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Association of Preoperative Stoma-Site Marking With Stoma-Related Outcomes After Laparoscopic Rectal Cancer Resection With Diverting Ileostomy: A Retrospective Cohort Study

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Abstract

Background: Preoperative stoma-site marking is well established for permanent stomas but may be underused for temporary diverting ileostomies. This study evaluated its association with leakage, stoma-related complications, peristomal skin condition, and stoma-related quality of life.

Methods: This retrospective observational study included 221 patients undergoing diverting ileostomy, of whom 195 received preoperative stoma-site marking and 26 did not. Between-group differences in leakage severity, stoma-related complications, Discolouration, Erosion and Tissue overgrowth (DET) scores, and Stoma-Quality of Life (Stoma-QoL) scores were assessed. Ordinal logistic regression evaluated leakage severity, and multivariable logistic regression identified factors associated with stoma-related complications. Spearman's correlation assessed the association between DET and Stoma-QoL scores.

Results: Leakage severity was lower in the marking group (P = 0.007), and stoma-site marking was associated with lower odds of greater leakage severity (common OR, 0.32; 95% CI, 0.13–0.75; P = 0.009). Peristomal skin irritation (14.9% vs. 34.6%) and infection (4.6% vs. 19.2%) were less frequent in the marking group. After multivariable adjustment, stoma-site marking remained associated with lower odds of stoma-related complications (OR, 0.28; 95% CI, 0.11–0.71; P = 0.008), whereas ASA grade III and diabetes were associated with higher odds. DET scores did not differ significantly between groups (P = 0.116), but Stoma-QoL scores were higher in the marking group (P = 0.019). DET and Stoma-QoL scores were negatively correlated ($\rho = -0.269$; $P < 0.001$).

Conclusions: Preoperative stoma-site marking was associated with less leakage, fewer stoma-related complications, and better stoma-related quality of life after diverting ileostomy.

Keywords: rectal cancer; prophylactic ileostomy; stoma site marking; stoma-related complications; quality of life

Main text

Introduction

Surgery remains the cornerstone of curative treatment for rectal cancer, with radiotherapy and chemotherapy incorporated as part of a multidisciplinary treatment strategy when indicated. In patients undergoing sphincter-preserving surgery for low rectal cancer, a diverting ileostomy is frequently constructed to protect a low colorectal or coloanal anastomosis. The decision to create a diverting ileostomy is generally based on a comprehensive assessment of patient- and tumor-related factors, including age, nutritional status, tumor distance from the anal verge, histopathological characteristics, and tumor stage. Previous studies have suggested that diverting ileostomy may reduce the clinical consequences of anastomotic leakage and decrease the severity of leakage-related complications following rectal resection, thereby providing temporary fecal diversion during the period of greatest anastomotic vulnerability [1–3].

Despite these potential benefits, ileostomy formation is associated with a substantial burden of stoma-related morbidity. Changes in body image and bowel function, together with complications such as peristomal skin irritation, infection, bleeding, stoma prolapse, parastomal hernia, and stoma necrosis, may adversely affect patients' physical and psychological well-being and contribute to anxiety and depression. The reported incidence of stoma-related complications ranges from approximately 20% to 70%, and these complications can substantially impair postoperative quality of life [4,5].

To minimize stoma-related complications, several international guidelines recommend preoperative stoma site marking by appropriately trained and experienced healthcare professionals for patients scheduled to undergo stoma formation [6–8]. Accumulating evidence indicates that preoperative stoma site marking is associated with a lower risk of postoperative stoma-related complications [9–13]. However, evidence specifically addressing preoperative stoma site marking in patients with rectal cancer undergoing diverting ileostomy remains limited. Most previous studies have included heterogeneous populations with different underlying diseases and have analyzed patients with permanent and temporary stomas together. Such heterogeneity in patient characteristics, surgical indications, and stoma types may limit the applicability of these findings to patients undergoing temporary diverting

ileostomy for rectal cancer.

Therefore, the present study aimed to retrospectively evaluate patients with rectal cancer who underwent diverting ileostomy at Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, and to investigate the association of preoperative stoma site marking with postoperative ileostomy-related complications and patient-reported quality of life.

Materials and Methods

Study Population

We retrospectively reviewed patients with rectal cancer who underwent laparoscopic radical resection with diverting ileostomy in the Department of General Surgery, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences, between January 2023 and April 2026. Patients were divided into a preoperative stoma site marking group and a non-marking group according to whether preoperative stoma site marking had been performed. The inclusion criteria were as follows: (1) rectal cancer confirmed by histopathological examination of biopsy specimens; (2) receipt of laparoscopic radical resection for rectal cancer with diverting ileostomy; and (3) willingness to participate in the study and ability to understand and complete the study questionnaires. The exclusion criteria were: (1) previous history of stoma formation; (2) presence of multiple stomas; and (3) incomplete clinical data. The protocol received approval from the Ethics Committee of Peking Union Medical College Hospital (approval No. K26C4055) . Written informed consent was obtained from all participants.

Preoperative Stoma Site Marking

Preoperative stoma site marking was performed 24–48 hours before surgery by an enterostomal therapist or surgeon. The optimal stoma site was determined on the abdominal wall after comprehensive consideration of the patient’s body habitus, daily activities, and clothing preferences.

The principles of stoma site selection were as follows: (1) the proposed stoma site was located within the rectus abdominis muscle; (2) using the line connecting the umbilicus and the right anterior superior iliac spine as a reference, the junction between the middle and upper thirds of this line was initially selected as the candidate site; (3) a stoma appliance baseplate was placed over the proposed site, and the site was adjusted as necessary to ensure that the baseplate did not overlap the umbilical depression; (4) the proposed stoma site was clearly visible and readily accessible to the patient in different body positions, particularly while sitting and standing; and (5) the site avoided skin folds, bony prominences, and the beltline in different positions, including standing, sitting, supine, and bending forward. After the optimal site had been determined, it was marked using a medical-grade waterproof skin marker **(Figure 1).**

Outcomes and Data Collection

The demographic and clinical characteristics collected included age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) physical status classification, tumor stage, preoperative comorbidities, and duration of stoma maintenance. Peristomal skin condition was assessed by a trained enterostomal therapist during follow-up at the stoma outpatient clinic using the Ostomy Skin Tool (OST) [14]. The OST evaluates three domains of peristomal skin damage: discoloration (D), erosion (E), and tissue overgrowth (T). For each domain, the extent of the affected peristomal area is scored from 0 to 3 and the severity of the lesion from 0 to 2. The scores for the three domains are summed to generate a total DET score ranging from 0 to 15, with a score of 0 indicating normal peristomal skin and a score of 15 indicating severe peristomal skin damage. Stoma-related quality of life was assessed using the Stoma Quality of Life questionnaire (Stoma-QoL), which was completed by the patients. The Stoma-QoL consists of 20 items, each scored from 0 to 4, yielding a raw total score ranging from 0 to 80. The raw score was subsequently converted proportionally to a 0–100 scale [15]. Data on stoma leakage and stoma-related complications were also collected. Stoma-related complications included peristomal skin irritation, stomal bleeding, peristomal skin infection, stoma prolapse, parastomal hernia, and stoma necrosis. The overall

incidence of stoma-related complications was evaluated, and the severity of complications was graded according to the modified STOMA Clavien–Dindo (C–D) classification system [16].

Statistical Analysis

All statistical analyses were performed using R software (version 4.5.2). Continuous variables are presented as mean ± standard deviation (SD) or median (interquartile range [IQR]), and categorical variables as frequencies and percentages. Between-group comparisons were performed using Student's t-test or the Wilcoxon rank-sum test for continuous variables and Pearson's χ^2 test or Fisher's exact test for categorical variables, as appropriate. Leakage severity was treated as an ordinal variable and compared between the marking and non-marking groups using the Mann–Whitney U test. Ordinal logistic regression was further performed to assess the association between preoperative stoma-site marking and leakage severity, with results reported as common odds ratios (ORs) with 95% confidence intervals (CIs). DET and Stoma-QoL scores were compared between the two groups using the Wilcoxon rank-sum test. Spearman's rank correlation was used to assess the association between DET and Stoma-QoL scores.

Univariable and multivariable logistic regression analyses were performed to identify factors associated with stoma-related complications. Preoperative stoma-site marking was included in the multivariable model a priori, regardless of its univariable P value. Other variables were considered for inclusion based on clinical relevance and/or a P value < 0.20 in univariable analyses. Results are reported as ORs with 95% CIs. All tests were two-sided, and a P value < 0.05 was considered statistically significant.

Result

Baseline characteristics

A total of 221 patients were included, including 195 patients in the stoma-site marking group and 26 in the non-marking group. The baseline characteristics are summarized in **Table 1**. There was no significant difference in age between the marking and non-marking groups

(59.7 ± 11.3 vs. 61.2 ± 10.5 years, P = 0.492). Sex distribution differed significantly between the groups (P = 0.014), with a higher proportion of female patients in the non-marking group than in the marking group (61.5% vs. 34.4%). No significant differences were observed in body mass index category, ASA grade, comorbidities, or ypTNM stage between the two groups (all P > 0.05).

Stoma leakage severity

Stoma leakage severity was significantly lower in the marking group than in the non-marking group (P = 0.007; **Table 2**). The proportion of patients without leakage was higher in the marking group (84.1% vs. 61.5%), whereas occasional leakage was less frequent (13.3% vs. 34.6%). Preoperative stoma-site marking was associated with lower odds of greater leakage severity in ordinal logistic regression analysis (common OR, 0.32; 95% CI, 0.13–0.75; P = 0.009).

Stoma-related postoperative complications

In unadjusted analyses **(Table 3)**, preoperative stoma-site marking was associated with lower incidences of peristomal skin irritation (14.9% vs. 34.6%, P = 0.023) and peristomal infection (4.6% vs. 19.2%, P = 0.015). C-D grade I (25.1% vs. 50.0%, P = 0.018) and grade II (8.2% vs. 23.1%, P = 0.029) stoma-related complications were also less frequent in the marking group. No significant between-group differences were observed for the other individual stoma-related complications (all P > 0.05).

Factors associated with stoma-related complications

In univariable logistic regression analysis, increasing age, ASA grade III, and diabetes mellitus were significantly associated with higher odds of stoma-related complications, whereas preoperative stoma-site marking was associated with lower odds of complications **(Table 4)**. After multivariable adjustment, preoperative stoma-site marking remained independently associated with lower odds of stoma-related complications (aOR, 0.28; 95% CI, 0.11–0.71; P = 0.008). ASA grade III (aOR, 9.36; 95% CI, 2.12–49.1; P = 0.005) and diabetes mellitus (aOR, 2.53; 95% CI, 1.10–5.83; P = 0.028) were independently associated with higher odds of complications. No other variables included in the multivariable model were statistically significant.

Peristomal skin condition and stoma-related quality of life

The median DET score was numerically lower in the marking group than in the non-marking group, although the difference was not statistically significant (2.0 [IQR, 0.0–4.0] vs. 4.0 [IQR, 2.0–4.0], P = 0.116; Figure 2). In contrast, the median Stoma-QoL score was significantly higher in the marking group than in the non-marking group (59.1 [IQR, 50.8–66.7] vs. 52.8 [IQR, 43.6–62.3], P = 0.019; Figure 3). DET scores were significantly negatively correlated with Stoma-QoL scores (Spearman's $\rho = -0.269$, $P < 0.001$; Figure 4).

Discussion

Preoperative stoma-site marking has received considerable attention in patients undergoing permanent intestinal stoma formation, and standardized principles and care pathways have been relatively well established [16]. In contrast, diverting ileostomies are often regarded as temporary, and clinical attention is therefore more frequently focused on primary tumor resection, anastomotic protection, and subsequent stoma reversal. Consequently, the need for preoperative site marking and sustained stoma management may be underestimated. However, diverting ileostomies are often maintained for several months, and reversal may be delayed because of adjuvant therapy, postoperative complications, or poor general condition. During this period, patients must manage stoma appliances, effluent, peristomal skin care, and lifestyle changes [17]. The temporary nature of a diverting ileostomy does not necessarily imply a lower burden of care, and appropriate preoperative assessment and stoma-site marking may remain clinically important.

In the present study, preoperative stoma-site marking was associated with lower leakage severity, fewer stoma-related complications, and higher Stoma-QoL scores. The proportion of patients without leakage was higher in the marking group than in the non-marking group (84.1% vs. 61.5%), whereas occasional leakage was less frequent (13.3% vs. 34.6%). The overall distribution of leakage severity differed significantly between the groups. Ordinal logistic regression further showed that preoperative stoma-site marking was associated with lower odds of greater leakage severity (common OR, 0.32; 95% CI, 0.13–0.75; P = 0.009). This finding suggests that the potential benefit of stoma-site marking may lie primarily in

reducing the likelihood of occasional or frequent leakage rather than merely preventing the most severe leakage events.

This finding is clinically plausible. Ileostomy effluent is typically liquid or semiliquid and contains digestive enzymes that may irritate the surrounding skin when appliance adherence is inadequate or leakage occurs. Appropriate preoperative marking aims to identify a relatively flat and visible site that avoids skin folds and bony prominences and can be easily accessed by the patient, thereby facilitating appliance fit and self-care [18]. Leakage prevention may therefore represent an important clinical link between preoperative marking and improved postoperative stoma management.

Consistent with the leakage findings, the marking group had lower incidences of peristomal skin irritation (14.9% vs. 34.6%) and peristomal infection (4.6% vs. 19.2%). C-D grade I and II stoma-related complications were also less frequent in the marking group. In contrast, no significant between-group differences were observed in stomal bleeding, parastomal hernia, stoma retraction, stoma prolapse, or stoma necrosis. These findings suggest that the association between preoperative marking and postoperative outcomes may be more apparent for complications related to appliance fit, leakage, and peristomal skin care, whereas structural complications may be influenced to a greater extent by surgical technique, tissue perfusion, and abdominal wall characteristics.

Because sex distribution differed between the groups at baseline, multivariable logistic regression was performed to account for potential confounding. After adjustment, preoperative stoma-site marking remained independently associated with lower odds of stoma-related complications (OR, 0.28; 95% CI, 0.11–0.71; P = 0.008). In contrast, ASA grade III (OR, 9.36; 95% CI, 2.12–49.1) and diabetes mellitus (OR, 2.53; 95% CI, 1.10–5.83) were independently associated with higher odds of complications. A higher ASA grade may reflect greater systemic disease burden and reduced physiological reserve, whereas diabetes may adversely affect microcirculation, tissue healing, immune function, and skin barrier integrity [19]. These findings support a risk-stratified approach in which patients with greater comorbidity receive closer postoperative surveillance and more intensive stoma care.

With respect to peristomal skin condition, the median DET score was lower in the marking group than in the non-marking group (2.0 [IQR, 0.0–4.0] vs. 4.0 [IQR, 2.0–4.0]), although the difference did not reach statistical significance. In contrast, the median Stoma-QoL score was significantly higher in the marking group (59.1 [IQR, 50.8–66.7] vs. 52.8 [IQR, 43.6–62.3]). DET scores were also weakly but significantly negatively correlated with Stoma-QoL scores (Spearman's $\rho = -0.269$, $P < 0.001$), indicating that more severe peristomal skin impairment was associated with poorer stoma-related quality of life. However, the weak correlation also suggests that quality of life is influenced by multiple factors beyond skin condition, including leakage, self-care ability, body image, and psychosocial adaptation.

Taken together, these findings support extending stoma management to the preoperative period rather than focusing exclusively on postoperative care. For patients undergoing rectal cancer surgery with a planned diverting ileostomy, preoperative stoma-site marking may be incorporated into a continuous care pathway that includes postoperative assessment, individualized appliance fitting, self-care education, and follow-up after discharge. Particular attention may be warranted for patients with a higher ASA grade, diabetes, or limited self-care capacity.

Several limitations should be acknowledged. First, this was a retrospective observational study, and residual or unmeasured confounding cannot be excluded despite multivariable adjustment; therefore, causal relationships cannot be established. Second, the non-marking group was relatively small, resulting in an imbalance in group sizes that may have reduced the precision of some estimates. In addition, leakage severity, DET scores, and Stoma-QoL may have been influenced by appliance type, timing of assessment, self-care ability, and postoperative nursing interventions, which could not be fully controlled in this retrospective analysis. Larger prospective studies with standardized follow-up schedules and stoma-care protocols are needed to further clarify these associations.

In conclusion, preoperative stoma-site marking was associated with lower leakage severity, lower odds of stoma-related complications, and higher stoma-related quality of life in patients with diverting ileostomies. ASA grade III and diabetes mellitus were independently

associated with higher odds of stoma-related complications. Although DET scores did not differ significantly between groups, greater peristomal skin impairment was associated with poorer Stoma-QoL. These findings support integrating preoperative stoma-site marking with leakage prevention, skin care, patient education, and longitudinal follow-up as part of perioperative stoma management.

Funding

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Consent to Participate declaration

Written informed consent was obtained from all patients prior to their participation in the study. All patients were informed of the study purpose, procedures, potential risks, and their rights to participate or withdraw from the study.

Ethics Approval

The study protocol received approval from the Ethics Committee of Peking Union Medical College Hospital (approval No. K26C4055).

Human Ethics and Consent to Participate Declarations

This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of Peking Union Medical College Hospital (approval No. K26C4055). Written informed consent was obtained from all patients prior to their participation in the study.

Conflicts of interest

None declared.

Data availability

All data generated or analyzed during this study are included in this manuscript and are available from corresponding author upon reasonable request.

Author Contributions

Guole Lin and Waiting Lam contributed to the study conception and design. Material preparation,data collection were performed by Waiting Lam, Junyang Lu, Xiaoyuan Qiu, Yang An, Chentong Wang and Yihan Lu. Formal analysis and investigation were performed

by Waiting Lam. The first draft of the manuscript was written by Waiting Lam and manuscript review and editing were performed by all authors. Funding acquisition was performed by Guole Lin.

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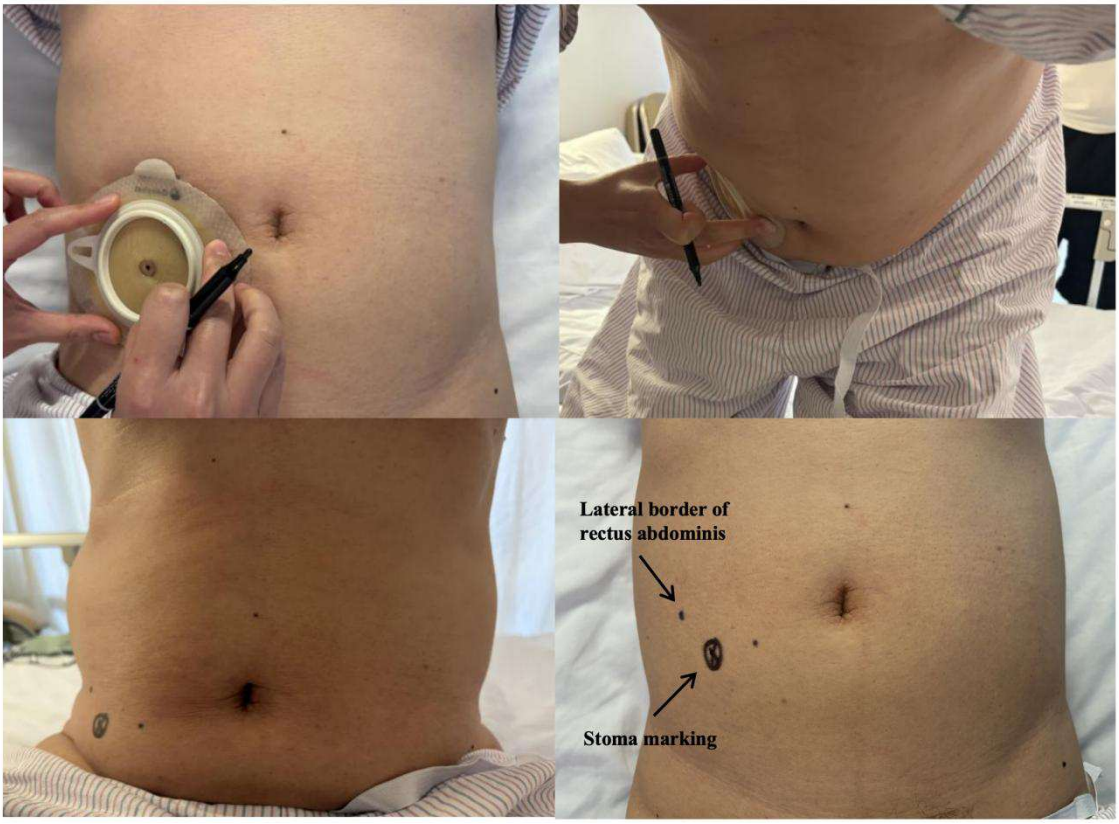


Figure 1 Example of preoperative stoma localization marking in a male patient undergoing radical rectal cancer surgery for prophylactic ileostomy

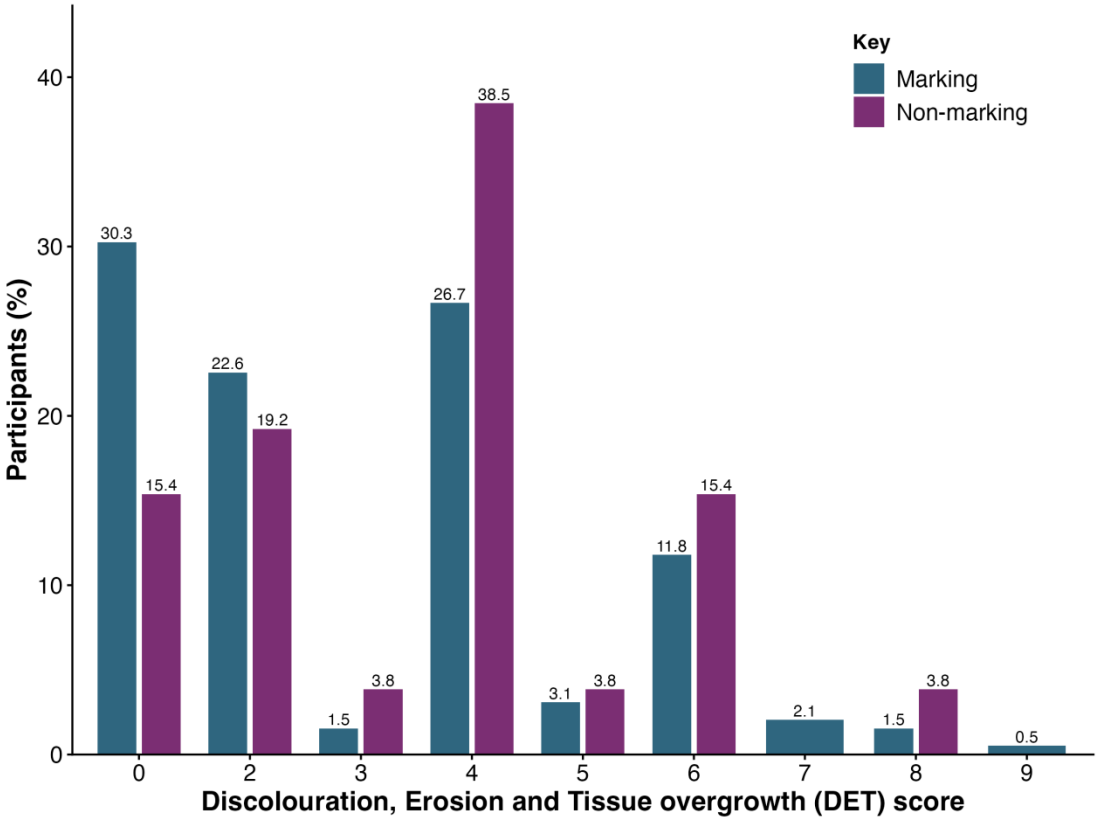


Figure 2 Distribution of Discolouration, Erosion and Tissue overgrowth (DET) scores according to preoperative stoma-site marking status. The median DET scores were 2.0 (IQR, 0.0–4.0) and 4.0 (IQR, 2.0–4.0) in the marking and non-marking groups, respectively (Wilcoxon rank-sum test, P = 0.116).

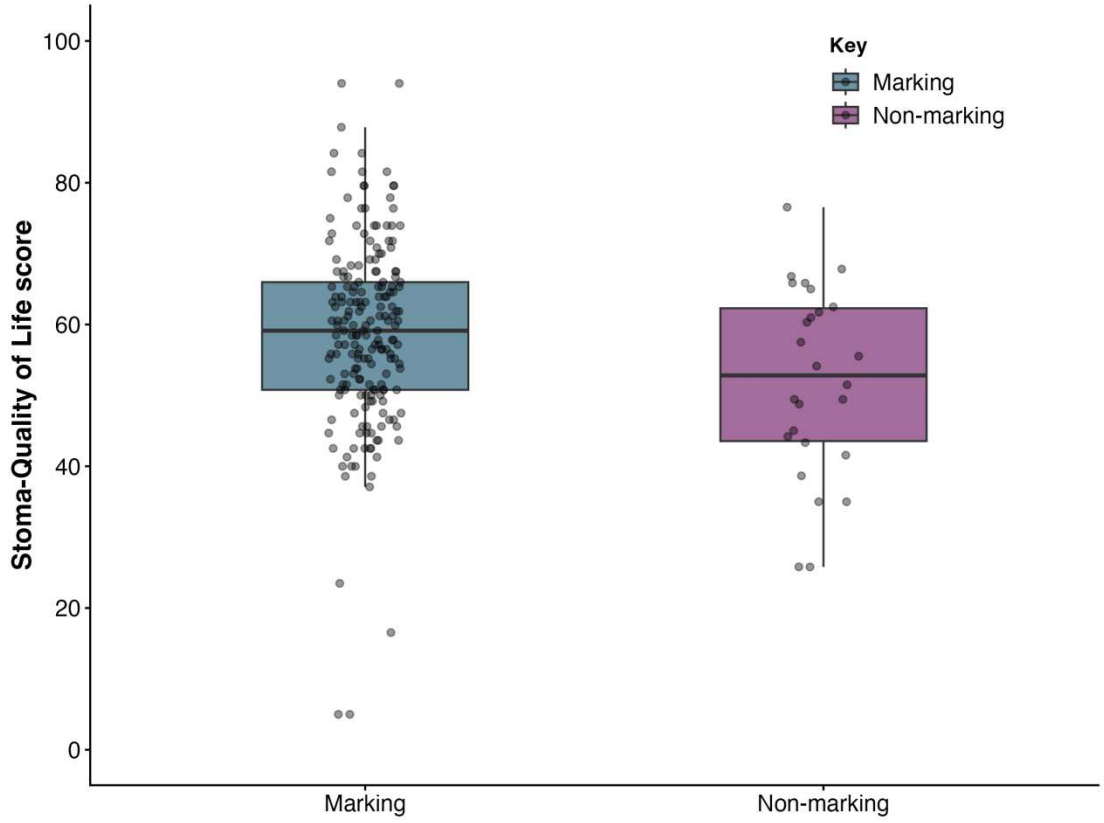


Figure 3 Distribution of Stoma-Quality of Life (Stoma-QoL) scores according to preoperative stoma-site marking status. The median Stoma-QoL score was 59.1 (IQR, 50.8–66.7) in the marking group and 52.8 (IQR, 43.6–62.3) in the non-marking group (Wilcoxon rank-sum test, P = 0.019).

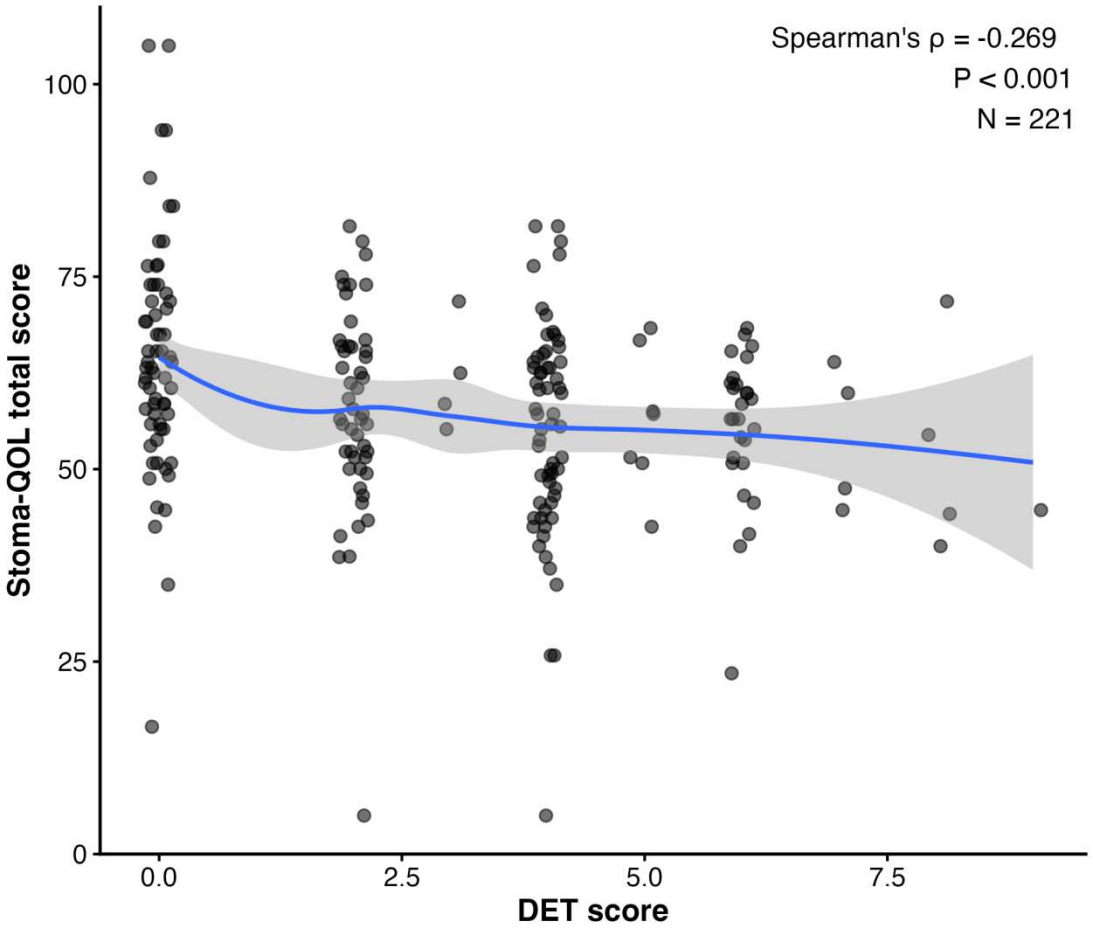


Figure 4 Correlation between Discolouration, Erosion and Tissue overgrowth (DET) scores and Stoma-Quality of Life (Stoma-QoL) scores. A significant negative correlation was observed between DET and Stoma-QoL scores (Spearman's $\rho = -0.269$, $P < 0.001$; $N = 221$).

Table 1 Baseline characteristics of the patients.

Characteristic	Stoma site		P value
	Marking (n = 195)	Non-marking(n = 26)	
Age (mean ± SD), years	59.7 ± 11.3	61.2 ± 10.5	0.492
Sex, n (%)			0.014[b]*
Female	67 (34.4%)	16 (61.5%)	
Male	128 (65.6%)	10 (38.5%)	
Body mass index category, n (%)			0.861[b]
<24	79 (40.5%)	11 (42.3%)	
≥24	116 (59.5%)	15 (57.7%)	
ASA grade, n (%)			0.470[a]
I	22 (11.3%)	5 (19.2%)	
II	146 (74.9%)	19 (73.1%)	
III	27 (13.8%)	2 (7.7%)	
Comorbidity, n (%)			
Cardiovascular	68 (34.9%)	7 (26.9%)	0.421[b]
Pulmonary	4 (2.1%)	0 (0.0%)	>0.999[a]
Diabetes mellitus	30 (15.4%)	5 (19.2%)	0.574[a]
Autoimmune	3 (1.5%)	1 (3.8%)	0.396[a]
ypTNM stage, n (%)			0.477[a]
0	69 (35.4%)	6 (23.1%)	
I	55 (28.2%)	7 (26.9%)	
II	29 (14.9%)	4 (15.4%)	
III	41 (21.0%)	9 (34.6%)	
IV	1 (0.5%)	0 (0.0%)	

Abbreviations: ASA, American Society of Anesthesiologist; ypTNM, post-neoadjuvant

Characteristic	Stoma site		P value
	Marking (n = 195)	Non-marking(n = 26)	

pathological tumor-node-metastasis; [a] Fisher's exact test; [b] Pearson χ^2 test； * P <0.05.

Table 2 Association between preoperative stoma-site marking and stoma leakage severity.

Leakage severity	Non-marking, n(%)	Marking, n(%)	Common OR (95% CI)	Mann-Whitney U test, P value	Ordinal logistic regression, P value
No leakage	16 (61.5%)	164 (84.1%)		0.007*	
Occasional leakage	9 (34.6%)	26 (13.3%)			
Frequent leakage	1 (3.8%)	5 (2.6%)			
overall			0.32 (0.13–0.75)		0.009*

* P <0.05

Table 3 Association between preoperative stoma site marking and postoperative stoma-related complications.

Complication	Marking, n(%)	Non-marking, n(%)	P value[a]
Peristomal skin irritation	29 (14.9%)	9 (34.6%)	0.023*
C-D grade I	21	5	
C-D grade II	8	4	
Stomal bleeding	11 (5.6%)	3 (11.5%)	0.218
C-D grade I	9	3	
C-D grade II	2	0	
Peristomal infection	9 (4.6%)	5 (19.2%)	0.015*
C-D grade I	4	3	
C-D grade II	5	2	
Parastomal hernia	7 (3.6%)	2 (7.7%)	0.286
C-D grade I	7	2	
C-D grade II	0	0	
Stoma retraction	4 (2.1%)	0 (0.0%)	1.000
C-D grade I	4	0	
C-D grade II	0	0	
Stoma prolapse	5 (2.6%)	0 (0.0%)	1.000
C-D grade I	4	0	
C-D grade II	1	0	
Stoma necrosis	0 (0.0%)	0 (0.0%)	1.000
STOMA C-D grade I stoma-related complication	49 (25.1%)	13 (50.0%）	0.018*
STOMA C-D grade II stoma-related complication	16 (8.2%)	6 (23.1%)	0.029*

Abbreviation: C-D, Clavien-Dindo; [a] Fisher's exact test; * P <0.05.

Table 4 Univariable and multivariable logistic regression analyses of factors associated with stoma-related complications.

Variables	Univariable		Multivariable	
	OR (95%CI)	P value	OR (95%CI)	P value
Age, years	1.04 (1.01–1.07)	0.011*	1.01 (0.97–1.04)	0.7
Sex				
Male	—		—	
Female	1.49 (0.83–2.67)	0.2	1.44 （0.73–2.82）	0.3
Stoma site marking				
Non-marking	—		—	
Marking	0.33 (0.14–0.75)	0.009*	0.28 (0.11–0.71)	0.008*
ASA grade				
I	—		—	
II	2.16 (0.78–7.66)	0.2	1.91 (0.61–7.47)	0.3
III	10.9 (3.19–45.7)	<0.001	9.36 (2.12–49.1)	0.005*
ypTNM stage				
0	—			
I	0.97 (0.45–2.06)	>0.9		
II	1.67 (0.70–3.95)	0.2		
III	1.32 (0.61–2.87)	0.5		

Comorbidity				
Cardiovascular	1.58 (0.87–2.85)	0.13	1.12 (0.54–2.30)	0.8
Pulmonary	7.02 (0.88–143)	0.094	7.75 (0.75–176)	0.11
Diabetes mellitus	2.88 (1.38–6.07)	0.005*	2.53 (1.10–5.83)	0.028*
Autoimmune	7.17 (0.90–146)	0.091	8.13 (0.92–174)	0.083
Duration of stoma maintenance，months	1.04 (0.99–1.09)	0.091	1.02 (0.97–1.07)	0.5

Abbreviations: CI = Confidence Interval, OR = Odds Ratio; * P <0.05.