Original article

Prognostic factors and management for left colonic perforation:

Can Hartmann procedure be preventable?

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Key words: Hartmann procedure, Colon perforation, Postoperative mortality

Abstract

Purposes: To identify factors significantly associated with mortality of patients with left colonic perforation, and to compare the outcome of the Hartman procedure (HP) and primary repair (PR) or primary anastomosis (PA) in left colonic perforation patients without factors associated with mortality.

Methods: This retrospective study included patients who underwent surgery for left colonic perforation from January 2009 to February 2018. Preoperative factors related to postoperative mortality, including vital signs, laboratory findings, and intraoperative findings, were analyzed by type of operation. The chi-square, Fisher exact, and Mann-Whitney U tests were used to analyze the data.

Results: Ninety-one patients were included (36 men, 55 women), and 15 (16.5%) died postoperatively. Prognostic factors were age, leukopenia, thrombocytopenia, bleeding tendency, acute kidney injury, hemodynamic instability, and existence of feculent ascites. Leukopenia and longer operative time were independent risk factors for mortality. Seventy-nine patients did not have leukopenia, and among them, 30 patients who underwent PR without diversion were excluded from the sub-analysis. HP was performed in 30 patients, and PR with diversion and PA with or without diversion were performed in 19. Compared to the other operative methods, HP had no benefit for reducing in hospital mortality ($p=0.458$) and morbidity.

Conclusions: Leukopenia could be an objective prognostic factor for left colonic perforation. Although HP is the gold standard for septic left colonic perforation, it did not improve in hospital mortality of the patients without leukopenia. For such patients, PR or PA may be suggested as an alternative option for left colonic perforation.

Key words: Hartmann procedure, Colon perforation, Postoperative mortality

Introduction

Most patients with left colonic perforation are diagnosed with peritonitis, which may lead to a life-threatening condition requiring emergent surgical management. Emergent surgery itself and the life-threatening condition are associated with high morbidity and mortality. Although there have been many advancements and innovations of the surgical technique and medicine, the mortality of patients with colonic perforation is still high [1, 2].

The Hartmann procedure (HP) was first introduced by Henry Albert Hartmann in 1921 during the 30th French Surgical Association meeting [3]. This procedure consists of a sigmoid colectomy with end colostomy and distal stump. The development of HP decreased the mortality rate of patients. For several decades, HP has been the standard emergent surgical procedure for treating left colonic perforation [4].

However, HP is associated with low quality of life (QOL) because of the required colostomy care [5], and restoration of intestinal continuity after HP is associated with its own morbidity and mortality [3, 6]. The reversal rate of HP tended to be lower than 50% in most reported articles [3]. Recently, several studies reported beneficial effect in morbidity and mortality of primary repair (PR) or primary anastomosis (PA) compared with HP. Additionally, several other studies reported that PR or PA had no beneficial effect on mortality and morbidity [7].

Considering this controversy of HP in patients with left colonic perforation, we hypothesized that HP would exhibit a comparable outcome with PR or PA in a specific patient group with low risk of mortality. If the patient group that would receive no benefit from HP was known, this knowledge would lead to a decrease in the morbidity and mortality associated with HP. The primary goal of our study was to identify factors significantly associated with mortality in patients with left colonic perforation. The secondary goal was to compare the outcome of HP and PR or PA in left colonic perforation patients without factors associated with mortality.

Methods

Study design and patients

The study protocol was approved by the Institutional Review Board of 000 Hospital (approval number: 2019-04-008). This retrospective study included patients who underwent surgery for colonic perforation from January 2009 to February 2018 in 000 Hospital. One hundred thirteen patients underwent a surgical procedure for the treatment of colonic perforation. One hundred eleven patients were selected because of fidelity of the data. Among them, 91 patients had left colonic perforation, and the remaining patients had right or transverse colonic perforation. The left colon was defined as the descending colon to the rectum. The IRB waved the need for informed consent on this retrospective chart review

Data collection

All data were collected by reviewing patients' medical records. Collected data were patients' demographics (age, sex, weight, body mass index, and history of abdominal operation), clinical history (cause of perforation and the time from symptom onset to surgery), initial vital signs, preoperative laboratory findings, operative findings (perforation site, type of operation, aspect of ascites, operative time), length of hospital stay, and existence of surgical site infection and newly developed postoperative complication.

Each factor was classified. We defined advanced age as older than 70 years. Hypotension was defined as systolic blood pressure lower than 90 mmHg. Heart rates were grouped as more than 90 beats/min and other. Fever was defined as a body temperature more than 37.8 °C (100 °F), and patients were grouped as having a fever more than 37.8 °C and 37.8 °C or less. Anemia was defined as a hemoglobin level less than 12.5 g/dL, as per the World Health Organization criteria for anemia [8]. Leukopenia was defined as a white blood cell count less than 4,000/mcL, as per systemic inflammatory response syndrome (SIRS) criteria [9]. Thrombocytopenia was defined as a platelet count lower than 100,000/mcL, according to Williamson et al.'s criterion for moderate thrombocytopenia [10]. Activated partial thromboplastin time prolongation of more than 60 seconds was regarded as having a bleeding tendency. A preoperative serum creatinine level more than 2.0 mg/dL without past history of chronic kidney disease was regarded as acute kidney injury. Hyponatremia and hypokalemia were defined as a serum sodium level lower than 135 meq/L and serum potassium level lower than 3.5 meq/L, respectively. A partial pressure of carbon dioxide level lower than 32 mmHg was regarded as tachypnea, according to the SIRS criteria [9]. Causes of perforation were categorized as a benign cause (diverticulitis, colitis, and ischemia), malignancy, iatrogenic cause, trauma, and other. Preoperative use of inotropes or vasopressors was considered to indicate patients with hemodynamic instability.

Sub-analysis

To compare HP with other operative method at moderate risk group, we excluded patients who had leukopenia because leukopenia was the only independently relevant prognostic factor for mortality of left colonic perforation. We also excluded patients who underwent PR without diversion because they had mild disease. Thus, this sub-analysis included patients at moderate risk group, who underwent operation except PR without diversion and didn't show leukopenia preoperatively. Forty-nine patients were included in the sub-analysis. The flow chart of patient is presented in Figure 1.

Statistical analysis

The chi-square test and Fisher exact test were used to analyze discrete variables. The Mann-Whitney U test was used to analyze continuous variables. Relationships with postoperative in hospital mortality were analyzed based on each data and the type of operation, and factors with *p*-value less than 0.05 in the univariate analysis were evaluated in logistic regression model for multivariate analysis. Odds ratios and 95% confidence intervals were calculated with the chi-square test and logistic regression model. Statistical analyses

were performed using SPSS, version 25.0 (IBM Corp., Armonk, NY). All reported *p*-values are two-sided, and *p*-values <0.05 were considered statistically significant.

Results

Overall, 91 patients were included in this study. Patient characteristics are presented in Table 1. Patients' mean age was 69.2 ± 12.8 years, and 36 patients were men. The most common cause of perforation was diverticulitis (30%). HP (41%) was the most frequently performed operation, and PR (35%) was the second most commonly conducted operation.

Fifteen patients died during hospitalization, and the in hospital mortality rate was 16%. Preoperative patient characteristics such as advanced age, existence of leukopenia, thrombocytopenia, bleeding tendency, acute kidney injury, and hemodynamic instability were associated with in hospital mortality (Table 2). Operative findings such as existence of feculent ascites and operative time were associated with in hospital mortality. Comorbidity, cause of perforation, type of operation wasn't statistically significant. HP showed higher tendency with in hospital mortality than other operation method, but it wasn't statistically significant. Multivariate logistic regression analysis showed that existence of preoperative leukopenia and longer operative time were the most relevant factors associated with in hospital mortality (Table 2).

Sub-analysis was performed between the group that underwent HP (*n* = 30) and the other group that underwent other operative methods such as PR with diversion (*n* = 6), PA only (*n* = 12), and PA with diversion (*n* = 1) (Figure 1). In this sub-analysis, preoperative and intraoperative findings such as acute kidney injury and feculent ascites showed no difference between the two groups. This finding may indicate that there was no preoperative difference in severity of the disease. Postoperative ileus showed a lower tendency and surgical site infections showed a higher tendency in the HP group than in the PR or PA group. Any anastomotic leakage was not confirmed in other operative method group. There was no statistical difference in mortality and morbidity between the two groups (Table 3).

Discussion

There are several studies about the prognostic factors associated with mortality of colonic perforation. Each study showed that patients' mortality was associated with factors including but not limited to serum albumin level, C-reactive protein level, acute renal failure, Mannheim Peritoneal Index, American Society of Anesthesiologists physical status classification system score [2, 11-14]. Scoring systems such as POSSUM, P-POSSUM, CR-POSSUM, Association of Coloproctology of Great Britain & Ireland mortality model were developed to assess the prognosis of colonic perforation. Despite the development of these scoring systems, the assessment and adjustment of an accurate scoring system for predicting the risk of postoperative mortality is still challenging [15-18]. In this study, preoperative existence of leukopenia and longer operative time was significantly associated with mortality.

Moore et al. [19] reported inadequate paradoxical granulopoiesis suppression after torso trauma. Subsequently, several studies revealed that bone marrow suppression caused by sepsis induces neutropenia [20, 21]. Sepsis also causes T-cell immune paralysis, so patients' immunity continues to get worse [22]. Tanaka et al. [23] reported that mortality and anti-inflammatory cytokines in the leukopenia group were higher than those of the leukocytosis group. Therefore, leukopenia could be regarded as a potential prognostic factor associated with mortality in septic patients.

Longer operative time itself was not a risk factor for higher mortality, in which was rather consequence of disease severity. In addition, operative time could be affected by skills of each surgeons. So we did not regarded longer operative time as an objective variable.

In this study, 14 patients with iatrogenic cause received PR and the other 2 patients received PA. HP was not performed for the patients with iatrogenic disease. In this group, 5 patients of 16 were operated after 24 hours from perforation. Four of them were treated with PR and the other one was with PA. Iatrogenic cause didn't show statistical significance in univariate analysis but it showed lower tendency of association with in hospital mortality. Iatrogenic cause Patients who underwent PR without diversion had mildly severe disease. PR was more performed in patients with iatrogenic disease that caused perforation within a few hours, no hemodynamic instability and no feculent ascites. We excluded patient who underwent PR only because of mild disease to eliminate bias in our sub-analysis. There were 8 cases of mortality in the sub-analysis and two of them were operated with other procedure than HP (PR with diversion and PA with diversion). These 2 patients were expired because of worsening of sepsis on the sixth and fifth postoperative days.

Despite advancement in the surgical technique, HP is still a frequently performed operation for the treatment of left colonic perforation [24]. Since the mid 2000s, there have been many discussions on the proper surgical management for colonic diverticular perforation, but there is still controversy [25]. In a systematic review and meta-analysis by Halim et al. [7], 22 of 25 articles reported that PA was associated with a lower in hospital mortality than HP, and the other 3 articles did not report this finding. Statistically, PA had a lower in hospital mortality than HP. However, because of the longer operative time of PA, HP seemed to be a safer option for high-risk comorbid patients. Our sub-analysis showed no statistically significant difference between HP and PR with diversion or PA in mortality among patients without leukopenia. According to our results and considering patients' QOL, surgical methods other than HP could be a better option for patients without leukopenia.

Reversal of HP is associated with its own mortality and morbidity. Many patients who underwent HP could not undergo the reversal operation because of their general condition or existence of malignancy. Many studies evaluated postoperative outcomes of reversal of HP. In Horesh et al.'s review [3], the reversal rate varied but tended to be less than 50%. Further, some studies reported a postoperative morbidity of more than 40% of the complication rate. [26, 27] Recently, there have been active discussions about the safety of laparoscopic HP and laparoscopic reversal of HP, and most studies have shown no significant difference in

mortality between the laparoscopic method and open method [4, 28, 29]. We also started to perform these surgical methods in recent years. We experienced the same result: no significant difference in mortality between laparoscopic surgery versus the open method. This change of new surgical technique could be another bias.

Our study has some limitations. First, it was a single-center study and the sample size was relatively small. The validity of the result could be affected. Second, our study had a retrospective design, so we could not obtain some information, such as the C-reactive protein level, procalcitonin level, and Acute Physiologic Assessment and Chronic Health Evaluation score. Finally, surgeries were performed by 10 different surgeons. However, there was no significant difference in postoperative outcomes by each surgeon.

Conclusion

Existence of leukopenia could be an objective prognostic factor for left colonic perforation. Considering difficulties of HP reversal operation and life quality of the patient, PR with diversion and PA with or without diversion may be suggested as an alternative option for left colonic perforation patients without leukopenia. Prospective controlled randomized study may be needed.

Reference

1. Ng, H.J., M. Yule, M. Tsoon, N.R. Binnie, and E.H. Aly, Current outcomes of emergency large bowel surgery. *Ann R Coll Surg Engl*, 2015. 97(2): p. 151-6.
2. Kriwanek, S., C. Armbruster, P. Beckerhinn, and K. Dittrich, Prognostic factors for survival in colonic perforation. *Int J Colorectal Dis*, 1994. 9(3): p. 158-62.
3. Horesh, N., Y. Rudnicki, Y. Dreznik, A.P. Zbar, M. Gutman, O. Zmora, et al., Reversal of Hartmann's procedure: still a complicated operation. *Tech Coloproctol*, 2018. 22(2): p. 81-87.
4. Toro, A., A. Ardiri, M. Mannino, A. Politi, A. Di Stefano, Z. Aftab, et al., Laparoscopic Reversal of Hartmann's Procedure: State of the Art 20 Years after the First Reported Case. *Gastroenterol Res Pract*, 2014. 2014: p. 530140.
5. Vermeulen, J., M.P. Gosselink, J.J. Busschbach, and J.F. Lange, Avoiding or reversing Hartmann's procedure provides improved quality of life after perforated diverticulitis. *J Gastrointest Surg*, 2010. 14(4): p. 651-7.
6. Richards, C.H., C.S. Roxburgh, and G. Scottish Surgical Research, Surgical outcome in patients undergoing reversal of Hartmann's procedures: a multicentre study. *Colorectal Dis*, 2015. 17(3): p. 242-9.
7. Halim, H., A. Askari, R. Nunn, and J. Hollingshead, Primary resection anastomosis versus Hartmann's procedure in Hinchey III and IV diverticulitis. *World J Emerg Surg*, 2019. 14: p. 32.
8. WHO, Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. *Vitamin and Mineral Nutrition Information System*. Geneva: World Health Organization, 2011.
9. Singer, M., C.S. Deutschman, C.W. Seymour, M. Shankar-Hari, D. Annane, M. Bauer, et al., The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*, 2016. 315(8): p. 801-10.
10. Williamson, D.R., M. Albert, D. Heels-Ansdell, D.M. Arnold, F. Lauzier, R. Zarychanski, et al., Thrombocytopenia in critically ill patients receiving thromboprophylaxis: frequency, risk factors, and outcomes. *Chest*, 2013. 144(4): p. 1207-1215.
11. Tan, K.K., J. Zhang, J.Z. Liu, S.F. Shen, A. Earnest, and R. Sim, Right colonic perforation in an Asian population: predictors of morbidity and mortality. *J Gastrointest Surg*, 2009. 13(12): p. 2252-9.
12. Shin, R., S.M. Lee, B. Sohn, D.W. Lee, I. Song, Y.J. Chai, et al., Predictors of Morbidity and Mortality After Surgery for Intestinal Perforation. *Ann Coloproctol*, 2016. 32(6): p. 221-

227.

13. Tan, K.K., C.C. Hong, J. Zhang, J.Z. Liu, and R. Sim, Predictors of outcome following surgery in colonic perforation: an institution's experience over 6 years. *J Gastrointest Surg*, 2011. 15(2): p. 277-84.
14. Bielecki, K., P. Kaminski, and M. Klukowski, Large bowel perforation: morbidity and mortality. *Tech Coloproctol*, 2002. 6(3): p. 177-82.
15. Yoo, R.N., B.H. Kye, G. Kim, H.J. Kim, and H.M. Cho, Mortality risk factor analysis in colonic perforation: would retroperitoneal contamination increase mortality in colonic perforation? *Ann Surg Treat Res*, 2017. 93(4): p. 203-208.
16. Tekkis, P.P., D.R. Prytherch, H.M. Kocher, A. Senapati, J.D. Poloniecki, J.D. Stamatakis, et al., Development of a dedicated risk-adjustment scoring system for colorectal surgery (colorectal POSSUM). *Br J Surg*, 2004. 91(9): p. 1174-82.
17. Prytherch, D.R., M.S. Whiteley, B. Higgins, P.C. Weaver, W.G. Prout, and S.J. Powell, POSSUM and Portsmouth POSSUM for predicting mortality. Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity. *Br J Surg*, 1998. 85(9): p. 1217-20.
18. Leung, E., K. McArdle, and L.S. Wong, Risk-adjusted scoring systems in colorectal surgery. *Int J Surg*, 2011. 9(2): p. 130-5.
19. Moore, F.A., V.M. Peterson, E.E. Moore, C. Rundus, and R. Poggetti, Inadequate granulopoiesis after major torso trauma: a hematopoietic regulatory paradox. *Surgery*, 1990. 108(4): p. 667-74; discussion 674-5.
20. Bone, R.C., W.J. Sibbald, and C.L. Sprung, The ACCP-SCCM consensus conference on sepsis and organ failure. *Chest*, 1992. 101(6): p. 1481-3.
21. Markwart, R., S.A. Condotta, R.P. Requardt, F. Borken, K. Schubert, C. Weigel, et al., Immunosuppression after sepsis: systemic inflammation and sepsis induce a loss of naive T-cells but no enduring cell-autonomous defects in T-cell function. *PLoS One*, 2014. 9(12): p. e115094.
22. Jensen, I.J., F.V. Sjaastad, T.S. Griffith, and V.P. Badovinac, Sepsis-Induced T Cell Immunoparalysis: The Ins and Outs of Impaired T Cell Immunity. *J Immunol*, 2018. 200(5): p. 1543-1553.
23. Tanaka, H., T. Ikeda, S. Ono, S. Suda, and T. Ueno, White blood cell counts have an impact on septic patient outcome followed by polymyxin-b immobilized fiber with direct hemoperfusion. *Critical Care*, 2015. 19(Suppl 1): p. P128-P128.
24. Cirocchi, R., S. Trastulli, J. Desiderio, C. Listorti, C. Boselli, A. Parisi, et al., Treatment of Hinchey stage III-IV diverticulitis: a systematic review and meta-analysis. *Int J Colorectal*

- Dis, 2013. 28(4): p. 447-57.
25. Seah, D.W., S. Ibrahim, and K.H. Tay, Hartmann procedure: is it still relevant today? ANZ J Surg, 2005. 75(6): p. 436-40.
 26. Mazeh, H., A.J. Greenstein, K. Swedish, S.Q. Nguyen, A. Lipskar, K.J. Weber, et al., Laparoscopic and open reversal of Hartmann's procedure--a comparative retrospective analysis. Surg Endosc, 2009. 23(3): p. 496-502.
 27. Banerjee, S., A.J. Leather, J.A. Rennie, N. Samano, J.G. Gonzalez, and S. Papagrigoriadis, Feasibility and morbidity of reversal of Hartmann's. Colorectal Dis, 2005. 7(5): p. 454-9.
 28. Turley, R.S., A.S. Barbas, M.E. Lidsky, C.R. Mantyh, J. Migaly, and J.E. Scarborough, Laparoscopic versus open Hartmann procedure for the emergency treatment of diverticulitis: a propensity-matched analysis. Dis Colon Rectum, 2013. 56(1): p. 72-82.
 29. Agaba, E.A., R.M. Zaidi, P. Ramzy, M. Aftab, E. Rubach, G. Gecelter, et al., Laparoscopic Hartmann's procedure: a viable option for treatment of acutely perforated diverticulitis. Surg Endosc, 2009. 23(7): p. 1483-6.

Table 1. Characteristics of the 91 patients who underwent surgery for left colonic perforation

Characteristic		N (%)
Age (mean $\pm$ SD)		69.2 $\pm$ 12.8
Sex	Male	36 (40)
	Female	55 (60)
Hospital stay	Fewer than 15 days	35 (38)
	More than 15 days	56 (62)
BMI (mean $\pm$ SD)		23.2 $\pm$ 3.1
History of abdominal operation	No	67 (74)
	Yes	24 (26)
Cause of perforation	Benign cause	57 (63)
	Cancer	9 (10)
	Iatrogenic (CFS)	16 (18)
	Trauma	4 (4)
	Other	5 (5)
Type of surgery performed	PR	32 (35)
	PR with diversion	8 (9)
	HP	38 (42)
	PA	12 (13)
	PA with diversion	1 (1)

PR, primary repair; HP, Hartmann procedure; PA, primary anastomosis; SD, standard deviation; CFS, colonofiberscopy

Table 2. Analysis of in hospital mortality

Variable		Univariate analysis			Multivariate analysis		
		Survivors (n=76)	Nonsurvivors(n=15)	P-value	Odd ratio	95% CI	P-value
Age (years)	≤70	40 (53)	3 (20)	0.025*	3.39	0.40-29.27	0.268
	>70	36 (47)	12 (80)				
Sex	Male	32 (42)	4 (27)	0.388			
	Female	44 (58)	11 (73)				
Hypertension history	No	29 (38)	2 (13)	0.078			
	Yes	47 (62)	13(87)				
Diabetes mellitus history	No	66 (87)	10 (67)	0.120			
	Yes	10 (13)	5 (33)				
Cerebrovascular Accident history	No	71 (93)	14(93)	1.000			
Cardiovascular disease history	No	69 (91)	12 (80)	0.359			
	Yes	7 (9)	3 (20)				
Chronic kidney disease history	No	70 (92)	12 (80)	0.164			
	Yes	6 (8)	3 (20)				
Heart rate (beats/min)	≤90	45 (59)	7 (47)	0.404			
	>90	31 (41)	8 (53)				
Body temperature (°C)	≤37.8	54 (71)	10 (67)	0.762			
	>37.8	22 (29)	5 (33)				
Anemia	No	39 (51)	4 (27)	0.096			
	Yes	37 (49)	11 (73)				
Leukopenia	No	70 (92)	9 (60)	0.004*	11.64	1.15-117.93	0.038*
	Yes	6 (8)	6 (40)				
Thrombocytopenia	No	74 (97)	12 (80)	0.030*	267.60	0.44-161993.5	0.087
	Yes	2 (3)	3 (20)				
Bleeding tendency	No	74 (100)	13 (87)	0.027*			
	Yes	0 (0)	2 (13)				
Acute kidney injury	No	74 (97)	11 (73)	0.006*	43.17	0.633-2944.2	0.081
	Yes	2 (3)	4 (27)				
Hyponatremia	No	54 (71)	10 (67)	0.757			
	Yes	21 (29)	5 (33)				
Hypokalemia	No	67 (89)	11 (73)	0.110			
	Yes	8 (11)	4 (27)				
Tachypnea	pCO ₂ ≥32	63 (84)	10 (67)	0.149			
	pCO ₂ <32	12 (16)	5 (33)				
Cause of perforation	Benign cause	45 (59)	12 (80)	0.280			
	Cancer	7 (9)	2 (13)				
	Iatrogenic (CFS)	16 (21)	0 (0)				
	Trauma	4 (5)	0 (0)				
	Other	4 (5)	1 (7)				
Time from symptom	<24 h	43 (70)	5 (50)	0.275			

onset to surgery	≥24 h	18 (30)	5 (50)				
Hemodynamic instability	No	68 (89)	8 (53)	0.002*	1.73	0.11-27.19	0.696
	Yes	8 (11)	7 (47)				
Feculent exudate	No	37 (61)	2 (13)	0.004*	70.73	0.74-6753.04	0.067
	Yes	23 (39)	11 (87)				
Laparoscopic operation	Open method	61 (80)	14 (93)	0.456			
	Laparoscopy	15 (20)	1 (7)				
Surgical site infection	No	48 (63)	9 (60)	1.000			
	Yes	28 (37)	6 (40)				
Postoperative ileus	No	56 (74)	10 (67)	0.546			
	Yes	20 (26)	5 (33)				
BMI		23.19 ± 3.1	23.25 ± 3.6	0.865			
White blood cell(×1000/mcL)		11.89 ± 8.4	9.14 ± 8.6	0.063			
Operative time(min)		173.46 ± 72.1	218.33 ± 69.8	0.026*	1.03	1.00-1.06	0.041*

CFS, colonofiberscopy; BMI, body mass index; pCO₂, partial pressure of carbon dioxide; **p*<0.05, statistically significant

95% CI, 95% Confidence Interval; Values are presented as a number (%) unless otherwise indicated

Table 3. Comparison of perioperative findings and postoperative outcomes of the HP versus other operative method at patients with moderate risk group of mortality

Variable		Other operative method (n = 19)	Hartmann procedure (n = 30)	<i>p</i> -value
Age (years)	≤70	9 (47)	12 (40)	0.768
	>70	10 (53)	18 (60)	
Thrombocytopenia	No	19 (100)	28 (93)	0.515
	Yes	0 (0)	2 (7)	
Bleeding tendency	No	19 (100)	28 (97)	1.000
	Yes	0 (0)	1 (3)	
Acute kidney injury	No	18 (95)	29 (97)	1.000
	Yes	1 (5)	1 (3)	
Feculent ascites	No	9 (60)	12 (52)	0.744
	Yes	6 (40)	11 (48)	
Surgical site infection	No	14 (74)	14 (47)	0.081
	Yes	5 (26)	16 (53)	
Postoperative ileus	No	12 (63)	26 (87)	0.081
	Yes	7 (37)	4 (13)	
Mortality	Survived	17 (89)	24 (80)	0.458
	Died	2 (11)	6 (20)	
Hospital stay	≥15 days	12 (63)	23 (77)	0.346
	<15 days	7 (37)	7 (23)	
Cause of perforation	Benign cause	14 (74)	21 (70)	0.130
	Cancer	1 (5)	7 (23)	
	Iatrogenic	2 (11)	0 (0)	
	Trauma	0 (0)	1 (3)	
	Others	2 (11)	1 (3)	

Values are presented as a number (%) unless otherwise indicated.

Figure 1. Distribution of the patients[†]

Figure 1. Distribution of the patients