

# Risk factors for parastomal hernia of loop stoma and relationships with other stoma complications in laparoscopic surgery

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## Research article

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# Abstract

**Purpose:** Laparoscopic approach is now a widespread technique used worldwide, but there are few recent studies on risk factors for parastomal hernia. Therefore, this study was performed to analyze the incidence of parastomal hernia in laparoscopic or open loop stoma, and to determine risk factors for parastomal hernia formation. Associations between parastomal hernia and other stoma-related complications were also analyzed. **Methods:** A retrospective analysis of patient and surgical characteristics was performed in 153 consecutive cases with stoma creation in loop ileostomy or colostomy performed at our hospital from January to December 2016. **Results:** Parastomal hernia developed in 77 cases (50.3%), including 39 (25.5%) diagnosed by physical examination and 38 (24.8%) detected by CT alone. In univariate analysis, a stoma that did not pass through the middle of the rectus abdominis muscle was a significant risk factor for parastomal hernia. This remained as the only independent risk factor for parastomal hernia formation in multivariate analysis. An additional analysis identified a laparoscopic approach as the only independent risk factor for formation of a stoma that did not pass through the middle of the rectus abdominis muscle. An analysis of stoma-related complications showed that peristomal skin disorders were significantly associated with parastomal hernia formation. **Conclusions:** This study showed that a stoma that is not formed through the middle of the rectus abdominis muscle is a risk factor for parastomal hernia, and that a laparoscopic approach is associated with this risk factor. Moreover, a parastomal hernia is significantly associated with peristomal skin disorders.

## Introduction

There have been rapid advances in laparoscopic procedures for low rectal cancer, and these have increased the probability of anal preservation in patients with very low rectal cancer and reduced use of abdominal perineal resection, which does not preserve anal function [1-3]. Accordingly, there has been increased use of loop stoma creation to prevent severe complications caused by a lower anastomosis with a high risk of leakage, which has risk factors of preoperative chemoradiotherapy (CRT), male patients, and lower anastomotic level [4-6]. However, loop stoma can also have unique complications that require another operation.

Parastomal hernia is a common stoma-related complication with a reported incidence of up to 81%, and this complication induces other stoma-related complications, affects quality of life (QOL), and increases financial costs in the healthcare system [7-9]. This incidence has changed little despite advances in surgical techniques and instruments. Techniques for preventing parastomal hernia formation, such as formation of a lateral rectus abdominis-positioned stoma and stapled mesh stoma reinforcement, have been reported [9-11]. However, these methods are not commonly used because many surgeons recognize that a stoma that passes through the rectus abdominis muscle sheath reduces parastomal hernia formation. Mesh reinforcement of a temporary diverting loop stoma is not common, but is accepted to reduce the risk of hernia formation at a permanent end ostomy site.

Parastomal hernia formation following laparoscopic rectal surgery may offset the immediate benefits, such as a better cosmetic outcome and decreased postoperative pain [12,13]. However, despite the widespread use of the laparoscopic approach worldwide, there are few recent studies on risk factors for stoma-related complications such as parastomal hernia. Therefore, the main purpose of this study was to analyze the recent incidence of parastomal hernia of loop stoma in laparoscopic or open surgery, and to determine risk factors for parastomal hernia formation. Associations of parastomal hernia with other stoma-related complications, including peristomal skin disorders, stoma outlet obstruction, and stoma prolapse, were also evaluated.

## Methods

### Patients

The study was performed as a retrospective analysis of patients in whom stoma creation was performed at the National Cancer Center Hospital East, Japan, between January and December 2016. During this period, a stoma was created in 202 patients. After exclusion of 42 patients with an end stoma and 7 who did not undergo postoperative CT, the final study population included 153 patients who underwent loop ileostomy or colostomy. This study was approved by the ethics committee of National Cancer Center Hospital (no. 2017-350).

### Data acquisition and follow-up

Data were collected for patient characteristics (sex, age, body mass index (BMI), abdominal wall thickness, rectus abdominis muscle thickness, history of open laparotomy, comorbidities (diabetes mellitus (DM) or steroid use), history of neoadjuvant chemotherapy (NAC) or preoperative CRT, emergency surgery, and American Society of Anesthesiologists (ASA) score), surgical characteristics (operation time, blood loss, blood transfusion, approach (laparoscopy or open), stoma type (ileostomy or colostomy), specimen extraction from stoma site, stoma formed through the middle of the rectus abdominis muscle, height of stoma, incision size of stoma, base area of stoma, and volume of stoma).

The thickness of the abdominal wall and rectus abdominis muscle at the umbilical level were measured on preoperative CT by surgeons. The base area of the stoma was calculated from the vertical and horizontal size of the skin level. The stoma volume was calculated from the maximum vertical size, the maximum horizontal size, and the maximum height. These measurements of the stoma size were made postoperatively by the operating nurse. The position of the stoma through the rectus abdominis muscle was checked on postoperative CT, which was regularly performed for follow-up of malignant diseases, with a stoma passing through the middle of this muscle defined as one with the whole stoma passing through the center of the trisection of the rectus abdominis muscle (Fig. 1a). A stoma not passing through the middle of this muscle was defined as one with the part of the stoma passing through the lateral side of the trisection of the rectus abdominis muscle (Fig. 1b). The trisection of the rectus abdominis muscle was defined as the straight line connecting the sides of the rectus abdominis muscle through which the stoma passes through and dividing the muscle into two. All data were extracted from medical and operation reports. The condition of the stoma was observed during hospitalization of the patients by

surgeons and wound, ostomy, and continence (WOC) nurses. Thereafter, patients were assessed during follow-up outpatient visits. For temporary stoma, patients who did and did not receive postoperative adjuvant therapy were scheduled for stoma closure after 6 months and after 3 months, respectively. All patients were followed until closure of the stoma or until December 2017, when data were collected for the study.

### Diagnosis of parastomal hernia and other stoma-related complications

Parastomal hernia was diagnosed as any protrusion around the stoma that was detected in physical examinations by surgeons or WOC nurses (Fig. 2a). Additionally, parastomal hernia was checked on postoperative CT in spine position, which was regularly performed for follow-up of malignant diseases. The parastomal hernia based on CT was diagnosed according to the presence of a hernia sac (Fig. 2b) [14]. The evaluation of CT examination was retrospectively reviewed by colorectal surgeon who was blinded to the patients' clinical information. Peristomal skin disorders were diagnosed as a change in the skin, such as erythema, erosion, blister/pustule, and ulcer/tissue overgrowth. The degree of peristomal skin disorders was evaluated using the DET score. The DET score was developed by Martins et al. in 2008 as part of the Ostomy Skin Tool (OST) for evaluation of peristomal skin. The severity of discoloration (D), erosion (E), and tissue overgrowth (T) is evaluated between 0 and 2, and each area is evaluated between 0 and 3. The DET score is in the range from 0 to 15, where 0 represents normal skin and 15 is the worst combination of severity and extent [15,16].  $DET \geq 7$  was defined as a case with severe peristomal skin disorders [16]. Stoma outlet obstruction was defined based on bowel dilation at the ostomy in clinical ileus, excluding other causes for bowel obstruction. Stoma prolapse was defined as a condition in which the full thickness of the bowel protruded through the stoma.

### Surgical techniques for stoma creation

Each stoma was preoperatively marked in the middle of the rectus abdominis muscle by surgeons and WOC nurses. The decision to create an ileostomy or colostomy was made by each operating surgeon. Depending on the surgeon's decision, a specimen was removed from a stoma site or a mini-laparotomy site. After extracting the specimen, the stoma was created using the skin bridge technique [17,18]. The skin bridge technique uses skin instead of a plastic rod to secure and prevent retraction of the stoma. The skin bridge is made by incising the skin at the predetermined site of stoma creation, and the subcutaneous fat is divided. The skin bridge is passed through the avascular window, which is opened in the mesentery at the apex of the chosen intestinal loop, and the skin bridge is sutured to the distal edge of the opening. All stoma had a transperitoneal route and were created in the middle of the rectus abdominis muscle based on preoperative stoma site marking. All operations were performed by surgeons with substantial experience with open and laparoscopic colorectal surgery.

### Statistical analysis

Categorical variables are reported as the number (percentage) of patients, and analyzed by Chi-square or Fisher exact test, while quantitative variables are reported as a median and range, and analyzed by Mann-Whitney U test. Multivariate analysis was performed using logistic regression analysis with the backward stepwise method based on P values and previous reported risk factors. All statistical analyses were performed using SPSS 22.0 (SPSS Inc., Chicago, IL, USA). Significance was defined as  $p < 0.05$ .

## Results

The patient characteristics are shown in Table 1. Of the 153 patients, 109 were male (71.2%) and 44 were female (28.8%), the median age was 62.0 years (range 27.0-81.0 years), and the median BMI was 22.2 kg/m<sup>2</sup> (range 14.7-33.4 kg/m<sup>2</sup>). There were 26 patients (17.0%) with DM, none were taking steroids, 48 (31.4%) had a history of open laparotomy, and 45 (29.4%) received preoperative NAC or CRT. Emergency surgery was performed in 19 patients (12.4%). A laparoscopic approach was used in 109 patients (71.2%) and an open approach in 44 (28.8%). An ileostomy was created in 129 patients (84.3%) and a colostomy in 24 (15.7%). A stoma closure was performed in 124 patients (81.1%).

Parastomal hernia developed in 77 patients (50.3%), including 39 (25.5%) diagnosed by physical examination and 38 (24.8%) detected by CT alone. Potential risk factors for parastomal hernia are shown in Table 2. A stoma that did not pass through the middle of the rectus abdominis muscle was significantly associated with parastomal hernia formation in univariate analysis ( $p=0.006$ ). Age, BMI, abdominal wall thickness, rectus abdominis muscle thickness, DM, emergency surgery, approach, stoma type, and specimen extraction from the stoma site were not significantly associated with parastomal hernia. In multivariate analysis, a stoma that did not pass through the middle of the rectus abdominis muscle was the only independent risk factor for parastomal hernia formation (odds ratio [OR], 2.679; 95% confidence interval [95%CI], 1.341-5.352;  $p=0.005$ ).

Sex, age, BMI, abdominal wall thickness, rectus abdominis muscle thickness, approach, stoma type, and specimen extraction from the stoma site were examined as potential risk factors for formation of a stoma that did not pass through the middle of the rectus abdominis muscle (Table 3). Univariate analysis showed that this kind of stoma was associated with emergency surgery ( $p=0.044$ ) and a laparoscopic approach ( $p=0.011$ ). In multivariate analysis, a laparoscopic approach was the only independent risk factor for formation of a stoma that did not pass through the middle of the rectus abdominis muscle (OR, 2.522; 95%CI, 1.229-5.177;  $p=0.012$ ).

A total of 106 patients (69.3%) had peristomal skin disorders, including 48 (31.4%) with a DET score  $\geq 7$ , 7 (4.6%) had stoma outlet obstruction, and 7 (4.6%) had stoma prolapse. The associations of these stoma-related complications with parastomal hernia are shown in Table 4. Peristomal skin disorders were significantly associated with parastomal hernia formation in univariate analysis ( $p=0.048$ ), and this complication retained significance in multivariate analysis (OR, 2.022; 95%CI, 1.002-4.081;  $p=0.049$ ).

## Discussion

In this study, we determined the incidence of parastomal hernia of loop stoma in the laparoscopic era, and identified risk factors for parastomal formation. We also found associations between parastomal hernia and stoma-related complications of peristomal skin disorders, stoma outlet obstruction, and stoma prolapse. These new findings provide important information for performance of optimal laparoscopic surgery. An understanding of risk factors for parastomal hernia is important because this can decrease the incidence of complications, contribute to improved QOL, and reduce medical costs [7-9]. A stoma that was not formed through the middle of the rectus abdominis muscle was found to be a risk factor for parastomal hernia, and a laparoscopic approach was associated with this risk factor.

Well-established risk factors for parastomal hernia after stoma creation include older age, increased BMI, DM, incision size, laparoscopic approach, and presence of other abdominal wall hernias [19,20]. A stoma passing through the rectus abdominis muscle has also been reported to reduce parastomal hernia formation [20,21]. A single study reported a lower hernia rate compared with a lateral pararectus approach, but it is uncertain whether a stoma passing through the rectus abdominis muscle prevents parastomal hernia formation, and European Hernia Society (EHS) guidelines do not indicate a preference for stoma construction at a lateral pararectus location over a transrectus location [22]. However, many surgeons recognize generally that a stoma passing through the rectus abdominis muscle sheath reduces parastomal hernia formation, and this maneuver is performed without a clear basis in creation of a stoma.

A stoma that did not pass through the middle of the rectus abdominis muscle was a risk factor for parastomal hernia formation. The middle of this muscle has the greatest thickness in almost all people, and it is possible that a stoma passing through this point is protecting against parastomal hernia formation into subcutaneous fat in front of the rectus abdominis muscle. High abdominal pressure causes herniation into the weak point of the abdominal wall, including that due to operation scar, parastoma, and the inguinal canal [23]. The stoma site is generally the weakest point, but a stoma passing through the middle of the rectus abdominis muscle may have a lower incidence of parastomal hernia formation because abdominal pressure might uniformly act on the parastomal site, rather than on a limited part of this site, as might occur for a stoma that does not pass through the middle of the muscle. Therefore, a transrectus stoma should be created with passage through the middle of the rectus abdominis muscle.

A laparoscopic approach was found to be associated with formation of a stoma that did not pass through the middle of the rectus abdominis muscle. A laparoscopic approach has previously been identified as an independent risk factor for parastomal hernia, but no randomized trials comparing laparoscopic and open approaches have been performed [19,24]. In stoma creation in a laparoscopic approach, especially for a temporary stoma in laparoscopic rectal surgery, the operation bed is often not flat, but in a head down and right down position, and pneumoperitoneum may remain. This position and pneumoperitoneum causes stoma site dislocation and difficulty passing the stoma through the middle of the rectus abdominis muscle because of changes in the preoperative stoma site marking and rectus abdominis position. Therefore, a laparoscopic approach may be associated with a stoma that does not pass through the middle of the rectus abdominis muscle, and might be a potential risk factor for parastomal hernia formation.

We also found that parastomal hernia was associated with peristomal skin disorders, as also shown in several other studies [20,25,26]. This may be due to frequent pouch leakage caused by parastomal hernia, which can induce damage to peristomal skin [20,27]. However, severe peristomal skin disorders were not associated with parastomal hernia. An association between parastomal hernia and stoma prolapse has also been shown previously [28,29], and in the present study, the incidence of stoma prolapse in cases with parastomal hernia was higher than that in cases with no parastomal hernia, but the difference was not significant. In contrast, stoma outlet obstruction was higher in cases with no parastomal hernia, and the fascia size has been associated with stoma outlet obstruction and parastomal hernia [27]. Thus, a shorter fascia incision results in stoma outlet obstruction, and a longer incision is linked to parastomal hernia. Thus, a low incidence of parastomal hernia might decrease peristomal skin disorders significantly, but is not related to severity, and increased stoma outlet obstruction may cause more severe problems for patients.

This study had several limitations. First, it was a retrospective study at a single institution in Japan and the number of patients was small. Second, the follow-up period associated with hernia formation was not constant and the exact time of the onset was unclear. Time frame has been reported to be an important risk factor for parastomal hernia [20]. However, in the present study, pre- and perioperative factors, but not postoperative factors, were examined as potential risk factors for parastomal hernia. Third, we did not investigate the severity of parastomal hernia, but this complication, especially when detected only by CT, did not affect QOL and financial costs. Further analysis in a larger sample size including cases with greater severity and using the diagnosis date of stoma-related complications is therefore needed to clarify the associations between risk factors and stoma-related complications, including parastomal hernia.

In conclusion, this study revealed that a stoma that does not pass through the middle of the rectus abdominis muscle is a risk factor for parastomal hernia, and that a laparoscopic approach is associated with this risk factor. Thus, a laparoscopic approach might be a risk factor for parastomal hernia. Further studies in more patients and with different severities and durations of stoma-related complications, including parastomal hernia, are needed to define these associations with certainty.

## Declarations

Ethics approval and consent to participate: This study was approved by the ethics committee of National Cancer Center Hospital (no. 2017-350).

Consent for publication: Not applicable.

Availability of data and material: The data that support the findings of this study are available from the ethics committee of National Cancer Center Hospital but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the ethics committee of National Cancer Center Hospital.

Competing interests: The authors declare that they have no competing interests

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## Tables

Table 1. Characteristics of patients who underwent loop stoma creation (n=153)

Characteristics	n (%)
Sex: Male/Female	109 (71.2)/44 (28.8)
Age, years	62.0 (27.0-81.0)*
BMI, kg/m <sup>2</sup>	22.2 (14.7-33.4)*
Abdominal wall thickness, mm	29.4 (10.2-56.7)*
Rectus abdominis muscle thickness, mm	10.0 (1.0-19.0)*
Diabetes mellitus	26 (17.0)
History of open laparotomy	48 (31.4)
Preoperative treatment (NAC or CRT)	45 (29.4)
Emergency operation	19 (12.4)
ASA score: 1/2/3	49 (32.0)/101 (66.0)/3 (2.0)
Approach type: Laparoscopy/Open	109 (71.2)/44 (28.8)
Stoma type: Ileostomy/Colostomy	129 (84.3)/ 24 (15.7)
Stoma closure	124 (81.1)

BMI, body mass index; NAC, neoadjuvant chemotherapy; CRT, chemoradiotherapy; ASA, American Society of Anesthesiologists; LAR, low anterior resection; ISR, intersphincteric resection

\*median

Table 2. Potential risk factors for parastomal hernia

	No parastomal hernia, n=76 (%)	Parastomal hernia, n=77 (%)	Univariate analysis P value	Multivariate analysis	
				OR (95%CI)	P value
Sex: male/female	52 (68.4)/24 (31.6)	57 (74.0)/20 (26.0)	0.444		
Age, years (range)	61.0 (27.0-81.0)*	63.0 (37.0- 80.0)*	0.419		0.148
BMI, kg/m <sup>2</sup> (range)	21.5 (14.7-31.6)*	23.0 (15.9- 33.4)*	0.070		0.162
Abdominal wall thickness, mm	28.6 (12.0-50.7)*	30.6 (10.2- 56.7)*	0.352		
Rectus abdominis muscle thickness, mm	10.7 (6.0-17.0)*	10.0 (1.0-19.0)*	0.239		
Diabetes mellitus	14 (18.4)	12 (15.6)	0.640		0.739
History of open laparotomy	26 (34.2)	22 (28.6)	0.452		
Preoperative treatment: NAC or CRT	19 (25.0)	26 (33.8)	0.234		
Emergency operation	11 (14.5)	8 (10.4)	0.189		
ASA score: 1/2/3	25 (32.9)/49 (64.5)/2 (2.6)	24 (31.2)/52 (67.5)/1 (1.3)	0.545		
Operation time	243.0 (19.0-840.0)*	290.0 (16.0- 717.0)*	0.381		
Blood loss	48.5 (0.0-11523.0)*	44.0 (0.0- 3051.0)*	0.778		
Blood transfusion	6 (7.9)	5 (6.5)	0.737		
Approach type: laparoscopy/open	51 (67.1)/25 (32.9)	58 (75.3)/19 (24.7)	0.261		0.731
Stoma type: ileostomy/colostomy	62 (81.6)/14 (18.4)	67 (87.0)/10 (13.0)	0.355		0.604
Specimen extraction from stoma site	12 (15.8)	21 (27.3)	0.084	2.159 (0.950- 4.909)	0.066
Stoma not through middle of rectus abdominis muscle	40 (52.6)	57 (74.0)	0.006	2.679 (1.341- 5.352)	0.005
Height of stoma, mm (range)	11.5 (3.0-30.0)*	12.0 (5.0-30.0)*	0.163		
Incision size of stoma, mm	38.0 (20.0-70.0)*	40.0 (20.0-	0.650		0.681

(range)		71.0)*	
Base area of stoma, cm <sup>2</sup> (range)	40.6 (12.6-107.4)*	40.6 (18.8-93.7)*	0.975
Volume of stoma, cm <sup>3</sup> (range)	21.1 (4.4-110.4)*	22.8 (4.8-88.3)*	0.312

BMI, body mass index; NAC, neoadjuvant chemotherapy; CRT, chemoradiotherapy; OR, odds ratio; CI, confidence interval

\*median

Table 3. Potential risk factors for formation of a stoma that does not pass through the middle of the rectus abdominis muscle

	Not through middle, n=97 (%)	Through middle, n=56 (%)	Univariate analysis P value	Multivariate analysis OR (95%CI)	P value
Sex: Male/Female	71 (73.2)/26 (26.8)	38 (67.9)/16 (32.1)	0.482		
Age, years	63.0 (27.0-81.0)*	60.5 (33.0-80.0)*	0.459		
BMI, kg/m <sup>2</sup>	22.6 (14.7-33.4)*	21.5 (15.5-29.5)*	0.384		
Abdominal wall thickness, mm	30.0 (10.2-56.7)*	28.7 (15.6-44.9)*	0.299		
Rectus abdominis muscle thickness, mm					
Emergency operation	7 (7.2)	10 (17.9)	0.044		0.421
Approach type: laparoscopy/open	76 (78.4)/21 (21.6)	33 (58.9)/23 (41.1)	0.011	2.522 (1.229-5.177)	0.012
Stoma type: ileostomy/colostomy	85 (87.6)/12 (12.4)	44 (78.6)/12 (21.4)	0.138		
Specimen extraction from stoma site	20 (20.6)	13 (23.2)	0.707		

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

\*median

Table 4. Association between parastomal hernia and other stoma-related complications

	No parastomal hernia, n=76 (%)	Parastomal hernia, n=77 (%)	Univariate analysis P value	Multivariate analysis OR (95%CI)	P value
Peristomal skin disorders	47 (61.0)	59 (76.6)	0.048	2.022 (1.002-4.081)	0.049
DET score $\geq 7$	23 (29.9)	25 (32.5)	0.500		
Stoma outlet obstruction	5 (6.5)	2 (2.6)	0.216		
Stoma prolapse	3 (3.9)	4 (5.2)	0.507		

OR, odds ratio; CI, confidence interval

## Figures

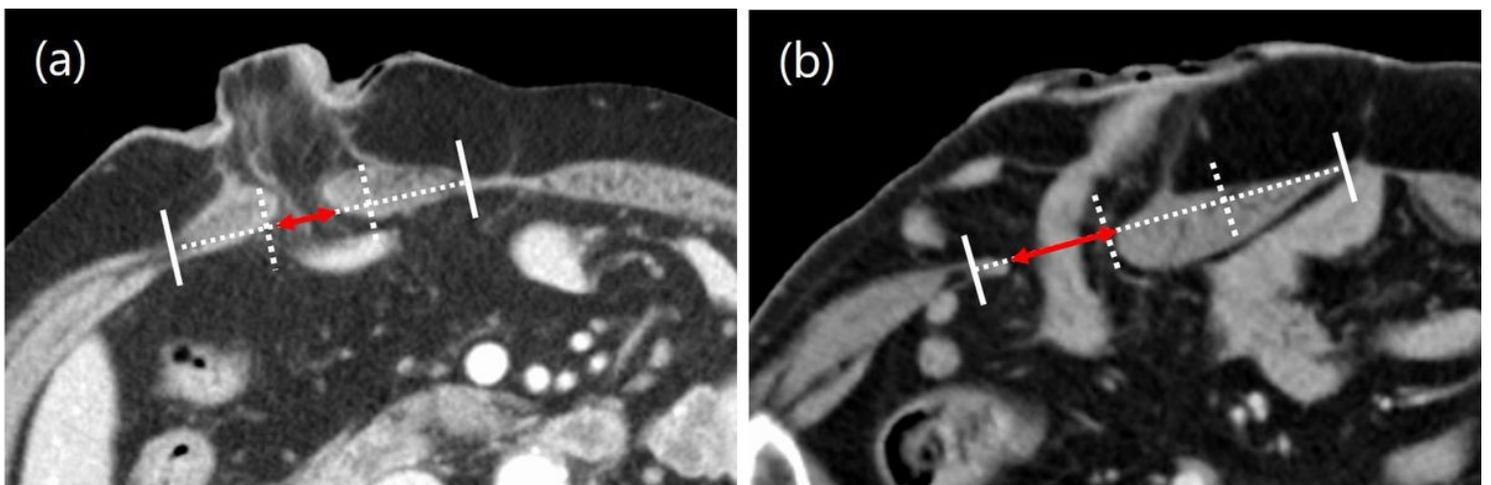
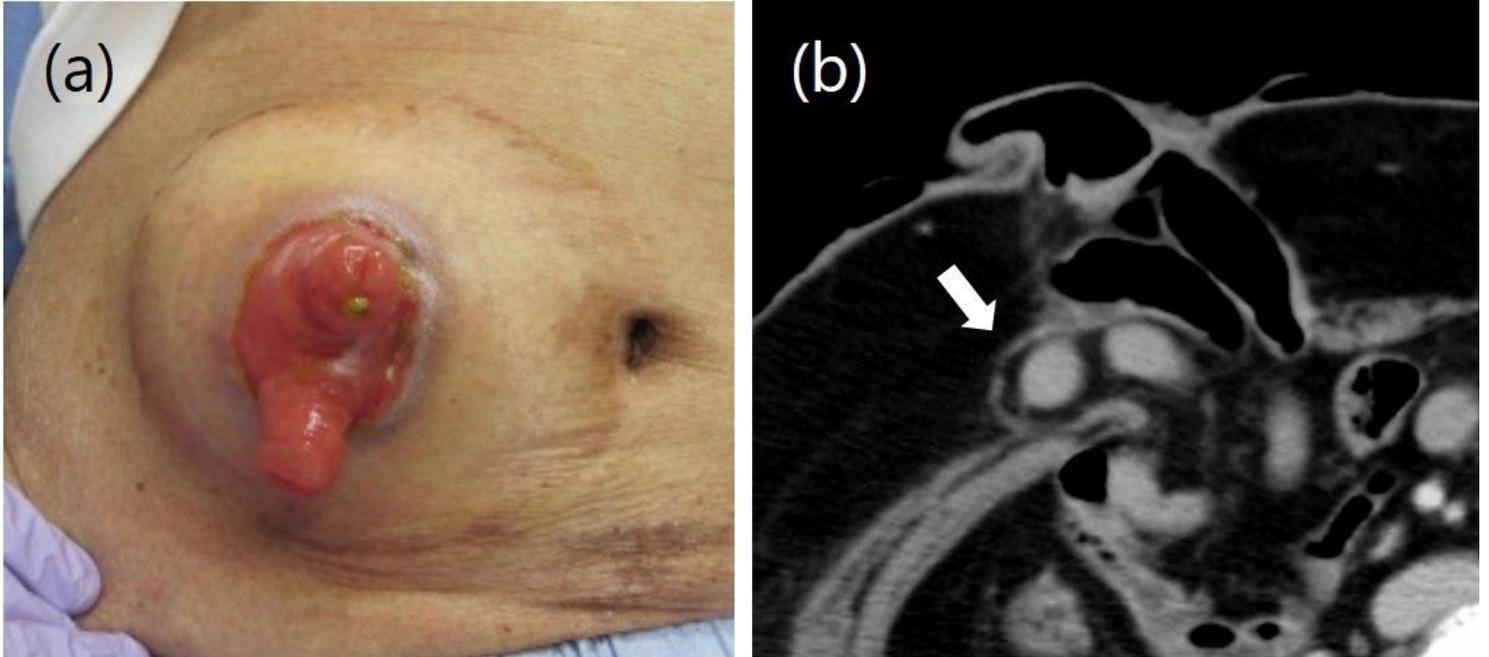


Figure 1

The position of the stoma passing through the rectus abdominis muscle, defined based on the whole stoma passing or not passing through the center of the trisection of the rectus abdominis muscle. (a) A

stoma passing through the middle of the rectus abdominis muscle. (b) A stoma not passing through the middle of the rectus abdominis muscle.



**Figure 2**

Definition of parastomal hernia. (a) Parastomal hernia was diagnosed as any protrusion around the stoma on physical examinations by surgeons or WOC nurses. (b) Postoperative abdominal CT was used to diagnose the parastomal hernia with a hernia sac (arrow).