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Why does Parastomal Hernia Occur in Facilities with Permanent End Sigmoid Colostomy Based on the Extraperitoneal Route?

Yuki Matsumi[1,2], Madoka Hamada[1], Fusao Sumiyama[1,3], Toshinori Kobayashi[1,4], Ryo Inada[1,5], Nozomi Ueno[6]

[1]Department of Gastrointestinal Surgery, Kansai Medical University Hospital, Hirakata, Japan, [2]Department of Gastroenterological Surgery, Okayama University Graduate School of Medicine, Okayama, Japan, [3]Department of Surgery, Katano Hospital, Katano, Japan, [4]Department of Colorectal Surgery, Kansai Medical University, Hirakata, Japan, [5]Department of Gastroenterological Surgery, Kochi Health Sciences Centre, Kochi, Japan, [6]Hernia Center, Saiseikai Suita Hospital, Suita, Japan

Address for correspondence:
Madoka Hamada, Department of Gastrointestinal Surgery, Kansai Medical University Hospital, Hirakata, Osaka 573-1191, Japan.
E-mail: KGH03145@nifty.com

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Abstract

AIM: The incidence of parastomal hernia (PH) following the transperitoneal end sigmoid colostomy (TP) with prophylactic mesh placement has been reported unexpectedly high. We reviewed the incidence of PH after laparoscopic abdominoperineal excision (lap APE) using extraperitoneal end sigmoid colostomy (EP) in principle since 2013 to examine the appropriateness of prophylactic mesh placement for PH prevention in the laparoscopic setting.

MATERIALS AND METHODS: From September 2013 to August 2021, 28 consecutive patients underwent lap APE for local curative resection of rectal adenocarcinoma with a postoperative follow-up period of at least 20 months at the Department of Gastrointestinal Surgery, Kansai Medical University Hospital. We diagnosed a PH (+) based on either the findings of a follow-up CT examination or those of a certified wound, ostomy, and continence nurse. We examined the causes of PH based on the clinical and surgical findings.

RESULTS: We have experienced PH in 6 out of 28 patients (PH (+)). Of these, 5 were cases where EP was technically abandoned in favor of TP. The Cox proportional hazard model revealed that the risk factors of the PH were significant in the TP (relative risk = 46.8; 95% confidence interval = 2.3–940.4). The Kaplan–Meier curve showed that the 3-year PH occurrence rate was significantly lower in EP (5.1%) than in TP (71.4%; $P < 0.001$).

CONCLUSION: The EP is a highly effective method for preventing PH, and the intraperitoneal onlay mesh methods, in which TP is used as a pseudo-EP in cases where TP is necessary, warrants further investigation.

Keywords:

end sigmoid colostomy, parastomal hernia, prophylactic mesh placement

Introduction

Parastomal hernia (PH) in permanent end sigmoid colostomies is a troublesome complication that can occur in 5%–48% of patients, and 0%–54% of them require repair following colostomy.[1] This complication significantly decreases the quality of life throughout the patient's lifetime. For this reason, many studies have reported a PH prevention technique at the time of stoma creation.[2-4]

In open surgery, Goligher[5] introduced the extraperitoneal route stoma (EPS) for the ileostomy, which can reduce the frequency of PH significantly than the transperitoneal route stoma (TPS) from 35% to 3.5%, as Londono-Schimmer *et al.* reported and in a meta-analysis.[1,6,7] In the laparoscopic

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setting, we reported an EPS creation procedure.[8] We noted its effect in preventing PH,[9] which revealed that the frequency of PH with EPS was significantly lower than that of TPS (4.5% vs. 33.3%, $P = 0.03$). Several procedures for creating EPS have been reported following our reports,[7,10-13] which are adopted routinely in many facilities.

Based on our results of PH prevention with EPS, we have created a permanent end sigmoid colostomy following abdominoperineal excision in principle with EPSs. However, we encountered a patient with a PH requiring hernia repair, indicating that further prophylactic PH prevention required a precise examination of the cause of PH following stoma creation in the facility using EPS routinely.

In general practice worldwide, TPSs are often used due to their simplicity of creation, and clinical trials are being conducted to try to prevent the occurrence of PH by using prophylactic mesh placement on TPSs to address subsequent PH.[14-24] The incidence of PH, unfortunately, following prophylactic mesh placement with long follow-up was dismal, with rates reported to be 100% in the keyhole technique, 55.6% in the modified Sugarbaker technique, and 45% in the retromuscular group.[16] In these studies of laparoscopic prophylactic mesh placement, the control arms were all TPS, and only Sugarbaker, as in the treatment of PH, is expected to be a relatively effective prophylactic technique.[25]

We already know that an EPS can prevent a significant amount of PH, although not completely. Suppose PH causes in facilities adopting EPS in standard can be investigated. In such cases, high-risk patients with PH can be selected, and prophylactic mesh placement can be used in a limited number of cases. Even if not wholly, we may improve the occurrence rate of the PH. This study aims to retrospectively analyze the frequency and causes of PH in our institution and investigate effective management strategies for these cases.

Materials and Methods

From September 2013 to August 2021, 32 consecutive patients underwent laparoscopic abdominoperineal excision (APE) for local curative resection of rectal adenocarcinoma at the Department of Gastrointestinal Surgery, Kansai Medical University Hospital. The indication for surgery was rectal adenocarcinoma, diagnosed with a prognosis of at least 2 years. The period from the primary operation date to the PH event was defined as the PH event-free period. The PH (+) group consisted of patients in whom a PH event occurred during the follow-up period until August 2025.

Suppose a follow-up computed tomography (CT; protruded hernia sac containing a loop of bowel forming the stoma itself, omentum, and/or intestinal loops other than that forming the stoma) or a certified wound ostomy continence nurse (CWOCN) clinical finding indicates PH (pain or discomfort around the stoma, trouble keeping the stoma appliance in place, bulging around the stoma); we diagnosed it as a PH (+). Postoperative patient follow-up was performed in accordance with the Japanese Classification of Colorectal Carcinoma.[26] CT examinations were performed at least every 6 months for 5 years in all patients, whose stoma was examined simultaneously by a CWOCN.

We excluded four patients from this study because of death or the loss of follow-up within 1 year after the operation, and 28 patients were examined whose postoperative follow-up period was over 20 months.

Patient characteristics are shown in Table 1. We compared the PH (+) and PH (−) groups regarding clinicopathological factors using univariate analysis in age, gender, body mass index (BMI), American Society of Anesthesiologists physical status [ASA-PS], neoadjuvant therapy, tumor distance from the anal verge (AV), cT, cN, cM, cStage (TNM 9th), pretreatment diverting stoma (DS) creation, operative approach, stoma route, lateral pelvic lymph node dissection, duration of operation, intraoperative blood loss, the number of dissected lymph nodes, the number of metastatic lymph nodes, tumor size, pT, pN, pStage (TNM 9th), histological type, curability(Japanese Classification of Colorectal, Appendiceal, and Anal Carcinoma: the 3rd English Edition), postoperative observation period). We have also examined the factors that caused PH using the Cox proportional hazards model to determine the significant factors in univariate analysis, excluding confounding factors.

Ethics

In this study, an Institutional Review Board (IRB) review was unnecessary because the research uses only anonymized medical information from research subjects.

Statistical analysis

Descriptive statistics are displayed as frequencies for categorical variables and medians, with the data presented in order from lowest to highest values for continuous variables. Univariate analysis was performed using the χ^2, Student's t, or Mann–Whitney U tests. The Cox proportional hazards model was used to determine the significant factors in univariate analysis. The PH occurrence rate was calculated by using the Kaplan–Meier method. Differences in the occurrence rate between the extraperitoneal end sigmoid colostomy (EP) and the transperitoneal end sigmoid colostom (TP)

were tested using the univariate generalized Wilcoxon, Cox–Mantel, and Log-rank tests. *P* values less than 0.05 were considered significant. Calculations were performed using Stat-Flex (ver. 7.0 for Windows, Artec, Osaka, Japan).

Results

There are six patients in the PH (+) group and 22 patients in the PH (−) group [Table 1]. There was no difference in the univariate analysis between PH (+) and PH (−) groups in age, gender, BMI, neoadjuvant therapy, AV, cT, cN, cM, cStage, operative approach, lateral pelvic lymph node dissection, duration of operation, the number of dissected lymph nodes, the number of metastatic lymph nodes, tumor size, pT, pN, pStage, histological type, curability, postoperative observation period (2160 days (717–2565) in the PH (+) group and 1855 days (630–3069) in the PH (−) group). The PH (+) group had more cases of high ASA-PS score ($p = 0.048$), preoperative DS creation ($p = 0.02$), and TP stoma route ($p = 0.001$).

The Cox proportional hazard model for items significantly different in the univariate analysis revealed that the risk

Table 1: Patient characteristics of parastomal hernia (PH; +) group and (–) group

		PH (+)	PH (–)	Total	UA (p)	Cox (p): RR (95%CI)
n		6	22	28		
Age	Median (range)	72 (63–78)	70.5 (47–94)	70.5. (47–94)	0.61	(–)
Gender	M/F	4/2	12/10	16/12	0.67	(–)
BMI (kg/m^2)	Median (range)	23.3 (16.6–27.6)	23.2 (16.4–29.7)	23.3 (16.4–29.7)	0.67	(–)
ASA-PS	1/2/3	0/5/1	9/12/1	9/17/2	0.048	0.014:21.6 (1.9–252.5)
Neoadjuvant T.	CRT/RT/CT/(–)	3/0/0/3	15/4/1/2	18/4/1/5	0.11	(–)
AV (cm)	Median (range)	0 (0–5)	0 (0–2)	0 (0–5)	0.71	(–)
cT	2/3/4b/x	1/0/4/1	1/5/16/0	2/5/20/1	0.11	(–)
cN	0/1a/1b/2a/2b/3	6/0/0/0/0/0	7/7/2/2/2/2	13/7/2/2/2/2	0.12	(–)
cM	0/1a/1b/x	5/0/0/1	19/2/1/0	24/2/1/1	0.21	(–)
cStage	I	1	1	2	0.10	
	IIa/c	0/3	2/3	2/6		
	IIIb/c	0/0	2/10	2/10		(–)
	VIa/b	0/0	2/1	2/1		
	x	2	1	3		
DS	(+)/(–)	3/3	1/21	4/24	0.02	n.s.
Approach	Lap	1	7	8	0.10	
	pf (Tp) APE	5	8	13		(–)
	TaTME	0	7	7		
Stoma route	EP/TP	1/5	20/2	21/7	0.001	0.012:46.8 (2.3–940.4)
LLND	B/L/R/(–)	1/1/0/4	3/1/2/16	4/2/2/20	0.67	(–)
Ope. Duration (min)	Median (range)	488 (317–634)	365 (178–680)	391 (178–680)	0.15	(–)
Blood loss (ml)	Median (range)	355 (235–1375)	205 (18–733)	249 (18–1375)	0.06	(–)
Dissected LN	Median (range)	6.5 (1–16)	10 (0–25)	9 (0–25)	0.38	(–)
Metastatic LN	Median (range)	0 (0–4)	0.5 (0–6)	0 (0–6)	0.26	(–)
Tumor size (mm)	Median (range)	35 (0–60)	20 (0–70)	27.5 (0–70)	0.34	(–)
pT	0/2/3/4b/x	1/1/3/0/1	0/10/6/2/4	1/11/9/2/5	0.20	(–)
pN	0/1/2/3	5/0/1/0	11/7/2/2	16/7/3/2	0.22	(–)
pStage	0	0	1	1	0.77	
	I	1	6	7		
	IIa	2	2	4		(–)
	IIIa/b/c	0/1/0	1/5/1	1/6/1		
	IVa/b	0/0	2/1	2/1		
	x	2	3	5		
Histology	muc/por/tub/x	1/0/4/1	1/2/18/1	2/2/22/2	0.45	(–)
Cur	A/B/C	6/0/0	19/1/2	25/1/2	0.63	(–)
POS(days)	Median (range)	2160 (717–2565)	1855 (630–3769)	1930 (630–3769)	0.87	(–)

PH = parastomal hernia; UA = univariate analysis; Cox = Cox proportional hazard model; RR = relative risk; 95% CI,95% confidence interval; BMI = body mass index; ASA-PS = American Society of Anesthesiologists physical status; AV = tumor distance from the anal verge; DS = pretreatment diverting stoma; LLND = lateral pelvic lymph node dissection; Dissected LN = the number of dissected lymph nodes; Metastatic LN = the number of metastatic lymph nodes; Cur= curability, POS = postoperative observation period ; M = male; F = female; CRT = chemoradiotherapy; RT = radiotherapy; CT = chemotherapy; lap = standard laparoscopic surgery; pfAPE prone position first abdominoperineal excision; Tp = transperineal; TaTME = trans-anal total mesorectal excision; EP = extraperitoneal end sigmoid colostomy; TP = transperitoneal end sigmoid colostomy; B = bilateral; L = left side; R = right side

factors of the PH were significant in TP (p=0.012, relative risk = 46.8; 95% confidence interval = 2.3–940.4) and in ASA-PS(p=0.014, relative risk = 21.6; 95% confidence interval = 1.9-252.5).

The Kaplan–Meier curve indicated that the 3-year PH occurrence rate was 5.1% in EP cases and 71.4% in TP, with a significant difference ($p < 0.001$); [Figure 1].

Although an EP was selected routinely for the permanent end sigmoid colostomy following APE in our institute, TP was selected in seven cases [Table 2].

In these cases, creating an EP was more complicated than in usual cases, such as splenic flexure take-down and the need to change the stoma route after closure of the DS. These cases left the DS afferent loop and used it in its original position as a permanent stoma.

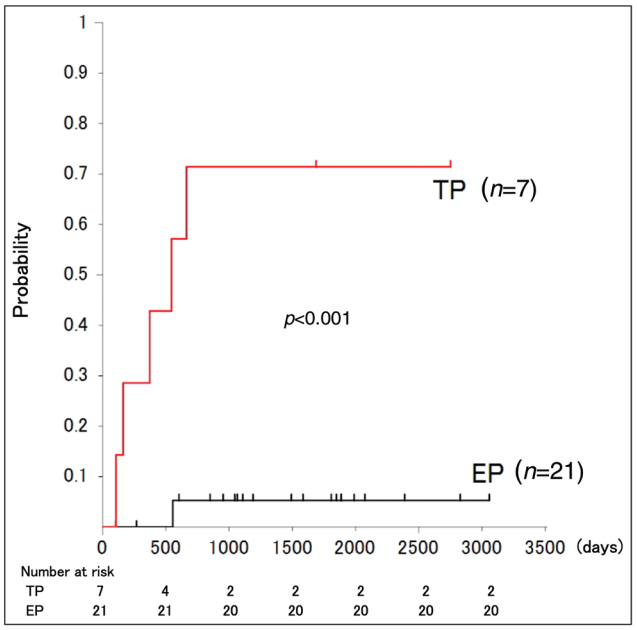

Figure 1: Kaplan–Meier curve of the incidence of parastomal hernia in the extraperitoneal end sigmoid colostomy (EP) and the transperitoneal end sigmoid colostomy (TP) groups. The 3-year incidence of PH between the groups is significant (p < 0.001; generalized Wilcoxon test, Cox–Mantel test, Log-rank test, Mantel–Haenszel test) for EP (5.1%) versus TP (71.4 %).

Because the stoma route does not directly affect the patient's life, the TP was selected as a result of a simple procedure at the final phase of the surgery, which led to PH in three of four patients with DS. One of the patients with total blindness who had a large complex tail gut cyst containing cancer tissue underwent APE in combination with sigmoidectomy. EP creation was challenging because of the short residual left-sided colon, and TP was selected. However, the PH developed into a complex condition that required management and repair twice (the keyhole technique was used the first time, and the Sugarbaker technique was used the second time due to the recurrence of PH). Of the six patients who developed PH, we selected TP in five cases.

Discussion

Similar to our previous study, only one case (5.1%) developed PH, which did not require repair in the EP in this study. Seventy-one percent of the TP (5/7) selected for complex cases experienced PH. Thus, if an EP had been created in all cases as planned, the incidence of PH requiring repair could have been almost entirely prevented. On the other hand, 5 of the 6 PH (+) cases occurred in the TP. The reason for being unable to control the onset of PH, considered controllable by surgery, had a case-specific rationale for the surgeon's choice of TP. In this study, the most natural choice for a TP was to use a preoperatively created DS afferent loop as a permanent stoma.

Indeed, changing the stoma route during radical surgery takes work. Due to the complexity of the EP procedure, there have been several randomized controlled trials (RCTs) on the use of mesh in combination with TP for PH prevention.[14–17,19–25,27,28] In these studies, the preventive effect of sublay prophylactic polypropylene mesh placement on TPs in open surgery[17,19,21] [Table 3] has been controversial.

On the other hand, López-Cano *et al*.[14,16] reported the effectiveness of PH prevention by prophylactic mesh

Table 2: Patients list with TP

Case	Age	Gender	BMI (kg/m²)	P/S	DS	NAdj	Tumor D (mm)	pStage	Ope Duration (min)	Blood Loss (mL)	f/u Period (days)	PHfree Survival (days)	PH	PH repair
1	71	M	22.7	S	(–)	CRT	35	I	385	733	2880	2751	(-)	(-)
2	63	M	22.6	S	(–)	CRT	0	X1	576	401	2336	664	(+)	(-)
3	78	M	23.7	P→S	(–)	(–)	60	IIIB	634	360	717	545	(+)	(-)
4	75	M	22.9	P	(+)	(–)	45	IIA	405	340	2565	106	(+)	(-)
5	69	F	16.6	P	(+)	CRT	35	IIA	472	235	2025	373	(+)	(-)
6	69	M	26.4	S	(+)	(–)	X2	X2	503	1375	2295	163	(+)	(+)
7	47	F	24.8	P	(+)	CT	50	IIIC	523	260	1688	1688	(-)	(-)

P/S, P = primary operation; S = secondary operation; DS = diverting stoma; NAdj = neoadjuvant therapy; Tumor D = tumor maximum diameter; pStage, TNM 9th; f/u = follow-up; PH = parastomal hernia; CRT = chemoradiotherapy; X1= recurrent tumor following LAR encountered pathological complete remission; X2, cancer in the cystic tumor originating from the tailgut cyst

Table 3: Randomized controlled trials of prophylactic mesh placement for parastomal hernia prevention

Author (Ref)	Year	N	Timming	Control	Experimental	Mesh Location	Mesh Type	Approach	p
Serra-Aracil X[15]	2009	54	Scheduled	TP	TP	Sublay	Ultrapro®	Open	0.033
Jänes A[22]	2009	54	Scheduled	TP	TP	Sublay	Vypro®	Open	<0.001
López-Cano M[14]	2012	36	Scheduled	TP	TP	IPOM (Keyhole)	Large-pore lightweight composite mesh	Lap	0.008
Vierimaa M[24]	2015	70	Scheduled	TP	TP	IPOM (keyhole)	DynaMesh®	Lap	NS
Lambrecht JR[23]	2015	58	Scheduled	TP	TP	Sublay	Prolite Ultra®, Parietene Light®	Open	<0.001
López-Cano M[25]	2016	52	Scheduled	TP	TP	IPOM (modified Sugarbaker technique)	Large-pore lightweight composite mesh	Lap	<0.005
Odensten C[17]	2019	232	Scheduled	TP	TP	Sublay	Lightweight polypropylene mesh	Open	0.866
Correa MA[18]	2021	185	Scheduled	TP	TP	Sublay	Ultrapro®	Open/Lap	NS
Prudhomme M [19]	2021	199	Scheduled	TP	TP	Sublay	Lightweight monofilament	Open	0.77
Pizza F[20]	2022	110	Scheduled	TP	TP	Ante-rectus position	Bio-A®	Open	<0.05
Brandsma HT[21]	2023	113	Scheduled	TP	TP	Sublay	Parietene®	Open	0.22
Mäkäräinen E[29]	2025	121	Scheduled	TP	TP	IPOM(funnel-shaped mesh)	DynaMesh-IPST®	Lap	<0.001

Ref = reference number; NS = not significant

placement using the modified Sugarbaker technique in a laparoscopic setting. Since PH is more difficult to treat when accompanied by an incisional hernia, laparoscopic surgery has a significant advantage. Although it is natural to be concerned about the risk of postoperative mesh infection of the intraperitoneal onlay mesh (IPOM) following elaborate surgery, this report highlights the safety of the laparoscopic IPOM Sugarbaker technique following APE, with no cases requiring reoperation due to mesh rejection or mesh infection.[25] Indeed, the efficacy of IPOM in preventing PH in TP has not been established, even with the Sugarbaker technique. However, the effectiveness of prophylactic mesh placement is worth considering for patients forced to undergo TP, as the Sugarbaker technique can be regarded as a modification of EP.

Another option for reducing the PH rate regarding DS might be creating a DS as a permanent end colostomy with EP or at a different site from the permanent sigmoid colostomy site. We prefer loop DS to end colostomy due to its simplicity, which avoids perioperative complications as much as possible. In this study, four cases of TP required a DS at the pretreatment condition (in two cases at another hospital before admission, and in the other two cases at our institute), which were located at the permanent sigmoid colostomy. Although the DS location is controversial in these cases, we preferred to place it at the permanent sigmoid stoma site, avoiding the potential risk for an additional ventral hernia. Furthermore, a DS at the permanent sigmoid stoma site was convenient for completing the operation in a complicated case, despite the necessity of the TP stoma, which carried a risk of PH. Although our policy has been based on the safety of perioperative conditions, the risks of PH due to the TP should be addressed.

As far as we know, no RCTs on the efficacy of EP versus TP using mesh in preventing PH have been done [Table 3]. Although the frequency of non-absorbable mesh placement after rectal resection without sphincter preservation in Germany gradually increased following the European Hernia Society guidelines for PH, published in 2017,[28] the frequency of prophylactic mesh use in 2020 was only 6.4%.[30] Furthermore, the mean length of hospital stay was significantly longer, and there was a slightly higher reoperation rate compared to patients without mesh. The prophylactic mesh placement for PH prevention should have a rationale based on the effects of implanting the foreign body at the same time, from an economic perspective.

If the patient in Case 6 in Table 2 had undergone prophylactic mesh placement, a repair surgery might not have been necessary. The DS could also have been treated as a permanent stoma to minimize the development of PH.

Although this study is a retrospective study from a single institution, with a limited number of cases, very few articles have prospectively examined the development of PH in consecutive cases of APE at facilities where EP is the standard, and explained and described the

causes of PH. In the present study, only 5.1% of patients had PH on EP, which was almost the same as the rate in our previous retrospective study.[9] It is clear that if EP is possible, prophylactic mesh placement is of little significance.

Unfortunately, there are cases in which TP must be selected. In these cases, selective prophylactic mesh placement using the IPOM Sugarbaker technique or the Funnel-Shaped mesh method,[29] which yet have sufficient data from long follow-up, might be a promising option for preventing PH.

Conclusion

The EP stoma is a highly effective method for preventing PH, and the sophisticated IPOM methods, in which TP is used as a pseudo-EP in cases where TP is necessary, warrant further investigation.

Author contributions

Conception and design: Madoka Hamada. Acquisition of the data: Yuki Matsumi, Madoka Hamada, Fusao Sumiyama, Toshinori Kobayashi, Ryo Inada.Drafting and revising the article: Madoka Hamada, Nozomi Ueno. Final approval: Madoka Hamada. All authors have read and approved the manuscript.

Ethical policy and institutional review board statement

All procedures performed in this study involving human participants were in accordance with the ethical standards of the IRB of the Ethics Committee and the National Research Committee, as well as the 1964 Helsinki Declaration and its subsequent amendments. In this study, an IRB was not required for ethical review because the research uses only anonymized medical information from research subjects.

Declaration of patient consent

Written consent forms for the published photos were obtained from the patients. Additionally, written consent was obtained from all registered patients to use their information for research and publication purposes.

Data availability statement

All materials described in the manuscript, including all relevant raw data, will be freely available to any scientist wishing to use them for noncommercial purposes without breaching participant confidentiality.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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