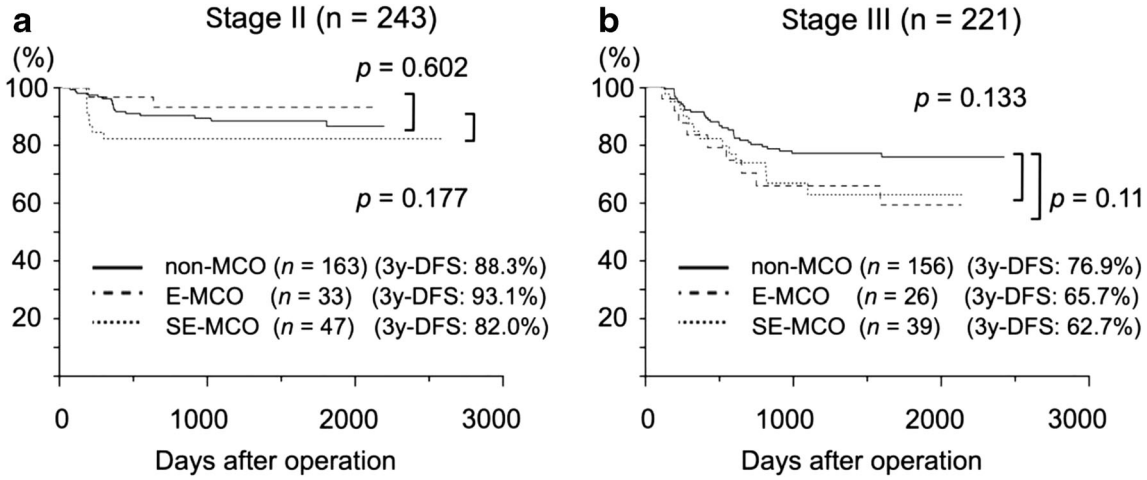


**Fig. 4** Kaplan–Meier analysis of DFS according to preoperative obstruction in patients with CRC patients in stage II and stage III. **a** In stage II ($n = 243$), between non-MCO ($n = 163$), E-MCO ($n = 33$), and SE-MCO ($n = 47$). **b** In stage III ($n = 221$), between non-MCO ($n = 156$), E-MCO ($n = 26$), and SE-MCO ($n = 39$)

with MCO after one-stage surgery tended to be worse than that of patients without MCO.

Analyzing colon and rectum separately, DFS of SE-MCO in colon cancer was significantly worse than that of non-MCO. In colon cases, the rate of T4b was 21.4% (9/42) in SE-MCO and higher than 7.3% (14/191) in non-MCO. In SE-MCO, the rate of T4b in colon cases was 21.4% (9/42) and higher than 6.8% (3/44) in rectum cases. Considering stool form, the rectum has the tendency to be obstructed and symptom can occur in a relatively shallow phase of the tumor. Deeper tumor depth might affect the worse prognosis in colon SE-MCO cases. Similarly, analyzing stage II and stage III separately, in stage II, there are not any differences in DFS between non-MCO, E-MCO, and SE-MCO. In stage III, differences in DFS between non-MCO, E-MCO, and SE-MCO were not significant, but tended to be worse in the E-MCO and SE-MCO ($p = 0.11$ and 0.133, respectively). A previous report shows that preoperative obstruction predicts a poor prognosis in stage III, but not in stage II, and our results were similar to that of this study [2].

Many clinicopathological parameters are associated with the phenomenon of obstruction, and analysis of obstruction itself is difficult. We used PSM to reduce the possibility of selection bias and the influence of other potentially confounding clinicopathological parameters of obstruction. After PSM, Kaplan–Meier analysis revealed that preoperative obstruction was not associated with worse long-term prognosis. There was little difference between the pre- and post-PSM results. Obstruction can be associated with other clinicopathological parameters, such as tumor size, tumor depth, lymphatic invasion, venous invasion, and lymph node metastasis. Although patients with obstruction have been shown to have worse survival and a higher risk of metastatic disease than those of patients without obstruction, factors other than obstruction also were predictive of worse prognosis in patients with obstruction [16]. In addition, it seemed the post-PSM 3y-DFS of non-MCO was better than that of pre-PSM. Especially, DFS of non-MCO after matching to E-MCO was 89.2%, while DFS of non-MCO before matching was 82.6%. We speculate that clinicopathological factors other than obstruction associated with E-MCO were not poor prognostic condition and post-PSM 3y-DFS of non-MCO became better than that of pre-PSM. This result also might suggest that prognostic influence of obstruction is associated with many other factors.

In our study, we also evaluated the prognostic influence of obstruction degree. Although subobstruction is common in clinical practice, the clinical significance of subobstruction remains unclear. Before PSM, contrary to our expectation, the prognosis after semi-emergency surgery for subobstruction was worse than that after emergency surgery for obstruction. This finding suggests that tumor progressivity that can occur with obstruction affects the prognosis rather than the phenomenon of obstruction itself. After PSM, our data indicated that one-stage surgery for MCO did not worsen the long-term prognosis relative to that of non-MCO. This result also suggests that obstruction is not the only factor associated with poor prognosis. Some other factors related to obstructed CRC may indicate a more advanced disease, possibly with radiologically undetectable occult metastases [2]. Consistent with our hypothesis, Katoh et al. indicated that factors other than bowel obstruction itself, such as occult metastatic disease as reflected by elevated CEA level, may contribute to a worse outcome [2].

Differences in treatment strategy for MCO also can confuse the understanding of the prognostic effect of MCO. A previous report suggested that obstruction is a poor prognostic factor [2]. However, in that study, the treatment strategy differed from that in our study. Among the 63 patients in that study, only 1 patient underwent emergency primary resection with

**Table 2** Patient characteristics after propensity score matching

| | Non-MCO vs MCO | | | Non-MCO vs E-MCO | | | Non-MCO vs SE-MCO | | |
|---|---|---|---|---|---|---|---|---|---|
| | Non-MCO ($n$ = 111) | MCO ($n$ = 111) | $p$ value | Non-MCO ($n$ = 52) | E-MCO ($n$ = 52) | $p$ value | Non-MCO ($n$ = 72) | SE-MCO ($n$ = 72) | $p$ value |
| Sex | | | | | | | | | |
| Male | 51 | 53 | 0.893 | 27 | 27 | 1.000 | 34 | 31 | 0.737 |
| Female | 60 | 55 | | 25 | 25 | | 38 | 41 | |
| Age (median, range) (years) | 75 (42–94) | 71 (40–100) | 0.211 | 76 (42–95) | 73.5 (44–100) | 0.521 | 73 (32–93) | 71 (40–92) | 0.462 |
| Tumor location | | | | | | | | | |
| Right-sided colon | 10 | 9 | 0.694 | 8 | 8 | 0.853 | 2 | 1 | 0.954 |
| Transverse colon | 27 | 20 | | 19 | 17 | | 8 | 8 | |
| Left-sided colon | 31 | 35 | | 12 | 16 | | 21 | 24 | |
| Rectum | 43 | 47 | | 13 | 11 | | 41 | 39 | |
| Histological differentiation | | | | | | | | | |
| tub1 | 28 | 24 | 0.679 | 9 | 8 | 1.000 | 21 | 18 | 0.730 |
| tub2 | 76 | 82 | | 40 | 40 | | 48 | 52 | |
| por, muc, scc | 7 | 5 | | 3 | 4 | | 3 | 2 | |
| Tumor depth | | | | | | | | | |
| T1 | 0 | 0 | 0.942 | 0 | 0 | 0.813 | 0 | 0 | 1.000 |
| T2 | 0 | 0 | | 0 | 0 | | 0 | 0 | |
| T3 | 68 | 66 | | 27 | 26 | | 43 | 43 | |
| T4a | 30 | 30 | | 15 | 13 | | 22 | 22 | |
| T4b | 13 | 15 | | 10 | 13 | | 7 | 7 | |
| Size (median, range) (mm) | 50 (12–140) | 55 (20–110) | 0.261 | 50 (12–140) | 50 (20–110) | 0.521 | 55 (11–140) | 55 (25–120) | 0.900 |
| Lymphatic invasion | | | | | | | | | |
| Present | 79 | 79 | 1.000 | 32 | 32 | 1.000 | 50 | 55 | 0.453 |
| Absent | 32 | 32 | | 20 | 20 | | 22 | 17 | |
| Venous invasion | | | | | | | | | |
| Present | 73 | 71 | 0.888 | 29 | 33 | 0.549 | 47 | 47 | 1.000 |
| Absent | 38 | 40 | | 23 | 19 | | 25 | 25 | |
| Serum CEA levels (median, range) (ng/ml) | 5.7 (0.8–118) | 5.1 (1–73.5) | 0.981 | 5.25 (0.9–118.2) | 5.05 (1.3–73.5) | 0.274 | 6.7 (0.9–118.2) | 6.1 (1–73.2) | 0.618 |
| Harvested number of lymph nodes (median, range) | 22 (2–80) | 23 (7–55) | 0.786 | 22 (2–76) | 22.5 (7–46) | 0.528 | 20 (7–80) | 22.5 (7–58) | 0.914 |
| Metastasis number of lymph nodes (median, range) | 1 (0–12) | 0 (0–10) | 0.894 | 0 (0–10) | 0 (0–10) | 0.966 | 0 (0–12) | 0 (0–9) | 0.854 |
| Stage | | | | | | | | | |
| II | 58 | 62 | 0.686 | 27 | 27 | 1.000 | 41 | 40 | 1.000 |
| III | 53 | 49 | | 25 | 25 | | 31 | 32 | |
| Adjuvant chemotherapy | | | | | | | | | |
| Present | 45 | 52 | 0.416 | 29 | 30 | 1.000 | 26 | 27 | 1.000 |
| Absent | 66 | 59 | | 23 | 22 | | 46 | 45 | |
| Laparoscopic operation | | | | | | | | | |
| Yes | 7 | 12 | 0.337 | 0 | 0 | 1.000 | 9 | 11 | 0.810 |
| No | 104 | 99 | | 52 | 52 | | 63 | 63 | |
| Diverting stoma | | | | | | | | | |
| Present | 0 | 0 | 1.000 | 0 | 0 | 1.000 | 0 | 0 | 1.000 |
| Absent | 111 | 111 | | 52 | 52 | | 72 | 72 | |
| Perforation | | | | | | | | | |
| Present | 1 | 3 | 0.621 | 1 | 1 | 1.000 | 0 | 0 | 1.000 |
| Absent | 110 | 108 | | 51 | 51 | | 72 | 72 | |

Note: Data are given as median (range) or $n$. $p$ values were determined by the Mann–Whitney test and Fisher's exact test

*MCO* malignant colorectal obstruction, *E-MCO* emergency malignant colorectal obstruction, *SE-MCO* semi-emergency malignant colorectal obstruction, *tub1* well-differentiated tubular adenocarcinoma, *tub2* moderately differentiated tubular adenocarcinoma, *por* poorly differentiated adenocarcinoma, *muc* mucinous adenocarcinoma, *scc* squamous cell carcinoma

curative intent, and the other 62 patients underwent curative resection electively after decompression of the bowel obstruction with emergency ileostomy or colostomy in 15 patients and with nonoral nutrition with/without a nasal or anal decompression in 47 patients. There is an argument in favor of two-stage curative surgery [13, 21]. The advantages of two-stage curative surgery are said to be the better safety and lower mortality rate. The poor prognosis of obstruction is shown by

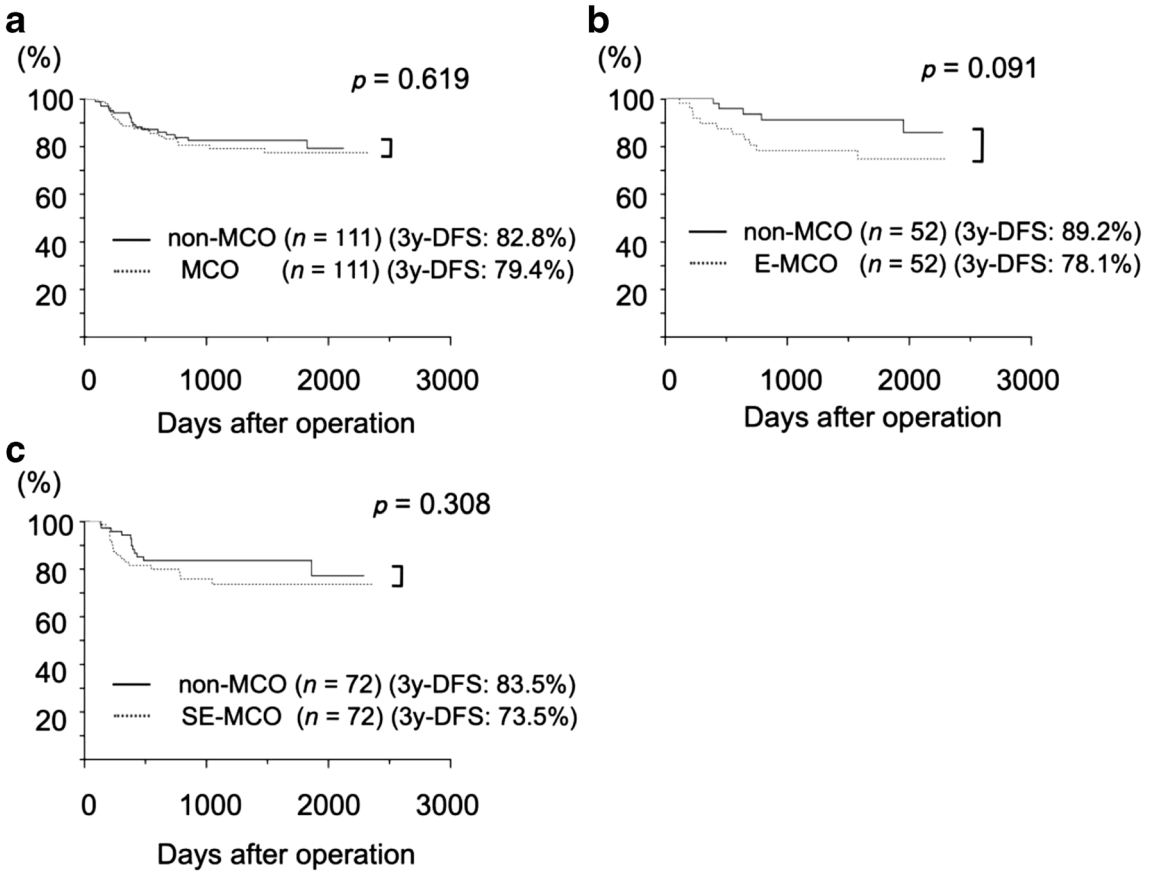


**Fig. 5** Kaplan–Meier analysis of DFS according to preoperative obstruction in patients with stage II/III CRC after propensity score matching. **a** Between non-MCO ($n$ = 111) and MCO ($n$ = 111). **b** Between non-MCO ($n$ = 52) and E-MCO ($n$ = 52). **c** Between non-MCO ($n$ = 72) and SE-MCO ($n$ = 72)

the reported high mortality and morbidity rates after emergency surgery [3, 11, 12]. Emergency surgery is thought to have a high risk of complications and bad short-term results [3, 11, 12]. However, the safety and feasibility of emergency one-stage anastomosis has been recently reported [14, 15, 22]. The deterioration of short-term results is thought to be one of the reasons for the worsening of prognosis, but we have obtained good short-term results in emergency and semi-emergency cases, which is presumed to be one factor that does not worsen the prognosis. In addition, there are few studies analyzing the long-term outcomes between staged-emergency surgery and one-stage emergency surgery without preoperative decompression [1, 23]. A previous report indicated that radiologically undetectable occult metastases in advanced disease may exist, and staged surgery might cause faster progression of the growth of occult metastasis than would one-stage surgery [2]. If safety and curability are achieved, one-stage surgery may be more favorable than staged surgery in MCO treatment.

There were no significant differences in the rates and sites of recurrence among the non-MCO and other groups. Enforced radial dilation of the colon could lead to microperforations, and tumor manipulation could lead to the dissemination of tumor cells into the peritoneal cavity [24, 25]. This pathological condition should present a higher peritoneal recurrence rate [25]. In the present study, more patients developed peritoneal recurrence in E-MCO than in non-MCO and SE-MCO. On the other hand, occult local remnant cancer cells should present as local recurrence. Although curative surgery for MCO is generally thought to be difficult and occult remnant cancer cells might exist, our study did not show a significant difference in the rate of local recurrence regardless of obstruction, which is consistent with the findings of a previous study [16]. This result suggests that definitive surgical resection with a sufficient surgical margin can reduce local recurrence even in MCO patients. In addition, in the present study, obstruction had no effect on cancer recurrence patterns except for peritoneal recurrence in E-MCO, which was a different finding from that in the previous study [16].

As optional treatment for MCO, preoperative decompression using SEMS and transanal drainage tube, which we excluded in this study, may contribute safer surgery [26]. The European Society of Gastrointestinal Endoscopy guidelines, which have been endorsed by the American Society of Gastrointestinal Endoscopy, do not recommend the routine use of stenting as a bridge to elective surgery for symptomatic

**Table 3** Sites of recurrent disease

| | Non-MCO ($n$ = 319) | MCO ($n$ = 145) | $p$ value | E-MCO ($n$ = 59) | $p$ value | SE-MCO ($n$ = 86) | $p$ value |
|---|---|---|---|---|---|---|---|
| Recurrence rates (%) | 52 (16.3) | 32 (22.0) | 0.152 | 11 (18.6) | 0.703 | 21 (24.4) | 0.112 |
| Number of recurrence sites | 62 | 36 | | 14 | | 22 | |
| Type of recurrence | | | | | | | |
| Distant | 45 | 30 | 0.364 | 10 | 1.000 | 20 | 0.691 |
| Locoregional | 4 | 2 | | 1 | | 1 | |
| Both | 3 | 0 | | 0 | | 0 | |
| Recurrence sites | | | | | | | |
| Liver | 19 | 15 | 0.934 | 4 | 0.817 | 11 | 0.356 |
| Lung | 17 | 11 | | 3 | | 8 | |
| Peritoneal dissemination | 9 | 5 | | 5 | | 0 | |
| Distant lymph nodes | 7 | 2 | | 1 | | 1 | |
| Local recurrence | 6 | 2 | | 1 | | 1 | |
| Ovary | 2 | 1 | | 0 | | 1 | |
| Anastomotic recurrence | 1 | 0 | | 0 | | 0 | |
| Bone | 1 | 0 | | 0 | | 0 | |

Note: Data are given as $n$ (%). $p$ values were determined by Fisher's exact test

*MCO* malignant colorectal obstruction, *E-MCO* emergency malignant colorectal obstruction, *SE-MCO* semi-emergency malignant colorectal obstruction

left-sided malignant obstruction [27]. SEMS might cause progression of the growth of occult metastasis caused by mechanical compression damage to the tumor tissue resulting from radial pressure of the SEMS placement [28]. Although we excluded preoperative decompression cases in this study analysis in consideration of preoperative decompression effect to long-term outcomes [29], a recent study showed that patients who underwent SEMS placement for MCO had long-term outcomes comparable with those of patients who underwent emergency surgery [25]. Given that the potential benefit of SEMS cannot be denied, preoperative decompression might be a useful treatment option in the future.

There were some limitations in this study. First, we excluded five patients who underwent preoperative decompression and this can be bias in this study. These five patients required continuous emergency decompression with or without surgery and they were assigned to CROSS score of 0–1. We performed preoperative decompression other than emergency surgery not intentionally, but because the patients selected emergency decompression and semi-emergency surgery other than emergency surgery. In these very small five cases, Kaplan–Meier analyses showed that the 3-year DFS rate was 60% and was worse than that of E-MCO (81.1%) shown in Fig. 2b (data not shown). Although including these five cases to analysis in this study might affect results, we cannot totally exclude preoperative decompression effect to long-term outcomes and we excluded these five patients from analyses. Second, our findings suggest either that obstruction is not a poor prognostic factor or that emergency surgery and semi-emergency surgery do not worsen the prognosis of MCO. Although our research design could not distinguish between these possibilities, one-stage surgery for MCO was associated with the same prognosis as that of non-MCO. Third, although in this study we did not determine a significant effect of obstruction on long-term outcomes, the prognoses of patients without MCO at almost any time point in the Kaplan–Meier curves were better than those of the other study group patients. In addition, we found that the prognosis unexpectedly tended to be worse before PSM in the SE-MCO group than that in the non-MCO and E-MCO groups. Although we used PSM, this study was conducted at a single small center. Consequently, our results require confirmation by a larger multicenter study before they can be generalized.

In conclusion, preoperative obstruction did not affect the long-term prognosis in patients with stage II/III CRC who underwent one-stage surgery. To our knowledge, this study is the first to evaluate the long-term outcome after one-stage surgery without decompression for stage II/III MCO by using a propensity score-matched analysis. Preoperative obstruction itself may not be a poor prognostic marker among stage II/III MCO patients after curative surgery. Safe and definitive surgical resection is feasible and desirable even for MCO patients to achieve good long-term outcomes.

## Compliance with ethical standards

The study protocol was approved by the Institutional Review Board of Minoh City Hospital (IRB No. R01-B4) and was conducted according to the ethical guidelines of the Declaration of Helsinki.

**Conflict of interest** The authors declare that they have no conflicts of interest.

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