

Original Article

Comparison between Manual Circular Staplers and Power Circular Staplers for Anastomosis in Left-sided Colorectal Surgery: A Postoperative Outcome Assessment

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Key Words

Manual circular staplers;
Power circular staplers;
Postoperative outcomes

Purpose. The present study compared the postoperative outcomes of manual circular staplers (MCSs) with those of powered circular staplers (PCSs) for anastomosis in left-sided colorectal surgery on the basis of our experience.

Methods. This retrospective study was conducted at a single institution, and we reviewed the charts of 162 patients who underwent left-side anastomosis with either MCS or PCS during colorectal surgery between July 2021 and January 2023. The primary outcomes assessed were postoperative anastomosis leakage or hemorrhage. Secondary outcomes were prolonged ileus and length of postoperative hospital stay.

Results. The 162 patients were divided into two groups on the basis of the type of stapler used for left-sided colon anastomosis: MCS and PCS. No incidence of postoperative anastomotic leakage or bleeding was noted in both groups. The proportion of patients experiencing prolonged ileus postoperatively was similar between the groups (14% for MCS vs. 12.2% for PCS). The median postoperative hospital stay was shorter in the PCS group than in the MCS group (8 days vs. 9 days). The multivariable analyses showed statistically significant shorter hospital stays for patients who received PCS for anastomosis (95% CI: 1.049-4.835, $p = 0.0037$).

Conclusions. PCSs for left-sided anastomosis did not improve bowel movement recovery outcomes. We hypothesize that the use of PCSs does not substantially reduce postoperative complications or enhance postoperative recovery. Nevertheless, a shorter length of hospital stay was observed in patients treated with PCS. Additional studies with larger patient cohorts should be conducted to substantiate this conclusion.

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Colectomy is a commonly used procedure for treating colorectal disease, and circular staplers are widely employed for anastomosis of left side colorectal surgery. Currently, circular staplers are classi-

fied into two types based on their firing mechanism: manual and electronic. Manual circular staplers (MCSs) have been utilized for over 30 years in anastomosis creation. This technique necessitates the operator to

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fire them by using hand force. Thus, anastomosis quality depends on operator-related factors, such as hand size, strength, and stability. The quality of the anastomosis is closely associated with certain postoperative complications, the most significant of which is anastomotic leakage, which increases the likelihood of reoperation, prolongs the length of hospital stay and leads to higher 30-day mortality.¹ With technological advancements, powered circular staplers (PCSs) were developed to minimize the effect of these operator-related factors and decrease the rate of technical error.² In circular staplers, powered firing reduces distal tip movement and enhancing stability during anastomosis. One study revealed that 97% lower force was needed to activate the PCSs, 37% less distal tip movement during application and 52% less bleeding at the cut line.³ This improved stability may reduce surgical complications, such as postoperative leakage and hemorrhage.⁴ A study⁵ published in 2021 reported that PCSs are associated with low rates of several perioperative and postoperative complications and 30-day readmission. V. Pla-Martí et al.² found a significantly lower anastomosis leak rate in the ECPS group (1.7%) versus the MCS group (11.8%) ($p = 0.022$). Based on the advantages of using the powered stapler mentioned, we hypothesize that the use of PCS reduces the incidence of postoperative complications and shortens the length of hospital stay, based on its mechanical and ergonomic advantages. However, the use of PCS has not been as longstanding or widespread as MCS, and further research is needed to confirm whether PCS is more effective than MCS in reducing postoperative complications. As a result, in the present study, we compared the postoperative outcomes of MCSs with those of PCSs for anastomosis in left-sided colorectal surgery.

Materials and Methods

Patients and data collection

This retrospective study was conducted at a single institution. We reviewed the medical records of patients who underwent anastomosis of left side colo-

rectal surgery, utilizing either MCSs or PCSs, between July 2021 and January 2023. A total of 162 patients were enrolled.

Patient characteristics, namely age, sex, body mass index, underlying conditions (diabetes and liver cirrhosis), type of disease, neoadjuvant therapy prior to surgery, lesion location, tumor size, American Society of Anesthesiologists (ASA) score, surgical approach (open or minimally invasive), type of operation (emergent or regular), surgical technique, and operation time, were collected and are listed in Table 1.

Generally, we used manual circular staplers for anastomosis. The choice of powered circular stapler was based on surgeon preference, subject to patient consent. PCS staplers were typically used in patients undergoing elective procedures. In this study, only one patient which was an emergent case received PCS for anastomosis.

The primary outcome measurements were anastomotic leakage and anastomotic site bleeding. The secondary outcome measurements were prolonged ileus and the length of postoperative hospital stay. Water intake was resumed when the patient passed gas. Postoperative leakage was diagnosed by the presence of bowel wall disruption on postoperative computed tomography or colonoscopy, or by the presence of turbid or fecal-appearing drainage from drains placed intraoperatively near the anastomosis or in the pelvis. Postoperative hemorrhage was identified as bleeding at the anastomosis site observed during a postoperative colonoscopy, if performed. Prolonged ileus was diagnosed when the patient remained nil per os for more than 6 days postoperatively.⁶⁻⁸

Steps of the procedure

After transecting the distal colon with a linear stapler, the proximal colon is transected using a scalpel, and the resected specimen containing the lesion is removed. The anvil is then inserted into the lumen of the proximal colon, and the purse-string suture is secured onto the anvil shaft above the tying notch. The circular stapler device is subsequently inserted into the closed lumen of the distal colon. The device trocar is fully extended until penetration is achieved, then fur-

Table 1. Characteristics of all patients

	MCS (n = 121)	PCS (n = 41)	<i>p</i>
Age (mean, SD)	64.98 (12.9)	67.7 (15.3)	0.27
Sex, male	73 (60%)	25 (61%)	1.0
Body weight index (mean, SD)	24.5 (3.75)	25 (3.68)	0.45
Underlying disease			
Diabetes mellitus	27 (22.3%)	8 (19.5%)	
Liver cirrhosis	1 (0.8%)	1 (2.4%)	0.2
Malignant disease	93 (77.7%)	35 (85.4%)	0.28
Diagnosis			
Adenocarcinoma	88 (72%)	35 (85.3%)	
Adenoma	6 (5%)	1 (2.4%)	
Diverticulitis	5 (4.1%)	1 (2.4%)	
Perforated diverticulitis	13 (10.7%)	3 (7.3%)	0.57
Neoadjuvant CCRT	18 (14.9%)	4 (3.3%)	0.50
AJCC pathologic staging			
Stage I	19 (14.9%)	10 (24.4%)	
Stage II	26 (22.3%)	10 (26.8%)	
Stage III	35 (29%)	14 (34.1%)	
Stage IV	8 (6.6%)	0 (0%)	
yStage 0	3 (2.5%)	1 (2.4%)	0.24
ASA			
I	2 (1.7%)	2 (4.9%)	
II	116 (95.7%)	39 (95.1%)	
III	3 (2.5%)	0 (0%)	0.315
Approach			
Open	49 (40.5%)	9 (22%)	
Minimally invasive	72 (59.5%)	32 (78%)	0.038
Emergent operation	12 (10%)	1 (2.4%)	0.19
Surgical technique			
Left hemicolectomy	11 (7.8%)	2 (4.9%)	
Anterior resection	48 (34%)	15 (36.6%)	
Low anterior resection	56 (39.7%)	22 (53.7%)	
Reverse Hartmann's procedure	5 (3.5%)	1 (2.4%)	0.73
Operation time (Median, Q1-Q3)	205 (179-260)	210 (180-240)	0.72

CCRT, concurrent chemoradiotherapy; AJCC, The American Joint Committee on Cancer; ASA, American Society of Anesthesiologists; MCS, manual circular stapler; PCS, power circular stapler.

ther extended until the orange band becomes visible. The anvil is then attached to the device, and the device is closed. The adjusting knob is rotated until appropriate tissue resistance is achieved (allowing a 15-second dwell time for tissue compression). The device is fired using a firm, continuous squeeze of the firing trigger until it contacts the device body. The device is subsequently opened by rotating the adjusting knob counter-clockwise for two complete 360° rotations. Finally, the device is removed, completing the anastomosis.⁹

Unlike manual staplers, the power circular stapler employs a powered firing mechanism, requiring only

trigger activation from the operator and eliminating the need for manual force exertion.

Statistical analysis

The Kolmogorov-Smirnov test was used to examine the normality of the distribution of continuous variables. Continuous variables with a normal distribution are presented as the mean \pm standard deviation, whereas those with a nonnormal distribution are presented as the median (Q1-Q3). The independent *t* test or Mann-Whitney U test was used to compare con-

tinuous variables. The chi-square test was used to compare categorical variables.

Univariable were used to investigate risk factors associated with ileus and the length of postoperative hospital stay. Subsequently, multivariable logistic regression analysis was performed on the variables with univariate p -values <0.2 .

A p value of <0.05 was considered statistically significant for all tests. All statistical analyses were performed using SPSS (version 25).

Results

Patient characteristics

A total of 162 patients were included in this study after medical chart review. The mean age of the patients was 65.67 ± 13.58 years. Among the 162 patients, 128 had malignant disease. Twenty-two patients with colorectal cancer received concurrent chemoradiotherapy. The majority of the patients had an ASA score of 2 ($n = 155$, 95.7%). Minimally invasive surgery, including laparoscopic and robotic-assisted procedures, was performed in 104 (64.2%) patients. MCSs were used in 121 (74.7%) patients, whereas PCSs were used in 41 (25.3%) patients. Table 1 lists the patient characteristics.

Statistical analysis results

The 162 patients were divided into two groups on

the basis of the type of circular stapler used for left-sided colon anastomosis: MCS and PCS.

Compared with MCSs, PCSs were more frequently used in minimally invasive surgery (59.5% vs. 78%); this difference was statistically significant ($p = 0.038$). Furthermore, 12 (10%) of the 121 patients in the MCS group underwent emergency surgery, whereas only 1 (2.4%) of the 41 patients in the PCS group underwent emergency surgery.

No incidence of postoperative anastomotic leakage or bleeding was noted in both two groups. The proportion of patients experiencing prolonged postoperative ileus was similar between the two groups (14% for MCSs vs. 12.2% for PCSs).

Several potential risk factors influencing postoperative ileus and hospitalization length were analyzed using univariate and logistic regression. The results were listed in Tables 3, 4. The duration of postoperative hospitalization was categorized as less than nine days or nine days or greater. In terms of postoperative ileus, univariate analysis showed that patients aged 65 years or older and those undergoing emergency surgery, were more prone to experiencing postoperative ileus, with statistically significant differences. Multivariate logistic regression analysis showed that only patients aged 65 years or older were more likely to postoperative ileus (95% CI 1.703-17.140, $p = 0.004$). With respect to postoperative hospitalization days, univariate analysis showed statistically significant longer hospital stays for patients aged 65 years or older, those undergoing open surgery, those who were emergent cases, and those who received MCPs for anasto-

Table 2. Primary and secondary outcome

	MCS (n = 121)	PCS (n = 41)	<i>p</i>
Complication			
Anastomosis leakage	Nil	Nil	
Anastomosis hemorrhage	Nil	Nil	
Prolonged ileus	17 (14%)	5 (12.2%)	1.0
Complication severity ^a			
Grade 1	7 (5.8%)	2 (4.9%)	0.955
Grade 2	10 (8.3%)	3 (7.3%)	
Postoperative hospitalization day (median, Q1-Q3)	9 (8-11)	8 (7-10)	0.052

^a Complication severity was estimated by Clavien-Dindo Classification.

Grade 1: Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions.

Grade 2: Requiring pharmacological treatment with drugs other than such allowed for grade I complications.

Table 3. Univariate logistic regression analysis

Characteristic	Odd ratio	95% CI	<i>p</i> value
Postoperative ileus			
Age			
< 65	1		
≥ 65	5.025	1.639-15.04	0.005
BMI			
< 25	1		
≥ 25	1.786	0.756-4.22	0.186
Surgical approach			
Minimal invasive	1		
Open	1.826	0.772-4.320	0.170
Status			
Regular	1		
Emergent	3.071	0.849-11.111	0.087
Device			
MCP	1		
PCS	1.178	0.453-3.062	0.737
Postoperative hospitalization day			
Age			
< 65	1		
≥ 65	2.379	1.259-4.496	0.008
BMI			
< 25	1		
≥ 25	1.171	0.627-2.190	0.620
Surgical approach			
Minimal invasive	1		
Open	2.4	1.220-4.720	0.011
Status			
Regular	1		
Emergent	2.556	0.665-9.841	0.172
Device			
MCP	2.460	1.190-5.086	0.015
PCS	1		

mosis. Multivariable analysis showed statistically significant longer hospital stays for patients aged 65 years or older (95% CI: 1.233-4.702, $p = 0.010$), those undergoing traditional surgical techniques (95% CI: 1.037-4.307, $p = 0.0039$) and those who received MCPs for anastomosis (95% CI: 1.049-4.835, $p = 0.0037$).

Discussion

The common postoperative complications of colorectal surgery include surgical site infection, anastomotic leakage, intra-abdominal abscess, ileus, and

Table 4. Multivariate logistic regression analysis

Characteristic	Odd ratio	95% CI	<i>p</i> value
Postoperative ileus			
Age			
< 65	1		
≥ 65	5.403	1.703-17.140	0.004
BMI			
< 25	1		
≥ 25	2.508	1.987-6.378	0.053
Surgical approach			
Minimal invasive	1		
Open	1.859	0.732-4.722	0.192
Status			
Regular	1		
Emergent	2.232	0.571-8.723	0.248
Postoperative hospitalization day			
Age			
< 65	1		
≥ 65	2.408	1.233-4.702	0.010
Surgical approach			
Minimal invasive	1		
Open	2.113	1.037-4.307	0.039
Status			
Regular	1		
Emergent	1.389	0.337-5.715	0.649
Device			
MCP	2.252	1.049-4.835	0.037
PCS	1		

bleeding.^{10,11} The present study enrolled 162 patients who underwent left-sided colorectal surgery with anastomosis using either an MCS or a PCS. The specific postoperative complications examined were postoperative bleeding and anastomotic leakage. The secondary outcomes evaluated were ileus, postoperative water intake day and the length of postoperative hospital stay.

According to Kirchhoff et al.,¹¹ the rate of anastomotic leakage as a major postoperative complication ranges from 2.9% to as high as 15.3%. Yoo et al.¹² described that the overall anastomotic leakage rate for left-sided anastomosis is approximately 6%, and that postoperative bleeding from stapled colorectal anastomosis occurs in up to 6.5% of patients. However, in the present study, we found no incidence of postoperative anastomotic leakage or bleeding in either the MCS or PCS group. This absence of complications

may be attributed to the experience of our surgeon, careful postoperative care, and the comprehensive nutritional support provided to patients postoperatively. The comprehensive nutritional support included the routine use of Oliclinomel for all patients undergoing colorectal surgery and albumin supplementation for malnourished patients. A trial demonstrated that early perioperative peripheral parenteral nutrition in patients undergoing colorectal surgery is beneficial for preventing postoperative complications.¹³

The incidence of prolonged ileus was 14% in the MCS group and 12.2% in the PCS group in the present study. These rates are similar to the rate of 14% reported by Chapuis et al.¹⁴ and the rate of 10.2% reported by Kronberg et al.¹⁵ Although the proportion of patients experiencing prolonged ileus postoperatively was similar in both the groups in the present study, the difference was not statistically significant. A univariate logistic regression model comparing PCS and ECPS users showed a higher incidence of postoperative ileus in the PCS group; however, this difference did not reach statistical significance. This result may be related to the fact that we are a single medical institution and the sample size is insufficient to achieve statistical significance. Future studies should include more patients or conducting multicenter studies could be considered.

In the current study, 10% of the patients in the MCS group underwent emergency surgery, whereas only 2.4% of the patients in the PCS group underwent emergency surgery. Emergency surgery was necessitated by conditions such as perforated diverticulitis or colorectal tumors with obstruction, and in some cases, perforation leading to generalized peritonitis. A longer postoperative recovery duration for bowel movement and postoperative hospitalization days are expected in these cases.¹⁶ However, our statistical analysis (Table 2) revealed that both groups had similar postoperative days to resuming oral intake, suggesting that the use of PCSs does not reduce the duration of postoperative intestinal peristalsis, despite the lack of a significant difference between the groups. In univariate logistic regression, it indicated that the patient underwent emergent surgery had longer hospitalization day and was easier to ileus, but these two results

also did not reach significant finding.

In the Laparoscopy-Assisted Surgery for Carcinoma of the Low Rectum randomized clinical trial,¹⁷ patients undergoing laparoscopic rectal cancer surgery had a shorter hospital stay and faster bowel function recovery. In the present study, 59.5% of the patients in the MCS group underwent minimally invasive surgery, whereas as many as 78% of the patients in the PCS group underwent minimally invasive surgery. The MCS group had a higher rate of open surgery than did the PCS group (40.5% vs. 22%, $p = 0.038$). This was attributed to a higher incidence of emergency cases, perforated diverticulitis, and neoadjuvant patients in the MCS group. The three factors mentioned above are more likely to lead to the selection of open surgery, as these cases are more prone to organ adhesions and the urgent nature of the situation makes the use of pneumoperitoneum unsuitable. However, despite this finding, the time to resume oral intake postoperatively was similar between the groups, even though a higher proportion of patients underwent minimally invasive surgery in the PCS group. These findings suggest that the use of powered staplers does not offer an advantage in terms of postoperative bowel movement recovery. Although we noted no significant difference in postoperative water intake day between the groups, the median postoperative hospitalization stay was 9 days (Q1-Q3: 8-11) in the MCS group and 8 days (Q1-Q3: 7-10) in the PCS group; this difference was not statistically significant ($p = 0.052$). In multivariable regression analysis, patients accepted MCP for anastomosis has longer hospitalization days with statistically significant difference (95% CI: 1.190-5.086, p value = 0.015). Pollack E reported that PCS was also associated with fewer length of stay days.¹⁸ Our result is consistent with previous finding.

This study has several limitations that should be considered. First, because this is a retrospective study conducted at a single center, the sample size was not sufficient to achieve a standard normal distribution for all patient characteristics. Second, surgical techniques substantially affect surgical outcomes, including postoperative complications. Our surgeons were highly experienced, which might have resulted in a lower complication rate. Thus, how postoperative leakage or

bleeding rates would be affected if surgery was performed by less-experienced surgeons remains unclear.

Conclusion

In our experience, PCSs for left-sided anastomosis do not improve bowel movement recovery outcomes. In our 162 patients, no incidence of postoperative leakage and bleeding was noted. We hypothesize that the use of powered staplers does not significantly reduce postoperative complications or enhance recovery. Nevertheless, a shorter length of hospital stay was observed in patients treated with PCS. Additional studies with larger patient cohorts are needed to substantiate these conclusions.

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原 著

在左側大腸往和手術中，比較使用手動環狀吻合槍或是電動環狀吻合槍的術後治療療效

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目的 這篇研究主要在我們的使用經驗中，比較手動環狀吻合槍或是電動環狀吻合槍對於術後恢復的影響

方法 在這篇回顧性研究中，我們回顧了自 2021 年 7 月至 2023 年 1 月期間，在一家醫院接受接受左側結腸手術且術中使用手動吻合或電動吻合槍的患者的病歷。最終，我們納入了 162 位患者進行本研究。主要術後療效指標有術後吻合處滲漏或出血。次要療效為延長性腸梗阻及術後住院天數。使用單變量及多變量迴歸分析來探討與腸梗阻及術後住院時間相關的風險因素

結果 把 162 名患者分為兩組進行比較，分別為使用手動環狀吻合槍 (MCS) 或是電動環狀吻合槍 (PCS) 進行左側結腸吻合。兩組均未觀察到有術後吻合處滲漏或出血。術後延長性腸梗阻的發生率近 (MCS 組 14% vs. PCS 組 12.2%)。統計分析顯示，電動環狀吻合槍組的患者的住院天數較短，中位數為 8 天，比手動環狀吻合槍組少 1 天。多變量迴歸分析顯示，電動環狀吻合槍的術後住院天數較短，且有統計學上的差異。

結論 在左側結腸吻合手術中，使用電動環狀吻合槍未顯示出改善腸道功能恢復的優勢。我們假設使用電動針箍器對減少術後併發症或促進術後恢復無顯著幫助。然而，多變項分析顯示電動針箍器減少減少術後住院天數。未來，我們需納入更多患者以進一步證實此結論。

關鍵詞 手動環狀吻合槍、電動環狀吻合槍、術後預後。