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Risk factors for prolongation of ileostomy closure operation

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Abstract. – OBJECTIVE: Understanding factors for prolonged operative time is essential for surgery. This study aims at identifying the factors related to prolonged ileostomy closure operation time.

PATIENTS AND METHODS: The data of 88 patients who underwent ileostomy reversal in the Department of Gastrointestinal Surgery of Jiaxing First Hospital between January 2018 and October 2021 were retrospectively analyzed. Prolonged operation time was defined as operative time >65 minutes. The Chi-square test was used to compare data between patients with normal operative time (≤65 minutes) and patients with prolonged operative time. Univariate and multivariate logistic regression analyses were performed to identify the factors associated with prolonged ileostomy closure operation time.

RESULTS: Among the 88 patients (mean age: 62.78 years), median ileostomy retention time was 127.50 (range: 61.00-1,192.00) days. The operation time ranged from 35.00 minutes to 125.00 minutes. Prolonged ileostomy closure time occurred in 41 (46.6%) patients. In univariate analysis, the factors associated with prolonged operation time were body mass index (BMI) ≥25 kg/m², previous history of abdominal surgery, and manual suture. History of serious complications after the primary operation was associated with shorter operation time. In multivariate analysis, the independent risk factors for prolonged operation time were BMI ≥25 kg/m² (OR = 4.552, 95% CI: 1.369-15.136, $p = 0.013$), previous history of abdominal surgery (OR = 4.377, 95% CI: 1.394-13.739, $p = 0.011$), and manual suture (OR = 3.941, 95% CI: 1.181-13.154, $p = 0.026$).

CONCLUSIONS: Overweight, previous history of abdominal surgery, and manual suture appear to be risk factors for prolonged operative time for ileostomy closure.

Key Words:
Ileostomy closure, Ileostomy reversal, Operation time, Risk factors, Overweight.

Introduction

Temporary enterostomy, with diversion of intestinal contents, is widely used for reducing the risk of postoperative anastomotic leakage following surgery for low rectal cancer, severe abdominal trauma, intestinal obstruction, inflammatory bowel disease, and other conditions[1,2]. Ileostomy is the most commonly used temporary stoma method[3], therefore, ileostomy closure has become a common surgical procedure.

Previous studies[4] on ileostomy closure have generally focused on the surgical indications, postoperative complications, and the method and timing of surgery. Age, the interval between ileostomy creation and closure, and operation time, have been identified as independent risk factors for postoperative complications after diverting ileostomy closure. The incidence of complications after ileostomy closure is estimated to be 10-30%[5], so ileostomy closure cannot be considered a safe surgical procedure.

Closure of ileostomy is usually quickly performed, but prolonged operation time is not rare in clinical practice. Longer operation time increases risk for postoperative infection, aspiration pneumonia, deep venous thrombosis, and other complications[6]. Shortening the operation time will reduce operation risks and complications. The aim of this retrospective study was to identify the factors responsible for prolonged ileostomy reversal operation time. Awareness of these risk factors will help surgeons formulate appropriate treatment strategies.

Patients and Methods

Study Population

The data of patients who underwent closure of ileostomy in the Department of Gastrointes-

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tinal Surgery of the First Hospital of Jiaxing between January 2018 and October 2021 were retrospectively analyzed. Patients were eligible for inclusion in this study if: 1) complete clinical data were available and 2) the operation was performed by experienced senior doctors. We excluded: 1) patients who had undergone closure of ileostomy along with some other operation and 2) those who had undergone reoperation or multiple operations between ileostomy creation and ileostomy closure.

The case records of the selected patients were collected and data were extracted about age and sex, comorbidities (hypertension, coronary heart disease and diabetes mellitus), body mass index (BMI), history of previous abdominal surgery (involving gallbladder, stomach, pancreas, appendix, or uterus), whether the primary operation was an emergency operation, whether the ostomy was performed due to cancer, mode of the primary operation (laparoscopic, open), history of serious complications after the primary operation (intestinal obstruction, intra-abdominal infection, gastrointestinal bleeding), stoma retention time, anastomosis method, operation time, post-operative incision infection, and duration of postoperative hospitalization.

This study was approved by the Ethics and Clinical Investigation Committee of Jiaxing First Hospital (approval number: LS2021-KY-365), with exemption granted for the need for informed consent.

Definitions

Prolonged operation time was defined as operation time higher than 65 minutes (i.e., the median operation time in this cohort). Primary operation was defined as surgery with ileostomy creation. Previous history of abdominal surgery referred to abdominal surgery other than primary operation. BMI was calculated by dividing the patient's weight (in kilograms) by the height (in meters) squared; the World Health Organization (WHO) classifies adults with a BMI between 25 and 29.9 kg/m^2 as "overweight"[7,8].

Procedure for Ileostomy Closure

The ileostomy was covered with iodoform gauze. The skin was disinfected, and an incision (about 2 cm in length) was made around the stoma. Adhesions between the abdominal wall and the ostomy intestine were separated, and the local bowel was fully freed. A functional end-to-end anastomosis was performed in patients with manual anastomosis, using continuous full-thickness suture with absorbable 3-0 thread. The side-to-side anastomosis was achieved with a linear stapler. The anastomosis with the intestine was reinforced with sutures. After confirming anastomotic patency and good blood supply, the peritoneum and external oblique aponeurosis were sutured with absorbable suture. The skin was closed with full thickness suture.

Statistical Analysis

Measurement data were summarized as mean ± standard deviation or median [(interquartile range (IQR)] and compared using the independent samples *t*-test or the Mann-Whitney U test, respectively. Enumeration data were expressed as number of cases and percentages and compared using the Chi-square test. Rates of prolonged operative time were compared and graphed across per unit increments of BMI, Chi-square test of linear trend was performed. Univariate and multivariate logistic regression analyses were performed to identify the factors associated with prolonged ileostomy closure operation time; factors significantly associated (at $p < 0.05$) with prolonged operation time in univariate analysis were included in multivariate analysis. Statistical analyses were performed using SPSS 26 (IBM Corp., Armonk, NY, USA). A *p*-value lower than 0.05 was considered statistically significant.

Results

Study Population

A total of 106 patients underwent ileostomy closure during the study period. Among these, 18 patients were excluded (1 patient who had received treatment at several hospitals, 10 patients who underwent other operations along with ileostomy closure, 6 patients with incomplete clinical data, and 1 patient in whom stoma reversal failed). The remaining 88 patients were included in the study. Table I presents the demographic and clinical characteristics of the patients. Figure 1 shows the distribution of the operation time in the 88 patients. The median operation time (65 minutes) was used to separate the 88 patients into two groups: a standard operation time group (n = 47, with operation time ≤65 minutes) and a prolonged operation time group (n = 41, with operation time >65 minutes).

Postoperative Incision Infection

15 of the 88 patients had post-operative incision infection. The operation time of the post-operative

Table I. Clinical characteristics of patients (n = 88).

Factors	Data
Male/female ratio	2.52
Age, years, mean (range)	62.78 (30-85)
BMI, mean (range)	22.48 (15.59-28.94)
Duration of surgery, minutes, median (range)	65 (35-125)
Postoperative hospital stay, days, median (range)	7 (3-28)
Stoma retention time, days, median (range)	127.50 (61-1192)
Post-operative incision infection, n (%)	15 (17.0%)
Previous history of abdominal surgery, n (%)	
Cholecystectomy	2 (2.3%)
GI surgery	2 (2.3%)
Pancreaticoduodenectomy	1 (1.1%)
Appendectomy	9 (10.2%)
Uterus surgery	9 (10.2%)
Splenectomy	1 (1.1%)
Comorbidity, n (%)	
Hypertension	29 (33.0%)
Coronary heart disease	2 (2.3%)
Diabetes mellitus	18 (20.5%)
Benign prostatic hyperplasia	1 (1.1%)
Serious complications after primary operation, n (%)	
Intestinal obstruction	9 (10.2%)
Intra-abdominal infection	2 (2.3%)
GI bleeding	1 (1.1%)

BMI, body mass index; GI, gastrointestinal.

incision infection group was 81.00 ± 22.92 minutes, while in the non-infection group it was 65.92 ± 19.6 minutes. The operation time was significantly longer in the post-operative incision infection group ($p = 0.010$). The length of postoperative hospital stay (days) in the group with post-operative incision infection was longer than that in the non-infection group (12.87 *vs.* 7.15, $p = 0.002$).

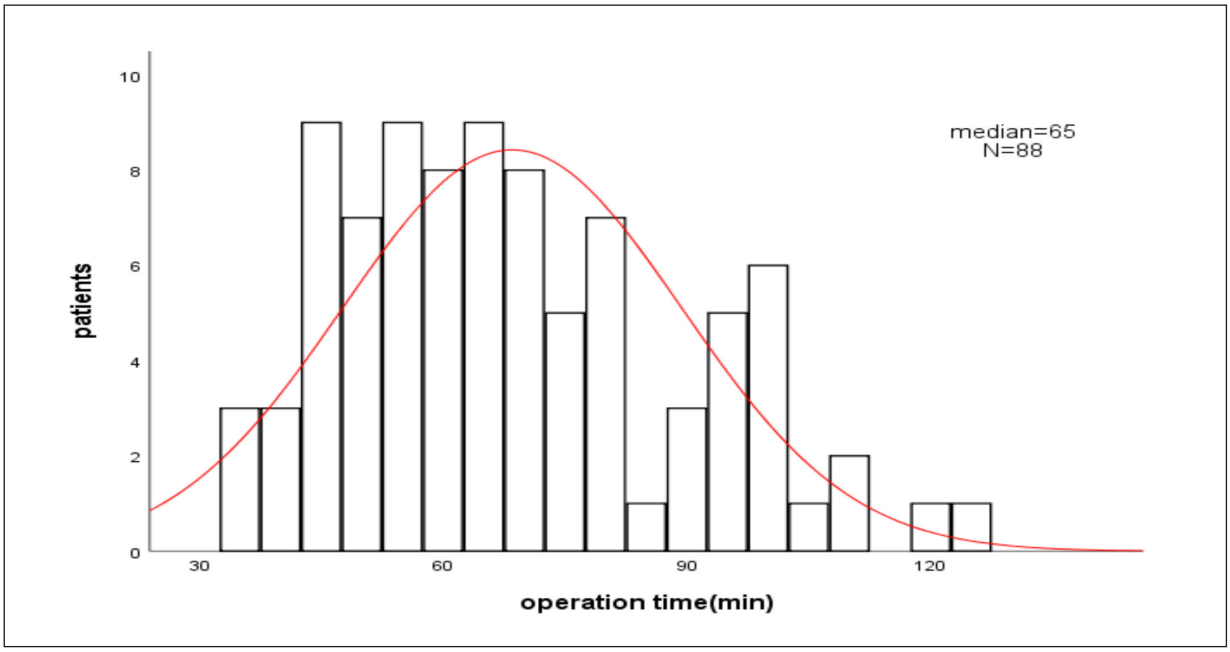

Figure 1. Frequency distribution of operation time in the 88 patients.

Table II. Comparison of clinical data between the two groups.

Factors	Standard ileostomy closure group (n = 47)	Prolonged ileostomy closure group (n = 41)	t/Z/χ^2	*p*
Age, years, mean ± SD	63.49 ± 11.20	61.98 ± 9.70	0.673	0.503
Postoperative hospital stay, days, mean ± SD	6.0 (5.0, 8.0)	8.0 (6.0, 9.0)	-2.401	**0.019**
Stoma retention time, years, median (range)	128.0 (95.0, 178.0)	127.0 (99.5, 192.0)	−0.611	0.541
Sex, *n* (%)				
Male	33 (70.2%)	30 (73.2%)	0.094	0.759
Female	14 (29.8%)	11 (26.8%)		
Comorbidity, n (%)				
No	28 (59.6%)	20 (48.8%)	1.029	0.310
Yes	19 (40.4%)	21 (51.2%)		
BMI (kg/m^2), *n* (%)				
<25	42 (89.4%)	27 (65.9%)	7.148	**0.008**
≥25	5 (10.6%)	14 (34.1%)		
Previous history of abdominal surgery, *n* (%)				
No	40 (85.1%)	26 (63.4%)	5.495	**0.019**
Yes	7 (14.9%)	15 (36.6%)		
Mode of primary operation, *n* (%)				
Open approach	9 (19.1%)	12 (29.3%)	1.234	0.267
Laparoscopic approach	38 (80.9%)	29 (70.7%)		
Primary operation performed as emergency procedure, *n* (%)			0.357	0.550
No	45 (95.7%)	37 (90.2%)		
Yes	2 (4.3%)	4 (9.8%)		
Ostomy performed due to cancer, *n* (%)				
No	4 (8.5%)	7 (14.6%)	0.321	0.571
Yes	43 (91.5%)	28 (85.4%)		
Serious complications after primary operation, *n* (%)			5.000	**0.025**
No	37 (78.7%)	39 (95.1%)		
Yes	10 (21.3%)	2 (4.9%)		
Anastomosis method, *n* (%)				
Stapler anastomosis	41 (87.2%)	27 (65.9%)	5.700	**0.017**
Manual suture	6 (12.8%)	14 (34.1%)		

SD, standard deviation; BMI, body mass index.

Comparison of Clinical Data Between the Two Groups

Table II presents a comparison of the characteristics of the two groups. The proportions of patients with overweight, previous history of abdominal surgery, and manual anastomosis were significantly higher in the prolonged operation time group (all $p < 0.05$). The mean age, mean stoma retention time, sex distribution, prevalence of comorbidities, mode of primary operation, proportion undergoing primary surgery as emergency, and proportion receiving stoma due to cancer were comparable between the two groups (all $p > 0.05$, Table II).

Factors Affecting the Duration of Surgery

The incidence of prolonged operative time increased with increasing BMI, and this trend is shown in Figure 2 (Chi-square test for linear trend, $p < 0.001$). Table III presents the results of univariate and multivariate analysis. In univariate analysis, overweight, previous history of abdominal surgery, and manual anastomosis were associated with prolonged operation time, while history of serious complications after primary operation was associated with shorter operative time. In multivariate analysis, the factors independently associated with prolonged operation time were overweight (OR = 4.552, 95% CI: 1.369-15.136, $p = 0.013$), previous history of

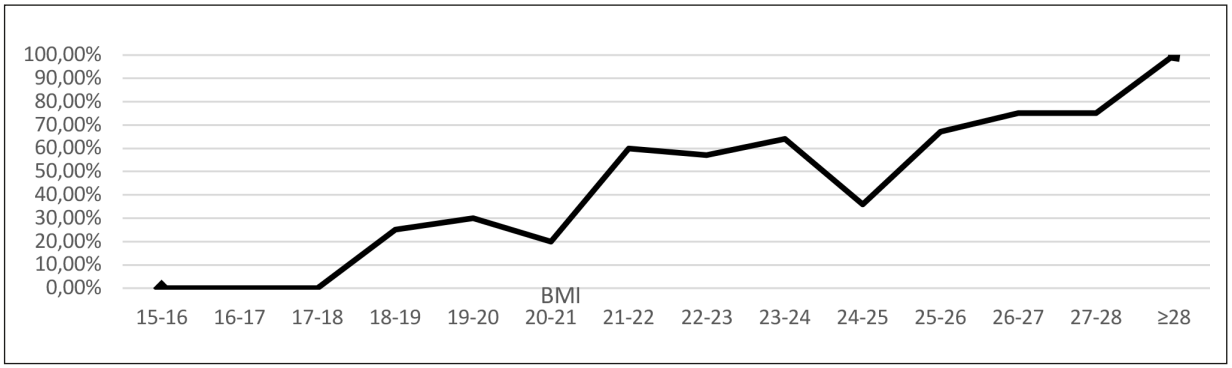

Figure 2. The raised incidence of prolonged operation time with the increase of BMI (n = 88; Chi-square linear trend, $p < 0.001$).

abdominal surgery (OR = 4.377, 95% CI: 1.394-13.739, $p = 0.011$), and manual anastomosis (OR = 3.941, 95% CI: 1.181-13.154, $p = 0.026$). Patients with history of serious complications after primary operation had odds ratio lower than 1, but it was not statistically significant (OR = 0.189, 95% CI: 0.033-1.084, $p = 0.062$). The visualization results are shown in Figure 3. A logistic regression model was established according to the results of the multivariate analysis to obtain the probability of multi-factor joint prediction (PRE_1), and the ROC curve was made. The prediction model comprehensively reflects the information of three risk factors: BMI, previous history of abdominal surgery, and anastomosis method. The area under the curve (AUC)

Table III. Results of logistic regression analysis.

Factors	Univariable model OR (95% CI)	*p*	Multivariable model OR (95% CI)	*p*
Sex Male Female	1 (ref) 0.864 (0.340-2.194)	0.759		
Comorbidity No Yes	1 (ref) 1.547 (0.665-3.603)	0.311		
BMI (kg/m^2) <25 ≥25	1 (ref) 4.356 (1.407-13.480)	**0.011**	4.552 (1.369-15.136)	**0.013**
Previous history of abdominal surgery No Yes	1 (ref) 3.297 (1.184-9.179)	**0.022**	4.377 (1.394-13.739)	**0.011**
Mode of primary operation Open approach Laparoscopic approach	1 (ref) 0.572 (0.213-1.541)	0.269		
Primary operation performed as emergency procedure No Yes	1 (ref) 2.432 (0.422-14.029)	0.320		
Ostomy performed due to cancer No Yes	1 (ref) 0.543 (0.142-2.076)	0.372		
Serious complications after primary operation No Yes	1 (ref) 0.190 (0.039-0.924)	**0.040**	0.189 (0.033-1.084)	0.062
Anastomosis method Stapler anastomosis Manual suture	1 (ref) 3.543 (1.212-10.357)	**0.021**	3.941 (1.181-13.154)	**0.026**

OR, odds ratio; CI, confidence interval; BMI, body mass index.

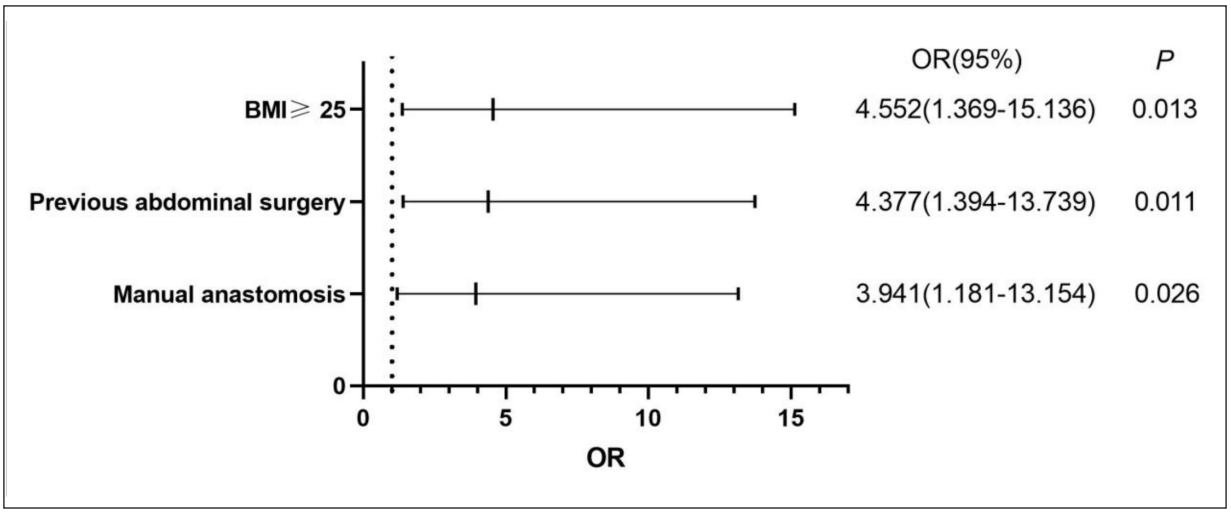

Figure 3. Independent risk factors associated with prolonged operation time.

of the model for predicting prolonged operation time is 0.763. When the Youden index was at its largest, its prediction sensitivity was 70.7% and the specificity was 70.2%.

Discussion

This study aimed to find out the factors associated with prolonged operation time for ileostomy closure. In our cohort of 88 patients 41 (46.6%) of patients had prolonged operation time. The factors associated with prolonged operation time were overweight, previous abdominal surgery, and use of manual anastomosis.

Among patients receiving protective ileostomy, a large proportion will undergo closure of ileostomy[9,10]. In general, the retention time of stoma ranges from 3 months to 6 months[4,11]. In our cohort, the stoma retention time was 127.50 days, or about 4 months, which is consistent with previous reports[4]. Although closure of ileostomy is simple and relatively easily performed, operation time may be prolonged in some cases. Prolonged operation time is associated with longer duration of postoperative bowel paralysis, longer hospital stay[12], and increased risk of postoperative complications such as incision infection and intestinal obstruction[4]. Reduction in operative time benefits the patient and helps optimizing utilization of operating room resources.

In this study, overweight (BMI ≥25 kg/m^2) was found to be independently associated with long operation time. Overweight and obesity, collectively referred to as "excess body weight", are defined as abnormal or excessive fat accumulation. High BMI has been shown to increase risk for a variety of diseases[13-15]. During surgery, the thick fat layer in the abdominal wall of obese patients could reduce the surgeon's field of vision and even lead to subsidiary injury. The excessive visceral adipose tissue in the obese patient might affect the identification of surgical level and blood vessels. The probability of injury to mesenteric vessels increases when they are wrapped in hypertrophic adipose tissue. At the same time, adipose tissue is fragile and easily torn, which may further reduce the accuracy of operation. These factors together increase operation difficulty and lead to an extension in the operation time[16].

Previous history of abdominal surgery increases difficulty of ileostomy closure and prolongs operation time mainly because of the presence of postoperative intra-abdominal adhesions that are found in 80-90% of these patients[17,18]. According to one theory[19], abdominal adhesions result from imbalance in fibrin deposition and degradation. Peritoneal injury caused by surgery gives inflammatory reactions, which stimulate fibroblast proliferation and fibrinogen production. Thrombin triggers the conversion of fibrinogen into fibrin. Normally, there is a balance between the release of fibrinogen and fibrinogen inhibitor; however, following mechanical injury, local ischemia, or inflammation of the peritoneum, decreases in tissue fibrinogen activator (t-PA) and urokinase fibrinogen activator (u-PA), as well as

in fibrinogen inhibitor, are found. Inhibition of fibrinolysis leads to fibrin deposition and, thereby, to formation of adhesions[20]. When adhesions are present, anatomical structure is distorted, and the surgeon must proceed carefully, separating the adhesions before freeing the intestinal tube around the stoma. This will inevitably increase operation time. Adhesions are more common following procedures that involve small intestine, colon, appendix, or the uterus than after procedures involving upper abdominal organs such as stomach, gallbladder, or pancreas[21,22]. In our cohort, 77.27% of patients with history of previous abdominal surgery had undergone procedures on lower abdominal organs; this may have led to the strong association we found between history of previous abdominal surgery and prolonged operation time.

The traditional method for reversing a loop ileostomy is a hand-sewn end-to-end bowel anastomosis. The side-to-side stapler anastomosis for closure of ileostomy was introduced in the 1980s and significantly shortened operating time and length of hospital stay according to most studies[23,24]. Several systematic reviews[23,25,26] and meta-analyses showed stapled closure of loop ileostomy associated with shorter operative time and lower risk of postoperative bowel obstruction. In our cohort, similar results were found, and patients who received side-to-side stapler anastomosis showed a shorter operation time, with a difference of about 10 min. Meanwhile, hand-sewn, and stapled techniques were similar in terms of anastomotic leak. It indicated both techniques are equally safe[25].

In the present study, univariate analysis suggested that a history of serious complications after primary surgery is related to the duration of ileostomy closure, but multivariate analysis did not find it to be an independent influencing factor. It is worth noting that among the patients with history of serious complications after primary surgery, 91.7% had a BMI <25 kg/m^2 before surgery. We speculate that the serious complications caused intestinal dysfunction and reduced nutrient absorption, and the resulting weight loss and reduction in abdominal fat made the secondary surgery easier to perform[27].

Conclusions

Patients with overweight, previous abdominal surgery, and manual anastomosis may require longer operation time for ileostomy closure. Promoting weight loss and using a stapler for anastomosis may help shortening the duration of surgery. For patients with history of previous abdominal surgery, the surgeon should be mentally prepared for prolonged operation time. Further large multicenter prospective studies are needed to verify the conclusions of this study.

Conflicts of Interest

The Authors declare that they have no conflict of interests.

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Ethics Approval

This study was approved by the Ethics and Clinical Investigation Committee of Jiaxing First Hospital (approval number: LS2021-KY-365)

Informed Consent

Ethics and Clinical Investigation Committee granted the exemption for the need of informed consent.

Data Availability

The data that support the findings of this study are available from the corresponding author, Xuning Shen, upon reasonable request.

Authors' Contributions

Xuning Shen designed the study and provided help in interpretation of the results. Chenyue Yu, Tiantian Qin and Yuying Dong collected the data, performed statistics, and interpreted of data for the work. Chenyue Yu drafted and edited the manuscript. All authors contributed to the article and approved the submitted version.

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