

Factors associated with incomplete colonoscopy at a Japanese academic hospital

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Abstract

AIM: To evaluate significant risk factors for incomplete colonoscopy at a Japanese academic hospital.

METHODS: A total of 11812 consecutive Japanese people were identified who underwent a colonoscopy at an academic hospital. A multiple logistic regression model was used to evaluate retrospectively the significant risk factors for incomplete colonoscopy.

RESULTS: The cecal intubation rate was 95.0%. By univariate analysis, age, female sex, poor bowel cleansing, and a history of abdominal or pelvic surgery were significant risk factors for incomplete colonoscopy ($P < 0.001$). Moreover, age- and sex-adjusted analysis showed that significant risk factors for incomplete colonoscopy were female sex (OR = 1.38, 95%CI: 1.17-1.64, $P = 0.0002$), age ≥ 60 years old (OR = 1.44, 95%CI: 1.22-1.71, $P < 0.0001$), a history of prior abdominal or pelvic surgery (OR = 1.55, 95%CI: 1.28-1.86, $P < 0.0001$), poor bowel cleansing (OR = 4.64, 95%CI: 3.69-5.84, $P < 0.0001$), and inflammatory bowel disease (IBD) (OR = 1.48, 95%CI: 1.13-1.95, $P = 0.0048$). In Japanese men, by age-adjusted analysis, IBD (OR = 1.69, 95%CI: 1.18-2.43, $P = 0.005$) was an independent risk factor for incomplete colonoscopy.

CONCLUSION: Several characteristics in the Japanese population were identified that could predict technical difficulty with colonoscopy.

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Key words: Colonoscopy; Incomplete; Intubation rates; Japanese academic hospital; Risk factors; Inflammatory bowel disease

Core tip: In a Japanese academic hospital, we retrospectively evaluated the significant risk factors for incomplete colonoscopy. A total of 11812 consecutive Japanese people were enrolled. By age- and sex-adjusted analysis, the significant risk factors for incomplete colonoscopy were female sex, age ≥ 60 years old, a history of prior abdominal or pelvic surgery, inadequate bowel preparation, and inflammatory bowel disease (IBD). In Japanese men, by age-adjusted analysis, IBD was an independent risk factor for incomplete colonoscopy. Therefore, several characteristics in the Japanese population might predict technical difficulty

with colonoscopy.

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INTRODUCTION

Colonoscopy is currently recommended for initial screening and as a surveillance test for the evaluation of colorectal polyps, cancer, and other lower gastrointestinal tract diseases, such as inflammatory bowel disease (IBD)^[1-3]. Colonoscopy is also useful for assessing the causes of unexplained changes in bowel habits, such as persistent constipation and diarrhea, for evaluating symptoms of abdominal pain or bleeding, and for investigating weight loss. A complete examination of the colon and rectum is fundamental to any screening program^[4]; however, incomplete colonoscopy occurs in approximately 10% of patients^[5-7]. Therefore, lower gastrointestinal tract pathology can be missed due to incomplete colonoscopy^[7]. A variety of factors that contribute to an incomplete colonoscopy, including prior abdominal surgeries resulting in adhesions, inadequate bowel cleansing, and patient discomfort, have been reported in the West^[6,7]. In contrast, there has been scant information concerning explanatory factors for incomplete colonoscopy in Asian patients, especially the Japanese population. Such information might assist in developing recommendations about which patients might be more suitable for capsule endoscopy^[8] or non-endoscopic modalities, including computed tomography (CT) and magnetic resonance (MR) colonography^[9-12] rather than colonoscopy. Therefore, we conducted a study to determine the colonoscopy completion rate and to identify the risk factors for incomplete insertion of the colonoscope at a Japanese academic hospital.

MATERIALS AND METHODS

Study design

We conducted an academic hospital-based, retrospective study to examine the factors associated with incomplete procedures in the Japanese population. Overall, 11812 consecutive Japanese people who underwent colonoscopy at Juntendo University Hospital between 2003 and 2006 were retrospectively examined. In our hospital, bowel preparation is performed with 2 L of polyethylene glycol (PEG) with an adjunct laxative, sodium picosulfate. The enrolled people underwent regular colonoscopy, with either an intermediate-length colonoscope (PCF-

260I; Olympus. Co., Ltd., Tokyo, Japan) or a long colonoscope (PCF-260L; Olympus. Co., Ltd.). In this study, we excluded patients who met any of the following criteria: a history of colorectal resection or cases of emergency or therapeutic colonoscopy. Cecal intubation rates were evaluated with regard to following factors; (1) age; (2) sex; (3) a history of abdominal or pelvic surgery; (4) quality of bowel cleansing; (5) melanosis coli^[13]; (6) IBD; and (7) the experience of the colonoscopist. IBD was diagnosed according to conventional criteria^[14].

Statistical analysis

Proportions of factors and mean age were compared between men and women by the Mann-Whitney *U*-test and Fisher's exact test, respectively. Age- and sex-adjusted OR, with 95%CI, were estimated using a multiple logistic regression model to examine the risk factors for incomplete colonoscopy. Moreover, stepwise multiple logistic regression analysis was used to select significant factors that were independently related to the risk of incomplete colonoscopy, where age and sex were forced to enter into the models; other significant factors were selected from among abdominal or pelvic surgery, adequate bowel cleansing, and IBD, with $P < 0.05$ for entry and removal. Statistical analysis was performed with STAT VIEW software, version J 5.1 (SAS Institute, Inc., Cary, NC, United States). $P < 0.05$ was considered statistically significant.

RESULTS

Characteristics of the Japanese population with complete or incomplete colonoscopy

Overall, 11812 consecutive Japanese people underwent colonoscopy at our hospital between 2003 and 2006. As shown in Table 1, the complete cecal intubation rate was 95.0% (11222/11812). The mean age was 57.8 ± 14.8 years old, the median age was 60 years old, the percentage of men was 65.1% (7686/11812), and that of women was 34.9% (4126/11812). The Japanese population with a history of abdominal or pelvic surgery, IBD, or melanosis coli numbered 20.5% (2417/11812), 10.2% (1199/11812), and 3.7% (438/11812), respectively. After bowel preparation, 5.0% (593/11812) had prepared inadequately. We first compared the following variables between the complete and incomplete colonoscopy groups: age; sex; poor bowel cleansing; a history of abdominal or pelvic surgery; melanosis coli; and IBD. In the incomplete colonoscopy group, the percentages of female sex, poor bowel cleansing and a history of abdominal or pelvic surgery were significantly higher than those in the complete group ($P < 0.001$). Moreover, in the incomplete colonoscopy group, the Japanese population was significantly older than in the complete colonoscopy group ($P < 0.001$). In contrast, there were no significant differences in the proportions of patients with melanosis coli and IBD between the complete and incomplete groups ($P = 0.50$ and 0.16 , respectively) (Table 1).

Table 1 Baseline characteristics of the Japanese population *n* (%)

Variables	Total (<i>n</i> = 11812)	Cecal intubation	
		Incomplete (<i>n</i> = 590)	Complete (<i>n</i> = 11222)
Age (mean ± SD)	57.8 ± 14.8	60.8 ± 15.6	57.6 ± 14.7
Age ≥ 60 yr	6174 (52.3)	358 (60.7)	5816 (51.8)
Sex (female)	4126 (34.9)	248 (42.2)	3878 (34.6)
Poor bowel cleansing	593 (5.0)	107 (18.1)	486 (4.3)
History of abdominal or pelvic surgery	2417 (20.5)	175 (29.7)	2242 (20.0)
Melanosis coli	438 (3.7)	25 (4.2)	413 (3.7)
Inflammatory bowel disease	1199 (10.2)	70 (11.9)	1129 (10.1)

Table 2 Characteristics of male and female patients *n* (%)

Variables	Male (<i>n</i> = 7686)	Female (<i>n</i> = 4126)	<i>P</i> value ¹
Age (mean ± SD)	58.2 ± 14.3	57.0 ± 28.7	0.0141
Poor bowel cleansing	353 (4.6)	240 (5.8)	0.0041
History of abdominal or pelvic surgery	1231 (16)	1186 (28.7)	< 0.0001
Melanosis coli	179 (2.3)	259 (6.6)	< 0.0001
Inflammatory bowel disease	753 (9.8)	446 (10.8)	0.0845

¹Mann-Whitney *U*-test (for age) or Fisher's exact test (for others).

Characteristics of variables in men and women undergoing colonoscopy

In this patient cohort, men underwent colonoscopy more frequently than women. Thus, the following variables were compared separately between men and women: age; poor bowel cleansing; history of abdominal or pelvic surgery; melanosis coli; and IBD. There were significantly higher percentages of women with poor bowel cleansing ($P = 0.004$), a history of abdominal or pelvic surgery ($P < 0.0001$), and melanosis coli ($P < 0.0001$) (Table 2). Moreover, men were significantly older than women ($P = 0.01$). There was no significant difference between men and women in IBD ($P = 0.08$) (Table 2).

Age- and sex-adjusted analysis of the complete cecal intubation rate

By the age- and sex-adjusted analysis, the significant risk factors for incomplete colonoscopy were female sex (OR = 1.38, 95%CI: 1.17-1.64, $P = 0.0002$), age ≥ 60 years old (OR = 1.44, 95%CI: 1.22-1.71, $P < 0.0001$), inadequate bowel cleansing (OR = 4.64, 95%CI: 3.69-5.84, $P < 0.0001$), a history of prior abdominal or pelvic surgery (OR = 1.55, 95%CI: 1.28-1.86, $P < 0.0001$), and IBD (OR = 1.48, 95%CI: 1.13-1.95, $P = 0.005$) (Table 3). Poor bowel cleansing showed a clearly high OR in comparison with the other factors; it was thus strongly associated with failure of the colonoscopy. The mean experience period of the colonoscopist was 15.6 ± 6.3 years, and the median was 15 years in our hospital. There was no significant differences in the complete cecal intubation rates between endoscopists with less than 15 and more than 15 years of experience. Moreover, the stepwise multiple logistic regression model revealed that female sex, age ≥ 60 years old, poor bowel cleansing, a history of prior abdominal or pelvic surgery, and IBD were independent risk factors

for incomplete colonoscopy ($P = 0.04$, < 0.0001 , < 0.0001 , < 0.0001 , and 0.01, respectively) (Table 3).

Analysis of risk factors associated with incomplete colonoscopy in men and women

To evaluate risk factors associated with incomplete colonoscopy in men and women separately, multiple logistic regression models were used. Age- and sex-adjusted analysis demonstrated that a history of abdominal or pelvic surgery in men (OR = 1.44, 95%CI: 1.10-1.87, $P = 0.007$) or in women (OR = 1.66, 95%CI: 1.27-2.16, $P = 0.0002$) and poor bowel cleansing in men (OR = 6.11, 95%CI: 4.58-8.17, $P < 0.0001$) or in women (OR = 3.03, 95%CI: 2.07-4.44, $P < 0.0001$) were significant risk factors for incomplete colonoscopy (Tables 4 and 5). Moreover, IBD (OR = 1.69, 95%CI: 1.18-2.43, $P = 0.005$) and age ≥ 60 years old (OR = 1.71, 95%CI: 1.36-2.15, $P < 0.0001$) were significant risk factors for incomplete colonoscopy in men but not in women (Tables 4 and 5). These differences between sexes were not significant (P for interaction of IBD with sex = 0.80). After multivariable adjustment, inadequate bowel cleansing in men (OR = 5.89, 95%CI: 4.39-7.90, $P < 0.0001$) or in women (OR = 3.09, 95%CI: 2.11-4.54, $P < 0.0001$), a history of abdominal or pelvic surgery in men (OR = 1.51, 95%CI: 1.15-1.99, $P = 0.003$) or in women (OR = 1.71, 95%CI: 1.31-2.24, $P < 0.0001$), and IBD in men (OR = 1.57, 95%CI: 1.08-2.28, $P = 0.02$) were independent risk factors for incomplete colonoscopy (Tables 4 and 5).

DISCUSSION

Colonoscopy is the investigation of choice for most colonic diseases, although its usefulness is limited by the technical proficiency of the endoscopist^[13]. The reported

Table 3 Age- and sex-adjusted and multivariable-adjusted analysis for complete cecal intubation rate

	n	Complete rate	P value ¹	Age- and sex-adjusted ²			Multivariable-adjusted ³		
				OR	95%CI	P value	OR	95%CI	P value
Total	11812	95.0%							
Sex									
Male	7686	95.6%		1.00			1.00		
Female	4126	94.0%	< 0.0001	1.38	1.17-1.64	0.0002	1.20	1.01-1.43	0.0377
Age (yr)									
< 60	5638	95.9%		1.00			1.00		
≥ 60	6174	94.2%	< 0.0001	1.44	1.22-1.71	< 0.0001	1.48	1.23-1.79	< 0.0001
Poor bowel cleansing									
-	11219	95.7%		1.00			1.00		
+	593	82.0%	< 0.0001	4.64	3.69-5.84	< 0.0001	4.57	3.62-5.76	< 0.0001
History of abdominal or pelvic surgery									
-	9395	95.6%		1.00			1.00		
+	2417	92.8%	< 0.0001	1.55	1.28-1.86	< 0.0001	1.65	1.36-1.99	< 0.0001
Melanosis									
-	11374	95.0%		1.00					
+	438	94.3%	0.5012	0.99	0.65-1.50	0.9503			
Inflammatory bowel disease									
-	10613	95.1%		1.00			1.00		
+	1199	94.2%	0.1617	1.48	1.13-1.95	0.0048	1.45	1.10-1.92	0.0091
Experience of colonoscopist (yr)									
< 15	5460	95.04%		1.00					
≥ 15	6329	95.0%	0.9324	0.99	0.84-1.17	0.9256			

¹Fisher's exact test; ²Age-adjusted for sex; sex-adjusted for age; ³Multivariable-adjusted OR in stepwise logistic regression model, where age and sex were forced to enter into the model; other significant factors were selected from history of abdominal or pelvic surgery, poor bowel preparation, and inflammatory bowel disease with *P* < 0.05 for entry and removal.

Table 4 Age-adjusted and multivariable-adjusted analysis for complete cecal intubation rate in men

	n	Complete rate	P value ¹	Age-adjusted ²			Multivariable-adjusted ³		
				OR	95% CI	P value	OR	95% CI	P value
Total	7686	95.6%							
Age (yr)									
< 60	3625	96.7%		1.00			1.00		
≥ 60	4061	94.5%	< 0.0001	1.71	1.36-2.15	< 0.0001	1.74	1.35-2.23	< 0.0001
Poor bowel cleansing									
-	7333	96.3%		1.00			1.00		
+	353	79.9%	< 0.0001	6.11	4.58-8.17	< 0.0001	5.89	4.39-7.90	< 0.0001
History of abdominal or pelvic surgery									
-	6455	95.9%		1.00			1.00		
+	1231	93.7%	0.0015	1.44	1.10-1.87	0.0073	1.51	1.15-1.99	0.003
Melanosis coli									
-	7507	95.6%		1.00					
+	179	93.9%	0.2674	1.23	0.66-2.29	0.5222	NS		
Inflammatory bowel disease									
-	6933	95.6%		1.00			1.00		
+	753	94.7%	0.2263	1.69	1.18-2.43	0.0045	1.57	1.08-2.28	0.017
Experience of colonoscopist (yr)									
< 15	3662	95.6%		1.00					
≥ 15	4009	95.6%	0.9557	0.98	0.79-1.22	0.8348	NS		

¹Fisher's exact test; ²Age-adjusted for sex; sex-adjusted for age; ³Multivariable-adjusted OR in stepwise logistic regression model, where age and sex were forced to enter into the model; other significant factors were selected from history of abdominal or pelvic surgery, poor bowel preparation, and inflammatory bowel disease with *P* < 0.05 for entry and removal. -: Not entered into the model to avoid multicollinearity; NS: Not selected.

rates for complete optical colonoscopy examination have ranged widely, from 57% to more than 99.4%^[16-22]. An incomplete colonoscopy examination can result in missed cancer if additional tests for completion are not performed. Our results showed 95.0% complete colonoscopies in usual clinical practice at a Japanese academic

hospital. It has been reported that older age, female sex, poor bowel cleansing, and having the procedure in a private office resulted in higher rates of incomplete colonoscopy in the West^[6,23-26]; however, there has been scant information concerning explanatory factors for incomplete colonoscopy in Asian people, especially the

Table 5 Age-adjusted and multivariable-adjusted analysis for complete cecal intubation rate in women

	<i>n</i>	Complete rate	<i>P</i> value ¹	Age-adjusted ²			Multivariable-adjusted ³		
				OR	95%CI	<i>P</i> value	OR	95%CI	<i>P</i> value
Total	4126	94.0%							
Age (yr)									
< 60	2013	94.4%		1.00			1		
≥ 60	2113	93.6%	0.3257	1.15	0.89-1.49	0.2951	1.13	0.87-1.48	0.3558
Poor bowel cleansing									
-	3886	94.5%		1.00			1		
+	240	85.0%	< 0.0001	3.03	2.07-4.44	< 0.0001	3.09	2.11-4.54	< 0.0001
History of abdominal or pelvic surgery									
-	2940	94.9%		1.00			1		
+	1186	91.7%	0.0002	1.66	1.27-2.16	0.0002	1.71	1.31-2.24	< 0.0001
Melanosis coli									
-	3867	94.0%		1.00					
+	259	94.6%	0.7872	0.86	0.50-1.51	0.6052	NS		
Inflammatory bowel disease									
-	3680	94.1%		1.00					
+	446	93.3%	0.5262	1.25	0.82-1.90	0.2964	NS		
Experience of colonoscopist (yr)									
< 15	1798	94.0%		1.00					
≥ 15	2320	94.0%	1	1.01	0.78-1.30	0.9653	NS		

¹Fisher's exact test; ²Age-adjusted for sex; sex-adjusted for age; ³Multivariable-adjusted OR in stepwise logistic regression model, where age and sex were forced to enter into the model; other significant factors were selected from history of abdominal or pelvic surgery, poor bowel preparation, and inflammatory bowel disease with *P* < 0.05 for entry and removal. -: Not entered into the model to avoid multicollinearity; NS: Not selected.

Japanese population. Several factors could be associated with incomplete procedures.

We first compared the following variables between the Japanese populations with complete and incomplete colonoscopy: age; poor bowel cleansing a history of abdominal or pelvic surgery; melanosis coli; and IBD. The univariate analysis showed that older age; female sex; poor bowel cleansing; and a history of abdominal or pelvic surgery were significant risk factors for incomplete colonoscopy in a Japanese academic hospital. It was reported that poor bowel cleansing was associated with prolonged intubation time, increased patient discomfort, and incomplete colonoscopy^[27]. Indeed, adequate bowel preparation is a prerequisite for high-quality colonoscopy^[28]. At our hospital, bowel preparation has been performed with 2 L PEG and a laxative adjunct, which is the gold standard^[28]. Poor bowel cleansing was one of the risk factors for incomplete colonoscopy. Moreover, in the West, it has been reported that women, especially those with a history of abdominal hysterectomy, and men who have undergone abdominal surgery usually have significantly lower cecal intubation rates because of an impassable sigmoid colon^[17,18,29]. Anatomic features, including colonic elongation and tortuosity, have also been shown to be associated with a failure to reach the cecum in optical colonoscopy^[10,16].

There was a significant sex difference in the enrolled patients. Traditionally, in Japan, men have worked outside the home and have served as the sole breadwinners for families, while women have stayed at home. Thus, many Japanese men in Tokyo use health examinations, including fecal occult blood testing. Men underwent colonoscopy more frequently than women in this patient cohort;

therefore, the risk factors for incomplete colonoscopy were subsequently compared between men and women in this study. Our results demonstrated that there were significant differences between men and women in age (*P* = 0.01), poor bowel cleansing (*P* = 0.004), a history of abdominal or pelvic surgery (*P* < 0.0001), and melanosis coli (*P* < 0.0001). Thus, all of the subsequent analyses were performed with statistical adjustments for age and sex. The factors associated with incomplete colonoscopy at an academic hospital in Tokyo were age ≥ 60 years old, female sex, poor bowel cleansing, a history of prior abdominal or pelvic surgery, and IBD. Unexpectedly, our results also showed that IBD was a significant risk factor for incomplete colonoscopy in men but not in women. It has been reported that a complete colonoscopic examination is not possible in 5%-20% of IBD cases, even for experienced colonoscopists, due to technical difficulties or the patient having severe activity, fulminant colitis, or stricture formation^[11,30]. However, there was no reason to expect that IBD would not differently affect the numbers in the complete and incomplete colonoscopy groups in women. In this study, the OR that indicated the risk of incomplete cecal intubation in IBD women was greater than 1.23, which was not significantly different from that in men (*P* > 0.5). The total numbers of women and men with IBD were 446 and 753, respectively. Thus, the result that there were no risk factors for incomplete colonoscopy in women with IBD, while there were for men, possibly occurred because of the relatively small numbers of women with IBD analyzed in this study. The use of a population-based cohort might be a strength because it more accurately reflects usual clinical practice than cohorts from specialist endoscopy centers.

The factors associated with incomplete colonoscopy in the Japanese population were female sex, older age, poor bowel cleansing, a history of prior abdominal or pelvic surgery, and IBD. We could not detect any different factors between Japan and the West in this study. Women older than the age of 60 years old with a history of prior abdominal or active IBD patients might be a population to submit to other more effective examinations before endoscopy is performed. Alternative investigations, such as CT and MR colonography^[9-12] can serve as useful adjuncts for the assessment of the entire colon in cases of incomplete colonoscopy. Comparison with alternative investigations was not possible in this study because none of the patients in this study underwent CT or MR colonography. In addition, both examinations have high costs and are not sensitive for the detection of small colonic polyps (< 1 cm)^[9,12]. A major disadvantage of CT colonography is the radiation dose^[9]. As both CT and MR colonography remain insufficient, an additional barium enema, which is close to the sensitivity and specificity for adenomas and cancer during colonoscopy, is still recommended at our hospital in cases of incomplete colonoscopy.

COMMENTS

Background

It has been reported that older age, female sex, poor bowel cleansing, and having the procedure in a private office resulted in higher rates of incomplete colonoscopy in the West; however, there has been scant information concerning explanatory factors for incomplete colonoscopy in Asian people, especially the Japanese population. Several factors could be associated with incomplete procedures. Such information may assist in developing recommendations about which patients might be more suitable for capsule endoscopy or non-endoscopic modalities including computed tomography and magnetic resonance colonography.

Research frontiers

The authors conducted a study to determine the colonoscopy completion rate and to identify risk factors for incomplete insertions of colonoscope in a Japanese academic hospital. In this study, a total of 11812 consecutive Japanese people were identified who underwent a colonoscopy in an academic hospital. A multiple logistic regression model was used to evaluate the significant risk factors of incomplete colonoscopy retrospectively.

Innovations and breakthroughs

By age- and sex-adjusted analysis, significant risk factors of incomplete colonoscopy were women, ≥ 60 years old, history of prior abdominal or pelvic surgery, poor bowel preparation, and inflammatory bowel disease.

Applications

Several characteristics in the Japanese population were identified that could predict technical difficulty with colonoscopy.

Terminology

The factors associated with incomplete colonoscopy in the Japanese population were female sex, older age, poor bowel cleansing, a history of prior abdominal or pelvic surgery, and IBD. There were no different factors between Japan and the West in this study.

Peer review

Authors reviewed 11812 patients undergoing colonoscopy in a hospital. This is a theoretically interesting study. They performed logistic regression to show the factors predicting incomplete colonoscopy, which include female, previous abdominal surgery, old age, and inflammatory bowel disease. The results are intriguing with practical values.

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