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Original Article

Low Patient Weight and Long Intubation Time Are Key Factors for Pain during Colonoscopy

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Although the clinical usefulness of colonoscopy has been established, the procedure remains painful for many patients. This study was designed to clarify the factors predicting colonoscopy-related pain. We evaluated 283 consecutive patients who completed a first-ever, total colonoscopy without sedatives or analgesics. The severity of pain symptoms was evaluated by a numeric rating scale (NRS) in a questionnaire immediately after the colonoscopy. Patient backgrounds and endoscopic findings were analyzed to evaluate their association with pain. Out of 283 patients, 53 scored their pain 0-1 on the NRS while 48 scored it 6-10. We defined the colonoscopies of the former and latter patients as painless and painful, respectively, and compared the two. Multivariate analyses revealed that low body weight (OR 4.95, 95%CI 1.89-12.99) and longer intubation time (OR 3.63, 95%CI 1.46-9.03) were significant risk factors for painful colonoscopy. To identify factors contributing to the increased intubation time, we divided subjects into short- and long-intubation-time groups based on a median insertion time of 7 min. Older age (OR 2.28, 95%CI 1.31-3.98), previous abdominal surgery (OR 1.93, 95%CI 1.13-3.32) and findings of invasive cancer (OR 10.90, 95%CI 1.34-88.90) were significant factors for longer intubation time.

Key words: colonoscopy, colonoscopy-related pain, comfortable colonoscopy

Colorectal cancer (CRC) is one of the most common types of cancer in the world. According to statistics from the International Agency for Research on Cancer (IARC), the morbidity of CRC has been increasing, making it the second-leading cause of death from cancer in Japan and in the world as a whole [1]. CRC arises from colorectal polyps: either adenomas, known for the adenoma-carcinoma sequence, or serrated lesions, for the serrated pathway [2-5]. In any case, it is important to recognize lesions at an early stage by colonoscopy. The National Polyp Study suggested that the early detection and removal of adenomatous polyps reduces the incidence of CRC [6]. Furthermore, patients with a 'clean colon', from which adenomatous polyps have been completely removed, have a significantly lower rate of CRC-related mortality [7].

We usually use the fecal occult blood test for CRC screening in health checkups in Japan, but only about 50% of positive patients undergo a complete examination by colonoscopy. The low acceptance rate of screening colonoscopy among asymptomatic people is a problem in Japan. One of the reasons for the screening

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avoidance is that many people consider colonoscopy to be a painful examination. This perception is especially problematic because patients whose first colonoscopy examination is painful will undergo fewer repeat examinations.

On the other hand, colonoscopy is a difficult procedure, even for endoscopists, and providing comfortable colonoscopy to all patients is one of our aims. Comfortable colonoscopy would lead to reduced CRC-related morbidity and mortality, as described above. Therefore, endoscopists need to be familiar with the risk factors for painful colonoscopy. By identifying patients at risk of a painful colonoscopy, it is possible to implement certain measures, including the use of analgesics before the examination [8,9]. This information should also be useful in the education of inexperienced colonoscopists.

It is reported that patient risk factors for difficult colonoscopy include lower body mass index (BMI), younger age and redundant colon [10]. Furthermore, procedural factors associated with difficult colonoscopy have been reported to include poor preparation status, past history of hysterectomy and non-use of antispasmodic agents [10]. However, there have been few reports on factors associated with difficult colonoscopy, and factors that can predict difficult colonoscopy in advance remain to be elucidated [11-17]. Thus, we evaluated these factors in the present study by administering a patient questionnaire about experience of pain and discomfort immediately after colonoscopy. The greatest advantage of this study was thus that the evaluation reflected feedback from actual patients.

Materials and Methods

Participants.   A total of 3,922 consecutive colonoscopies which underwent at Okayama University Hospital from November 2013 to December 2015 were included in this study. Among the 3,922 colonoscopies, 602 colonoscopies for ulcerative colitis, Crohn's disease or heterotaxia and 182 colonoscopies for emergency or hemostatic colonoscopy were excluded. We identified 283 patients who underwent a first-ever colonoscopy without sedatives or analgesics and who underwent total colonoscopy. The reasons for such colonoscopy were fecal occult blood test positivity, investigation of symptoms (*e.g.*, constipation, abdominal pain, diarrhea and bloody stool), suspected CRC due to tumor

markers or imaging findings, patient's request, and other. All patients provided their written informed consent for the questionnaire administration after colonoscopy and for the use of their clinical data. The study protocol conformed to the ethical guidelines of the World Medical Association Declaration of Helsinki and was approved by the Okayama University Hospital Ethics Committee.

Bowel preparation.   Participants were instructed to eat a low-fiber diet the day before undergoing colonoscopy, to abstain from eating food after 21 : 00 and to ingest a laxative at bedtime. They ingested whole bowel irrigation Niflec® or Moviprep® (EA Pharma, Tokyo); polyethylene glycol or Magcorol P® (Horii Pharmaceutical, Osaka, Japan); or magnesium citrate. Some received a high-pressure enema just prior to the colonoscopy. The colonoscopy was started after the completion of intestinal cleansing.

Endoscopists and tools.   Within the study period, all participants underwent colonoscopy examinations that were performed by a total of 25 endoscopists belonging to Okayama University Hospital. The endoscopists had over 6 years of experience (range 6-18 years) and were certified by the Japanese Society of Gastrointestinal Endoscopy. We used Olympus colonoscopes (CF-H260AZI, PCF-Q260, PCF-Q260AZI, CF-HQ290ZI). CO_2 gas was insufflated during insertion and observation. Scopolamine butylbromide or glucagon was administered prior to insertion as an antispasmodic. A short, soft hood (MAJ-1990, D-201; Olympus, Tokyo) was attached to the tip of the scope before insertion in some cases, according to the colonoscopists's preference. The insertion time was defined as the time from the start of colonoscopy until reaching the cecum, and the observation time was defined as the time from observing the cecum until the end of colonoscopy. These times were measured using the timer function built into the endoscopy system.

Data collection.   All participants completed a questionnaire immediately after their colonoscopy was finished. Information collected from the questionnaires included the participant's age, sex, height, weight, alcohol consumption equivalent to $\geqq 350$ ml of beer every two days (yes/no), antithrombotic medication (yes/no), hypertension (yes/no), and liver disease (yes/no). Other information collected from the questionnaire included the history of abdominal surgery, the surgical site and pain in colonoscopy. Colonoscopy-

related pain was assessed using a numerical rating scale (NRS) consisting of a line, with 0 indicating no pain and 10 indicating the worst possible pain [18].

Statistical analysis. The differences between the measured and group values were analyzed using chi-squared tests and Student's *t*-test. A multivariate analysis was performed using a conditional logistic regression model, and *p*-values < 0.05 were considered statistically significant.

Ethical considerations. The study protocol was approved by the institutional review board of Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical (IRB number: 1904-037). Informed consent was obtained from all patients. All methods were performed in accordance with the Declaration of Helsinki.

Results

Clinical characteristics of the patients. Figure 1 shows a flow diagram of the present study. A total of 283 patients (n = 123 female patients, 43.5%) undergoing their first colonoscopy examination were evaluated. Table 1 summarizes their baseline demographic and clinical characteristics. The median age was 62 years (range, 17-92), the mean height was 161.6 ± 8.6 cm, the mean body weight was 59.1 ± 11.8 kg, and the mean

Table 1　Characteristics of participants in this study

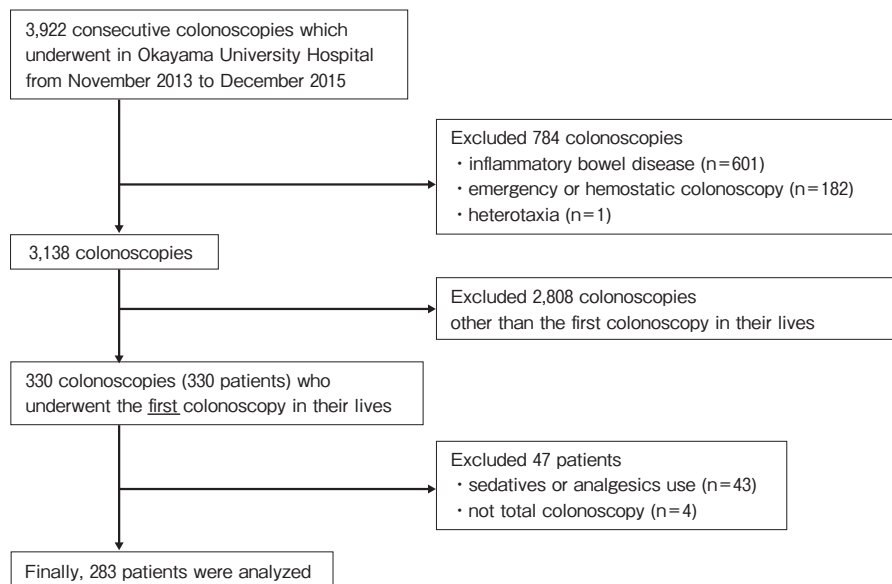|	Participants n = 283	
Sex		
female	123	43.5%
Age, years, median (range)	62 (17−92)	
Height, cm, mean (SD)	161.6 ± 8.6	
Body weight, kg, mean (SD)	59.1 ± 11.8	
Body mass index, kg/m², mean (SD)	22.5 ± 3.6	
Alchol drinking	46	16.3%
Antithrombotic agents	47	16.6%
Past history and comorbidities		
previous abdominal surgery	85	30%
hypertension	57	20.1%
liver disease	13	4.6%
Techniques applied in endoscopy		
soft short hood	132	46.6%
antispasmodics	242	85.5%
Intubation time, min., mean (SD)	9.3 ± 7.2	
Observation time, min., mean (SD)	14.4 ± 7.0	
Endoscopic diagnosis		
colorectal tumor	113	39.9%
invasive cancer	11	3.9%
adenomatous polyps	106	37.5%
colitis	7	2.5%
diverticulum	103	36.4%
Numerical rating scale, median (range)	3 (0−10)	

Fig. 1 Flow diagram of patient enrollment. Of the consecutive cases during the study period, 283 patients who underwent their first-ever colonoscopy examination without sedatives and analgesics and completed a total colonoscopy were analyzed.

BMI was 22.5 ± 3.63 kg/m². The indications for colonoscopy were as follows: fecal occult blood test positivity, n = 114 (40.3%); investigation for the cause of any symptoms, n = 61 (21.6%); suspected colon cancer, n = 41 (14.5%); patient's request, n = 23 (8.1%); and other, n = 44 (15.5%). There was no significant difference in pain or intubation time between people with and without symptoms. Among the 283 patients, 85 had history of open or laparoscopic abdominal surgery (including overlapping cases: appendectomy, n = 44; gastrointestinal surgery other than colorectal surgery, n = 7; hepatobiliary-pancreatic surgery, n = 13; gynecologic surgery, n = 26; urological surgery, n = 3). No patients had a history of colorectal surgery. The history of abdominal surgery did not affect the pain. Forty-six (16.3%) patients drank alcohol, 13 (4.6%) had liver disease, 57 (20.1%) had hypertension, and 47 (16.6%) were using antithrombotic agents. Two hundred forty-two (85.5%) patients were given antispasmodics and for 132 (46.6%) the endoscopist used a short, soft hood; these factors were not associated with any obvious difference in the data related to scope insertion or patient's pain.

Colonoscopy and NRS values. The findings and diagnoses by colonoscopy were as follows: colon tumor, n = 113 (39.9% [invasive cancer, n = 11; adenomatous polyps, n = 106; other, n = 9]), diverticulum, n = 103 (36.4%); and colitis, n = 7 (2.5%). There were no patients with colitis with stenosis or obstruction. The mean intubation time was 9.3 ± 7.2 min. The mean observation time was 14.4 ± 7.0 min. The median NRS was 3 (range, 0-10) points.

Table 2 compares the painless, mild-to-moderate pain and severe pain groups (grouped according to NRS). The comparison among three groups showed that lower body weight ($p < 0.05$) and longer intubation time ($p < 0.05$) were associated with pain. We defined the painless group as the patients reporting an NRS of 0 or 1 points, because the number of surveys with 0 points alone was too small to be analyzed. Conversely, patients reporting an NRS of 6-10 were assigned to the severe pain group; the painless and severe pain groups were almost the same size. Then we compared the two groups to elucidate the cause of pain during colonoscopy. A multivariate logistic regression analysis revealed that lower body weight and longer intubation

Table 2   Patients characteristics according to NRS

	NRS 0–1 n = 53		NRS 2–5 n = 182		NRS 6–10 n = 48		P-value
Sex							
female	22	41.5%	78	42.9%	23	47.9%	0.78
Age, years, median (range)	63 (26–86)		62 (17–92)		61.5 (18–89)		0.92
Height, cm, mean (SD)	161.8 ± 8.4		162.0 ± 8.6		159.7 ± 8.7		0.34
Body weight, kg, mean (SD)	60.7 ± 10.9		59.7 ± 12.1		54.9 ± 10.4		<0.016
Body mass index, kg/m², mean (SD)	23.1 ± 3.5		22.6 ± 3.6		21.6 ± 3.8		0.07
Alchol drinking	9	17.0%	27	14.8%	10	20.8%	0.61
Antithrombotic agents	9	17.0%	30	16.5%	8	16.7%	0.99
Past history and comorbidities							
previous abdominal surgery	16	30.2%	53	29.1%	16	33.3%	0.85
hypertension	12	22.6%	33	18.1%	12	25.0%	0.51
liver disease	2	3.8%	9	4.9%	2	4.2%	0.92
Techniques applied in endoscopy							
soft short hood	26	49.1%	88	48.4%	18	37.5%	0.37
antispasmodics	48	90.6%	154	84.6%	40	83.3%	0.47
Intubation time, min., mean (SD)	7.8 ± 4.3		9.1 ± 7.3		12.2 ± 8.5		<0.016
Observation time, min., mean (SD)	15.4 ± 6.9		14.1 ± 6.3		14.3 ± 9.2		0.20
Endoscopic diagnosis							
colorectal tumor	25	47.2%	71	39.0%	17	35.4%	0.45
invasive cancer	1	1.9%	7	3.8%	2	4.2%	0.66
adenomatous polyps	25	47.2%	67	36.8%	16	33.3%	0.30
colitis	0	0%	5	2.7%	2	4.2%	0.20
diverticulum	16	30.0%	69	37.9%	18	37.5%	0.57

time were independently associated with patient pain (Table 3).

Factors associated with difficult colonoscope insertion. Based on the result that longer intubation time was directly related with the patient's experience of pain, we next attempted to identify the factors associated with increased intubation time. Patients were divided into a short-intubation-time group (≤7 min) and a long-intubation-time group (>7 min) by a median intubation time of 7 min, in order to identify risk factors for time-consuming intubation (*i.e.,* difficult colonoscopy). Table 4 shows a comparison of the short- and long-intubation-time groups. A univariate analysis showed

that older age ($p < 0.01$), previous abdominal surgery ($p < 0.01$), and findings of invasive cancer ($p < 0.01$) were associated with longer intubation time. The surgical site was not relevant. A multivariate logistic regression analysis revealed that older age, previous abdominal surgery and invasive cancer were independent risk factors for longer intubation time (Table 5).

Discussion

Reliably painless colonoscopy has been an unrealized goal of endoscopists for many years. For painless and comfortable colonoscopy, many studies on insertion methods have focused on the doctor's point of view

Table 3 The risk factors of predicting the painful colonoscopy for patients

Factors	OR (95%C.I.)	*P*-value
Sex (female)	1.04 (0.41–2.64)	
Age (years)	0.97 (0.94–1.01)	
Body weight (kg)	4.95 (1.89–12.99)	<0.01
Previous Abdominal surgery	1.24 (0.47–3.28)	
antispasmodics	3.19 (0.82–12.33)	
Intubation time (minute)	3.63 (1.46–9.03)	<0.01
Diverticulum	1.47 (0.58–3.76)	

Table 5 The risk factors associated with the long intubation time

Factors	OR (95%C.I.)	*P*-value
Sex (female)	1.19 (0.70–2.07)	
Age (years)	2.28 (1.31–3.98)	<0.05
Body weight (kg)	1.15 (0.22–5.84)	
Previous Abdominal surgery	1.93 (1.13–3.32)	<0.05
Invasive cancer	10.90 (1.34–88.90)	<0.05
Diverticulum	1.11 (0.67–1.86)	

Table 4 Patients characteristics according to intubation time

	≤7 min n=143		>7 min n=140		*P*-value
Sex					
female	58	40.6%	65	46.4%	0.34
Age, years, median (range)	59 (17–86)		64 (18–92)		<0.01
Height, cm, mean (SD)	162.0 ± 8.4		161.1 ± 8.9		0.55
Body weight, kg, mean (SD)	59.9 ± 12.4		58.2 ± 11.1		0.30
Body mass index, kg/m², mean (SD)	22.7 ± 3.9		22.4 ± 3.4		0.59
Alchol drinking	19	13.3%	27	19.3%	0.2
Antithrombotic agents	25	17.5%	22	15.7%	1
Past history and comorbidities					
previous abdominal surgery	32	22.4%	53	37.9%	<0.01
hypertension	26	18.2%	31	22.1%	0.46
liver disease	5	3.5%	8	5.7%	0.41
Techniques applied in endoscopy					
soft short hood	69	48.3%	63	45.0%	0.63
antispasmodics	126	88.1%	116	82.9%	0.24
Endoscopic diagnosis					
colorectal tumor	54	37.8%	59	42.1%	0.47
invasive cancer	1	0.7%	10	7.1%	<0.01
adenomatous polyps	53	37.1%	55	39.3%	0.72
colitis	3	2.1%	4	0.3%	0.72
diverticulum	53	37.1%	50	37.1%	0.90

(*e.g.*, water-aided colonoscopy [19], carbon dioxide insufflation [20], a short, transparent soft scope hood [21], aromatherapy [22], relaxation music [23], video distraction [24]). In contrast, few studies have focused on the patient's view. In the present analysis, therefore, we asked all patients to complete a post-colonoscopy questionnaire about any factors that caused them distress during colonoscopy.

In this study, we recruited patients who underwent colonoscopy without sedatives and analgesics and collected each questionnaire immediately after colonoscopy. We thus were able to get feedback from patients before the memory of the event faded. Moreover, we targeted only colonoscopy-naïve cases. This was because we considered that those who had previously experienced colonoscopy could not make a fair evaluation due to comparisons with the former examination or strong prejudice. Furthermore, by including only patients undergoing their first colonoscopy examination, the endoscopists were able to perform colonoscopy without a preconception as to whether or not the patient was susceptible to pain.

Twenty-five board-certified endoscopists with different years of experience participated in this study. There was no significant difference among the endoscopists in terms of previous experience of pain or long intubation time. This was probably because the years of experience are not always proportional to skill in the case of endoscopic procedures, and because board-certified professionals are to some extent guaranteed to have average skill or better.

Our study suggested that a longer intubation time was an independent risk factor for uncomfortable colonoscopy for the patient. It can be said that the impression at the time of insertion determines the overall impression of the colonoscopy because the questionnaire was collected not after insertion of the scope but after the entire examination was finished. Endoscopists constantly practice to improve our colonoscope insertion techniques. Our study supported this aim, in that the quicker and smoother the insertion of the colonoscope, the better the patient's impression of the procedure.

We also found that lower patient body weight was significantly associated with feeling pain during colonoscopy. Patients with lower BMI values also tended to feel pain during colonoscopy, although that difference was not statistically significant. In contrast, neither light weight nor low BMI was associated with a long intubation time. Some reports have suggested that low abdominal muscle mass makes colonoscope insertion difficult [10,25].

We next investigated the types of patients for whom colonoscopy was difficult to perform by analyzing factors associated with long intubation time. It is generally recognized among endoscopists that a long insertion time indicates difficult colonoscopy. We found that older age, previous abdominal surgery and invasive cancer were significantly associated with a long intubation time. It has been reported that the intestines tend to loosen with age [26], which was considered to be the reason for difficult colonoscopy in elderly patients. Constipation is also reported as a predictor of difficult colonoscopy [10], and many elderly people have chronic constipation [27]. Therefore, constipation may have something to do with the longer intubation time in the elderly. Intestinal adhesions are considered the reason why previous abdominal surgery makes colonoscopy difficult. We suspected that pelvic surgeries such as appendectomy or gynecologic surgery or urological surgery are more likely to have adhesions, and we respectively investigated the risk of difficulty of scope insertion by surgical site as well. However, it was interesting that there was no significant difference in pain symptoms according to surgical site. Invasive cancer was significantly associated with long intubation time, which represents a new finding in the literature. We speculate that this is because invasive cancers are often associated with intestinal adhesions. Indeed, invasive cancer was discovered during the process of endoscope insertion in most cases. We also expected that multiple diverticula would be associated with difficulty in intubation and painful colonoscopy. However, neither the number nor the locations of diverticula were associated with longer intubation or painful colonoscopy.

The results of this study enable us to predict patients who may be distressed by colonoscopy or for whom colonoscope insertion may be difficult before performing the examination. In the clinical practice of endoscopy, quite a few endoscopists have considered that it is impossible to predict whether colonoscopy would be painful or comfortable prior to the examination. As a result, more than a few patients experience painful colonoscopy, which is especially unfortunate in that such patients are probably less motivated to undergo repeat colonoscopy. This would be expected to reduce

the rate of patients who receive screening colonoscopy. If colonoscopists were able to identify patients likely to experience pain in the procedure in advance, they could take appropriate measures: for instance, using sedatives or analgesics; taking extra care with the scope insertion; and/or selecting a board-certified expert as a colonoscopist rather than an inexperienced colonoscopist. The question of whether sedatives should be used during colonoscopy remains a controversial one [28]. Identifying the types of patients who may require sedatives during colonoscopy would also contribute to the appropriate use of sedative agents.

The results of our study, which stratified patients who might find colonoscopy painful, may also be applicable to training inexperienced colonoscopists. In a teaching hospital like our facility, trainers always try to let beginners engage in easy cases. However, in the case of colonoscopy there have been no clear indications regarding which cases will be easy. Hereafter, referring to the results of this study, trainees should avoid performing colonoscopy in cases involving patients with lower body weight, elderly patients, patients with a history of abdominal surgery or patients with suspected invasive cancer. At our institution, we have already been practicing these exclusion criteria for trainee participation.

This study had several limitations. First, 25 endoscopists with different years of experience participated in this study. Although the difference was not statistically significant, the colonoscopist group was slightly biased toward more (or fewer) colonoscopy examinations in this study. Second, four types of colonoscope were used in this study, and the choice of the scope was up to each colonoscopist. This may have produced a bias although the colonoscopes used in this study were PCF-Q260AI and PCF-Q260AZI, both of which have a variable tube stiffness system and almost the same outer diameter. Since the difference in scope operability was negligible, we did not consider that differences in scope affected the results.

In conclusion, the present study revealed factors that make colonoscopy painful. Knowledge of these factors is the first step in providing comfortable colonoscopy that does not cause pain to the patient. We believe that comfortable colonoscopy will contribute to improving the rate of repeat examination, which will lead to the earlier detection and treatment of CRC.

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