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Original Article

Not only hysterectomy but also cesarean section can predict incomplete flexible sigmoidoscopy among patients with prior abdominal or pelvic surgery

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Abstract

Background: Flexible sigmoidoscopy (FS) is a safe and effective method for colorectal cancer (CRC) screening. Several studies have demonstrated that individuals who have undergone surgery are at a greater risk of having incomplete FS. This study explored predictors of incomplete FS and reduced polyp detection rates for participants who had undergone abdominal or pelvic surgery.

Methods: From January 2009 to December 2009, individuals participating in health examinations and who had undergone abdominal or pelvic surgery were invited to participate in this investigation. Four experienced gastroenterologists performed examinations using a 60-cm Olympus video sigmoidoscope. Factors associated with incomplete FS insertions and reduced polyp detection rates were analyzed using logistic regression models.

Results: Overall, 106 eligible individuals were analyzed, and 45 (42%) incomplete FS insertions were reviewed. Fifty participants (47%) had undergone pelvic surgery, and the other 56 (53%) had undergone abdominal surgery. Pelvic surgeries were cesarean section (25%) and hysterectomy (15%); appendectomy (36%) was the most common abdominal surgery. The main pathological FS findings were hemorrhoids (54%) and adenomatous polyps (18%). Multivariate analysis indicated that only prior pelvic surgery [odds ratio (OR), 3.54; $p = 0.01$] was an independent risk factor for incomplete FS insertion. Incomplete examinations were inversely related to adenomatous polyp detection rates (OR, 0.23; $p = 0.03$).

Conclusion: Prior pelvic surgery, particularly cesarean section and hysterectomy, is an independent factor for incomplete FS insertion in a selected adult population. In addition, incomplete FS can increase the risk of missing polyps, particularly in individuals who underwent pelvic surgery.

Keywords: cesarean section; colorectal cancer; hysterectomy; sigmoidoscopy; surgery

1. Introduction

Colorectal cancer (CRC) is the second leading malignancy in industrialized countries and causes >500,000 deaths/year worldwide.[1] The fecal occult blood test, flexible sigmoidoscopy (FS), and colonoscopy are recommended options for CRC screening in national guidelines from most Western countries.[2,3] Additionally, CRC incidence is rapidly increasing

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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in Asia. The Asia Pacific Working Group on Colorectal Cancer recommends performing FS every 5 years as an option for CRC screening.[4]

Screening by FS, a safe and effective method, is associated with a decreased incidence of CRC and mortality-related CRC.[5−7] In clinical practice, the utility of FS is dependent on adequate visualization of the colorectal mucosa and complete FS insertion such that polyps can be eradicated prior to when they transform into invasive neoplasms. Incomplete insertion, unfortunately, is a major shortcoming associated with FS. A community-based investigation by Olynyk et al[8] suggested that the normal risk for CRC was 30%, and asymptomatic individuals aged 55−59 years had an insertion depth of <50 cm. Painter et al,[9] who conducted a case-controlled study, reported that intubation of the descending colon was not achieved in up to 25% of participants with an average risk for CRC. Several predictors for incomplete FS insertion have been developed for select groups. The most well-known populations are currently individuals aged >65 years, females, those with low body mass index (BMI), inadequate bowel preparation, and prior surgery, in particular hysterectomy.[10−15] Nevertheless, to date, no comparable data exist for completion rates of FS in a cohort between abdominal versus pelvic surgery. Within the health examination setting in a tertiary medical center, investigators conducted an observational trial for CRC screening by FS to identify predictors of incomplete FS insertion among individuals who had previously received surgery. The secondary objective was to determine whether incomplete FS examination resulted in a reduced polyp detection rate.

2. Methods

2.1. Patients

From January 2009 to December 2009, adults who participated in a health examination at Kaohsiung Veterans General Hospital, Kaohsiung, Taiwan, were enrolled after providing full consent. This study also enrolled patients aged 20−80 years who had undergone abdominal (extrapelvic) or pelvic surgery. Exclusion criteria were combined etiology (abdominal plus pelvic surgery), presence of inflammatory bowel disease, and prior colorectal neoplasm or malignant polyp. This study was approved by the Institutional Review Board at Kaohsiung Veterans General Hospital (Number VGHKS99-CT4-06).

2.2. Methods

Participants were prepared and dined lightly for 2 days prior to the sigmoidoscopy, and on the day of the health examination. After lunch, nursing staff performed bowel preparation using a disposable enema irrigator (Laitest 125 mL/bottle, Taiwan Stanch Co., Ltd., Taipei, Taiwan) containing 50% glycerol and 50% distilled water for each participant 60 minutes prior to the procedure.[16] No analgesic or sedative agents were administered other than topical lubricant containing 2% xylocaine. Digital rectal examinations were conducted prior to sigmoidoscopy. A repeat colon cleansing was performed when a retained stool was identified in the rectum when participants agreed. All scopic procedures were conducted between 2:00 PM and 5:00 PM using standard 60-cm Olympus video sigmoidoscopes (Olympus PCF-240; Olympus Optical Co., Ltd., Tokyo, Japan) by four experienced gastroenterologists, who perform at least 180 sigmoidoscopies annually. At sigmoidoscopy, the examiner recorded the anatomical site of the sigmoidoscope tip as the rectum, sigmoid colon, descending colon, or splenic flexure. Maximum scope insertion depth and pathologies were also recorded. Insertion <60 cm above the anal verge was defined as an incomplete FS insertion. At the same time, reasons for incomplete sigmoidoscopy (e.g., patient intolerance, abdominal bowel angulation, and inadequate colon cleansing) were carefully determined. An adequate colon cleansing was defined as facilitating visualization of 90% of the bowel lumen up to the FS insertion depth.[12] Poor preparation (<90% colon mucosa observed) was categorized as "mild degree" (allowed the scope to pass through) or "severe degree" (forbade the scope to pass through).

2.3. Questionnaires

During the health checkup, a complete patient history was obtained and physical examinations were performed. The BMI, a measurement tool comparing height to weight, indicated whether participants were overweight [BMI (kg/m^2) = (weight in kilograms)/(height in meters)].[2] Smoking was defined as inhalation of smoke from burning tobacco daily. Habitual consumption of alcohol and caffeine were defined as individuals imbibing alcohol or caffeine ≥twice/week in the preceding 6 months. Habitual exercise was defined as participants who, on average, had an exercise routine for ≥30 minutes per session ≥twice/week for ≥1 year. Constipation was defined as <three bowel movements/week and hard and dry stools. Diarrhea was defined as having >three bowel movements or passing >200 g of watery stool daily. A vegetarian was defined as an individual who did not eat meat, fish, or seafood; however, in this definition, vegetarians could eat eggs, egg products, milk, and milk products.

2.4. Statistical analysis

Baseline data are expressed as mean ± standard deviation (SD) or *n* (%). Quantitative variables were compared using the independent *t* test, and qualitative variables were compared using the Chi-square test and Fisher's exact test when appropriate. A logistic regression model was employed to measure predictors for incomplete FS insertion and reduced polyp detection rates (among individuals with at least one polyp) by univariate and/or multivariate analysis. All hypothesis tests were performed against a two-sided alternative where appropriate. A value of $p < 0.05$ was considered statistically significant. Analyses used SPSS version 12.0 for Windows (SPSS, Inc., Chicago, IL, USA).

3. Results

In total, 1073 consecutive adults screened for CRC were reviewed during the 12-month period from January 2009 to December 2009. Among these, 113 with a history of surgery, either abdominal or pelvic, participated in this observational investigation. Seven patients were excluded due to combined etiology ($n = 3$), inflammatory bowel disease ($n = 1$), or a prior colorectal neoplasm ($n = 3$). Finally, 106 participants were enrolled for statistical analysis.

In total, 106 participants underwent FS. Their mean age was 54 ± 12 years, and 61% were female ($n = 65$). Less than 3% ($n = 3$) had a family history of CRC (Table 1). In total, 42% ($n = 45$) had an incomplete FS insertion, where the sigmoidoscope reached <60 cm into the colon. Among the participants with incomplete insertions, mean intubation depth was 36 ± 9 cm above the anal verge (range, 20–53 cm; Table 2). Fifty participants (47%) had undergone pelvic surgery and the other 56 patients (53%) had undergone abdominal surgery. Pelvic surgeries were cesarean section (25%; $n = 26$), hysterectomy (15%; $n = 16$), oophorectomy (6%; $n = 6$), laparotomy for ectopic pregnancy (1%; $n = 1$), and endometrectomy (1%; $n = 1$). Abdominal surgeries were appendectomy (36%; $n = 38$), cholecystectomy (9%; $n = 10$), splenectomy (4%; $n = 4$), hernioplasty (3%; $n = 3$), and gastrectomy (1%; $n = 1$; Table 3).

Causes for incomplete FS insertion were participant intolerance (49%; $n = 22$), abnormal bowel angulation (29%; $n = 13$), and inadequate bowel preparation (22%; $n = 10$; Table 2). In total, pathologic findings of the 106 sigmoidoscopies were hemorrhoids (54%; $n = 57$), adenomatous polyp (18%; $n = 19$), hyperplastic polyp (6%; $n = 6$), diverticulosis (5%; $n = 5$), and melanosis coli (2%; $n = 2$). No pathology was observed in nearly 25% of participants (Table 4). The polyps were found less frequently by incomplete FS insertions than by complete FS insertions (9% vs. 25%, $p = 0.04$) by Chi-square test. The nursing staff searched for gastrointestinal complications or cardiovascular events for up to 4 weeks after FS, beginning with the sigmoidoscopy day. No participant experienced perforation or other fatal procedure-related complications.

Baseline patient characteristics (Table 1), bowel preparation, stool passage after enema (Table 2), and surgical type (abdominal vs. pelvic; Table 3) were analyzed by using logistic regression univariate analysis, which demonstrated that health practices of vegetarians, inadequate bowel preparation, and surgical type were significantly predictive of incomplete FS insertion. Multivariate analysis reveals that only a prior pelvic surgery remained an independent predictor of incomplete FS insertion [odds ratio (OR), 3.54; 95% confidence interval (CI), 1.34–9.31; $p = 0.01$], whereas poor bowel preparation was a borderline significant predictor for incomplete FS insertion (OR, 2.86; 95% CI, 1.00–8.19; $p = 0.051$; Table 5).

Conversely, univariate analysis for polyp detection rates revealed that BMI, habitual exercise, and incomplete FS insertions were statistically significant predictive factors. Moreover, only incomplete FS insertion was an independent factor for a reduced polyp detection rate (OR, 0.23; 95% CI, 0.06–0.85; $p = 0.03$). Furthermore, trends of increasing polyp detection rate were correlated with increasing BMI (OR, 1.09; 95% CI, 0.99–1.19; $p = 0.051$) and habitual exercise (OR, 3.55; 95% CI, 0.99–12.71; $p = 0.052$; Table 6).

4. Discussion

The current study examined whether different predictors for incomplete FS insertion exist among adults with a prior surgery, either abdominal or pelvic, and whether incomplete FS examination resulted in a reduced polyp detection rate. Analytical results indicate that a history of pelvic surgery, especially cesarean section and hysterectomy, was an independent risk factor for incomplete FS insertion. Additionally,

Table 1
Baseline patient characteristics.

Variables	All participants ($n = 106$)	Incomplete insertion ($n = 45$)	Complete insertion ($n = 61$)	p (incomplete vs. complete)
Age (y)	54 ± 12	55 ± 11	53 ± 14	0.58
Female sex	65 (61)	31 (69)	34 (56)	0.17
BMI (kg/m^2)	25 ± 6	24 ± 4	25 ± 7	0.41
Waist (cm)	83.6 ± 12	82 ± 10	85 ± 12	0.36
Hypertension	23 (22)	8 (18)	15 (25)	0.40
Diabetes mellitus	11 (10)	4 (9)	7 (12)	0.76
Smoking	13 (12)	3 (7)	10 (16)	0.15
Drinking	10 (9)	1 (2)	9 (15)	0.04
Coffee consumption	23 (22)	9 (20)	14 (23)	0.81
Vegetarians	19 (18)	12 (27)	7 (12)	0.04
Habitual exercise	59 (56)	27 (60)	32 (53)	0.44
Daily water intake (L)	1.9 ± 0.7	2.0 ± 0.7	1.9 ± 0.7	0.64
Constipation	10 (9)	4 (9)	6 (10)	1.00
Diarrhea	5 (5)	2 (4)	3 (5)	1.00
Recent laxative use	5 (5)	3 (5)	2 (4)	0.26
Family history of CRC	3 (3)	2 (4)	1 (2)	0.57

Data are presented as n (%) or mean ± SD.
CRC = colorectal cancer; SD = standard deviation.

Table 2
Baseline sigmoidoscopy characteristics.

Variables	All participants ($n = 106$)	Incomplete insertion ($n = 45$)	Complete insertion ($n = 61$)	p (incomplete vs. complete)
Previous sigmoidoscopy	13 (12)	6 (13)	7 (11)	0.77
Stool passage after enema (times)	1.2 ± 0.5	1.2 ± 0.4	1.2 ± 0.5	0.65
Poor preparation	25 (24)	13 (29)	12 (20)	0.27
Mild/severe		3 (7)/10 (22)	12 (20)/0 (0)	
Causes of incomplete insertions				
Patient intolerance		22 (49)		
Abnormal bowel angulation		13 (29)		
Poor preparation		10 (22)		
Depth of insertion (cm)		36 ± 9	60	
Rectum		4 (9)	0 (0)	0.03
Sigmoid colon		28 (62)	21 (34)	<0.01
Descending colon		13 (29)	38 (63)	<0.01
Splenic flexure		0 (0)	2 (3)	0.51

Data are presented as n (%) or mean ± SD.
SD = standard deviation.

this trial revealed that incomplete FS insertions could result in an increase in massing polyps.

Is 42% with incomplete FS insertion of this study group good enough? In the current study, FS was performed by experienced gastroenterologists. No other similar study focused on FS in different surgery groups has been presented. Doria-Rose et al[10] reported that in the whole group, the incomplete rate was about 5–29%, performed by a mixed group of gastroenterologists and general practitioners; Walter et al[11] showed 18%, performed by general practitioners.

A previous observational study identified a relationship between incomplete FS insertion and surgery, either abdominal or pelvic. Ramakrishnan and Scheid[12] identified decreased FS insertion depth in females with a history of hysterectomy and males with a history of abdominal surgery. Their analysis also showed that females aged <70 years with a prior hysterectomy, compared to the lowest risk group, were more likely to have an incomplete FS examination (OR, 6.89; 95% CI, 2.68–17.73), and age ≥75 years for males with a history of abdominal surgery was correlated with inadequate insertion depth. A longitudinal study by Holman et al,[17] which analyzed factors related to incomplete FS examination in 421 American individuals performed by family practice physicians, showed that females with a prior pelvic surgery had less insertion depth than those who had not had a prior pelvic surgery by a t test (47 cm vs. 53 cm, $p = 0.002$). In a family practice residency program, Brill and Baumgardner[18] reported that previous abdominal surgery increased the likelihood of incomplete FS examinations in both males and females, whereas Stewart et al[15] found that abdominal surgery predicted difficult or incomplete FS insertion for females only.

The prevalence of hysterectomy is relatively constant in the West. Adams et al[13] noted that 25% of females aged 55–64 years in the UK had had a hysterectomy. Notably, analytical data showed that the most common pelvic surgery was cesarean section (CS; 25%), not hysterectomy (15%). Several conflicting factors involving neurological, hormonal, anatomical, psychological, and pharmacologic aspects affect bowel dysfunction after pelvic surgery,[19] whereas altered anatomical structures and postoperative adhesion formation are most likely to interfere with endoscopic examinations, particularly in the impassable sigmoid colon.[13] To our knowledge, no direct data exist for FS completion rates in individuals with or without abdominal/pelvic surgery, partly owing to the difficulties in correctly evaluating the approached segment.

Table 3
Characteristics of prior surgery.

Type	All participants ($n = 106$)	Incomplete insertion ($n = 45$)	Complete insertion ($n = 61$)	p (incomplete vs. complete)
Pelvic surgery	50 (47)	28 (62)	22 (36)	0.01
Cesarean section	26 (25)	11 (24)	15 (25)	1.00
Hysterectomy	16 (15)	11 (24)	5 (8)	0.03
Oophorectomy	6 (6)	5 (11)	1 (2)	0.08
Laparotomy for ectopic pregnancy	1 (1)	1 (2)	0 (0)	0.42
Endometrectomy	1 (1)	0 (0)	1 (2)	1.00
Abdominal surgery	56 (53)	17 (38)	39 (64)	0.01
Appendectomy	38 (36)	12 (27)	26 (43)	0.10
Cholecystectomy	10 (9)	4 (9)	6 (10)	1.00
Splenectomy	4 (4)	0 (0)	4 (7)	0.14
Hernioplasty	3 (3)	1 (2)	2 (3)	1.00
Gastrectomy	1 (1)	0 (0)	1 (2)	1.00

Data are presented as n (%) or mean ± SD.

Table 4
Sigmoidoscopic findings of distal colon and rectum.

Pathology	All participants (n = 106)	Incomplete insertion (n = 45)	Complete insertion (n = 61)	p (incomplete vs. complete)
Hemorrhoid	57 (54)	28 (62)	29 (47)	0.17
Adenomatous polyp	19 (18)	4 (9)	15 (25)	0.04
Hyperplastic polyp	6 (6)	2 (4)	4 (7)	1.00
Diverticulosis	5 (5)	2 (4)	3 (5)	1.00
Melanosis coli	2 (2)	0 (0)	2 (3)	0.51
No pathology	28 (26)	13 (29)	15 (25)	0.66

Data are presented as n (%).

The rate of CS in Taiwan (34%)[20] is significantly higher than the optimal 10−15% recommended by the World Health Organization. The proportion of infants born by CS is also higher than that in other Chinese populations, such as in Hong Kong (27.4%)[21] and mainland China (22.5%).[22] The high CS rate and increasing trend are an unnecessary additional risk for mothers and their infants. Factors related to Chinese females with a high CS birth rate have been considered a critical issue of international public health. Cai et al[22] conducted a population-based study in China to examine the trend in CS deliveries. A logistic regression analysis revealed that the highest CS rate was associated with a form of payment by government insurance, self-reported complications during pregnancy, high birth weight, and maternal age. Additionally, Hsu et al[23] reported that CS in Taiwan is affected by the folk belief Pe-Ji, which influences the favored time of delivery for some pregnancies. Their data also supported new research for strategies to decrease the rising CS rate in countries where folk briefs are powerful.

Data in this study indicated that good bowel preparation, defined as > 90% visualization of the colonic mucosa, occurred in nearly 75% of participants who had undergone abdominal/pelvic surgery. Similarly, previous trials showed good and excellent oral or enema preparation for FS in the range of 57.3−88% of participants.[24,25] Adequate bowel preparation is essential for increasing the likelihood of detecting colonic neoplasms. [26] (1) Aiding sigmoidoscope insertion to its maximal reach, (2) lowering patient discomfort during sigmoidoscopy, (3) reducing the time required for the procedure, and (4) decreasing repeated examinations, which increase procedure costs and disadvantages, are all important in CRC screening. Stewart et al[15] conducted a prospective study of FS, documenting poor bowel preparation as an independent risk factor for reduced FS intubation in up to one-third of asymptomatic volunteers, whereas a marginally significant difference existed between poor bowel preparation and incomplete FS insertion depth in up to 42% of selected participants in this investigation. Furthermore, a retrospective, community-based study in the USA, conducted by Ramakrishnan and Scheid,[12] demonstrated a relationship between incomplete FS insertion and poor bowel preparation, particular for females (OR, 3.58; 95% CI, 1.75−7.31).

In this study, only inadequate insertion depth during examination was an independent factor for reduced polyp detection rate (p = 0.03). Without question, inadequate sigmoidoscopy, such as limited insertion depth of the sigmoidoscope, can result in reduced efficacy of CRC screening and an increasing polyp miss rate. Doria-Rose et al[10] indicated that those who had an endoscopic exam with an insertion depth <40 cm were at increased risk of distal CRC. The presence of sigmoidoscopy limitations, such as patient tolerance, bowel preparation, and angulation, did not predict further distal CRC, apart from their association with insertion depth. Eloubeidi et al reported that the polyp detection rate was significantly and inversely related to female sex, diverticulosis, prior sigmoidoscopy, and non-physician endoscopists, and positively correlated with age. Simultaneously, data obtained by this study showed that a trend of increasing polyp detection rate was correlated with increasing BMI (p = 0.051) and habitual exercise (p = 0.052). Indeed, obesity contributed to incomplete examination or polyp detection rate with both pro and con evidence.[16,27] The association between habitual exercise and polyp detection rate warrants further investigation for clarification, because data in this study lacked sufficient detail to shed light on this phenomenon.

No participant experienced perforation or other fatal procedure-related complications in this study. In a survey by Levin et al,[28] in which sigmoidoscopies were performed 109,534 times, 24 individuals (approximately 0.02%) were hospitalized for a gastrointestinal complication; of these, seven (approximately 0.006%) had the following complications: two perforations, two episodes of diverticulitis, two episodes of postprocedure bleeding, and one episode of unexplained colitis. In the multivariate model, complications were significantly more common in males than females (OR,

Table 5
Multivariate analysis for predicting incomplete sigmoidoscopy.

Predictor	Odds ratio	95% CI	p
Pelvic vs. abdominal surgery	3.54	1.34−9.31	0.01
Vegetarian	1.95	0.60−6.37	0.27
Poor vs. good preparation	2.86	1.00−8.19	0.051

CI = confidence interval; SD = standard deviation.

Table 6
Multivariate analysis for predicting adenomatous polyp detection rate.

Predictor	Odds ratio	95% CI	p
Incomplete sigmoidoscopy	0.23	0.06−0.85	0.03
Body mass index (per unit change)	1.09	0.99−1.19	0.051
Habitual exercise	3.55	0.99−12.71	0.052

CI = confidence interval; SD = standard deviation.

3.34; 95% CI, 1.34−10.13). Based on the experience of the four endoscopists in this study, the most important reason for the greater safety of FS compared with that of painless colonoscopy was that unsedated participants were capable of providing feedback to endoscopists, restricting endoscopy-related overinflation of the colon and barotrauma or abrasion of the bowel wall.

This study has some limitations. First, like all retrospective studies, it has the possibility of selection bias. Participants with post-surgery status (e.g., colectomy, gastrectomy, or cholecystectomy) may have reasons to follow up in the surgical outpatient department. Second, depth insertion was only a crude measurement, even among individuals who had undergone procedures that reached a similar insertion depth. Third, this study did not record current medications used by participants, which may have affected bowel movement/preparation. Fourth, analyses evaluating the predictors of polyp detection were based on a relatively small number of cases. Last, the study results may not be generalized to Western populations.

In conclusion, this investigation indicates that prior pelvic surgery, particularly CS and hysterectomy, was an independent factor for incomplete FS insertions in this cohort. In addition, incomplete FS can increase the risk of missing polyps, particularly in individuals who have undergone pelvic surgery.

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