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BRIEF ARTICLE

Ultrathin endoscope flexibility can predict discomfort associated with unsedated transnasal esophagogastroduodenoscopy

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Abstract

AIM: To evaluate the effects of choice of insertion route and ultrathin endoscope types.

METHODS: This prospective study (January-June 2012) included 882 consecutive patients who underwent annual health checkups. Transnasal esophagogastroduodenoscopy (EGD) was performed in 503 patients and transoral EGD in 235 patients using six types of ultrathin endoscopes. Patients were given a choice of insertion route, either transoral or transnasal, prior to EGD examination. For transoral insertion, the endoscope was equipped with a thin-type mouthpiece and tongue depressor. Conscious sedation was not used for any patient. EGD-associated discomfort was assessed using a visual analog scale (VAS; no discomfort 0-maximum discomfort 10).

RESULTS: Rates of preference for transnasal insertion were significantly higher in male (male/female 299/204 *vs* 118/117) and younger patients (56.8 ± 11.2 years *vs* 61.3 ± 13.0 years), although no significant difference was found in VAS scores between transoral and transnasal insertion (3.9 ± 2.3 *vs* 4.1 ± 2.5). Multivariate analysis revealed that gender, age, operator, and endoscope were independent significant predictors of VAS for transnasal insertion, although gender, age, and endoscope were those for transoral insertion. Further analysis revealed only the endoscopic flexibility index (EFI) as an independent significant predictor of VAS for transnasal insertion. Both EFI and tip diameter were independent significant predictors of VAS for transoral insertion.

CONCLUSION: Flexibility of ultrathin endoscopes can be a predictor of EGD-associated discomfort, especially in transnasal insertion.

Key words: Esophagogastroduodenoscopy; Ultrathin endoscope; Visual analog scale; Discomfort; Surveillance

Core tip: To evaluate the effects of choice of insertion route and ultrathin endoscope types for unsedated surveillance esophagogastroduodenoscopy (EGD), this prospective study was conducted including 882 consecutive patients who underwent annual health checkup using six types of ultrathin endoscopes in a single in-

stitute. EGD-associated discomfort was assessed using a visual analog scale (VAS) by patients themselves. Statistical analysis of VAS revealed the following two points; Transnasal insertion of ultrathin endoscopy for unsedated EGD can be preferable for younger males rather than elder females. Flexibility of ultrathin endoscopes can be a reliable predictor of reduction in transnasal EGD-associated discomfort rather than thinness of tip.

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INTRODUCTION

With improvements in resolution and image enhancement, gastrointestinal endoscopic technology has advanced considerably, detecting an increasing number of superficial neoplasms during surveillance esophagogastroduodenoscopy (EGD)[1-5]. New endoscopic treatments for superficial neoplasms, including endoscopic submucosal dissection, have been reported to be effective and less invasive compared with traditional open surgical exploration and treatment[6-10]. Against the backdrop of such concerns, importance of detecting them in early stage has been emphasized more than ever to achieve curative resection endoscopically.

Although identification of patients at high risk for superficial esophageal squamous cell carcinoma (SESCC) and early gastric cancer (EGC) has been reported as useful, diagnoses must still be confirmed by histopathological assessment of biopsy specimens obtained via endoscopy[11-13]. However, EGD-associated discomfort is a major problem for many patients, who are reluctant to undergo subsequent EGD procedures. Although sedation is possible for reduction of EGD-associated discomfort, cost and various adverse events associated with use of sedative agents must be considered among the risks and benefits of this option[14-17].

Use of an ultrathin endoscope may also reduce unsedated EGD-associated discomfort. Transnasal insertion of ultrathin endoscopes is reported to be a promising alternative in terms of patient satisfaction and cardiopulmonary function[18-21]. Although various types of ultrathin endoscopes are available at present, predictors of discomfort associated with EGD performed using ultrathin endoscopes have not been determined.

This prospective study was conducted to identify predictors of discomfort associated with unsedated EGD performed using ultrathin endoscopes.

MATERIALS AND METHODS

This study was conducted at the Center for Epidemiology and Preventive Medicine of the University of Tokyo after receiving ethics committee approval. From January to June 2012, 882 consecutive patients who underwent annual health checkups were included in this study. Subjects were given a choice of insertion route, either transoral or transnasal, prior to EGD examination. The subjects were prepared for transnasal insertion using the modified spray method, which involves spraying 0.05% naphazoline nitrate into each nostril, followed by injection of a viscous gel of 2% lidocaine hydrochloride[22]. Conscious sedation was not used for any patient.

Six ultrathin endoscopes (A: GIF-XP260N, B: GIF-XP260NS, C: EG-530NW, D: EG-580NW, E: EG16-K10, and F: prototype EG17-K10) from three manufacturers (Olympus Corp., Tokyo, Japan; Fujifilm Holdings Corp., Tokyo, Japan; and Hoya Corp., Tokyo, Japan) were utilized in this study. Prototype EG17-K10 was equipped as part of a collaborative effort by the University of Tokyo Hospital and Hoya Corporation. Profiles of these endoscopies are shown in Table 1. All endoscopes were utilized for this study after being used for more than one hundred EGDs.

The flexibility of each endoscope was evaluated as follows. We fixed the middle portion of the endoscope to a flat surface, and allowed the tip of the endoscope to bend freely under the influence of gravity. After adjusting the length of endoscope from 150 to 400 mm allowed free movement under the influence of gravity, we mapped the position of the tip of the endoscope on a two dimensional grid. Continuous two-dimensional horizontal and vertical distances were plotted, as shown in Figure 1. The mean horizontal distances at the fixed points of 200, 250, 300, 350 and 400 mm were utilized as an endoscopic flexibility index (EFI) to provide a surrogate value of flexibility for each endoscope. Measurements of EFI for each endoscope were performed at room temperature.

The combination of endoscopes changed depending on the day of the week. Consequently, the patients were randomly allocated to six endoscope groups.

All examinations were performed by two operators who had been certified by the Japanese Gastroenterological Endoscopy Society. For transoral insertion, the endoscope was equipped with a thin-type mouthpiece and tongue depressor (Endo-leader; Top Corp.; Tokyo, Japan)[23]. In cases where transnasal insertion failed due to narrowness of nasal cavity or intolerable discomfort, transoral insertion was performed continuously after confirmation with the patient. After completion of the examination, EGD-associated discomfort was evaluated using a visual analogue scale (VAS) by patients themselves in another room from 0 to 10, which were minimum and maximum of discomfort respectively.

Parameters analyzed in this study were examination

Table 1 Profiles of six endoscopes and outcomes for transnasal insertion

	A	B	C	D	E	F
EFI (mm)	224	192.4	175.2	174.8	146	166.6
Tip diameter (mm)	5	5.4	5.9	5.9	5.2	5.4
Transnasal insertion						
Insertion success rate	58/59	110/112	119/123	112/118	47/47	57/57
Nasal bleeding rate	0/58	2/110	2/119	2/112	1/47	0/57
VAS	4.2 ± 2.7	4.0 ± 2.1	4.0 ± 2.4	4.0 ± 2.3	3.2 ± 2.2	3.8 ± 2.3
Examination time (s)	351.0 ± 58.8	345.8 ± 62.2	324.9 ± 61.1	340.0 ± 48.1	376.7 ± 61.7	349.1 ± 57.3

VAS: Visual analog scale; EFI: Endoscopic flexibility index.

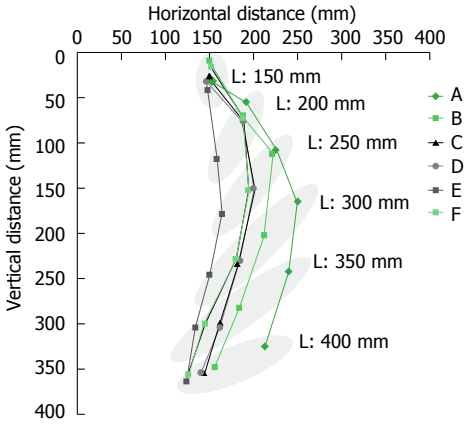

Figure 1 A two-dimensional plot of the transition from the tip of the endoscope. L: The length of endoscope allowed free movement under the influence of gravity.

time and VAS score. Moreover, the insertion success rate and nasal bleeding rate were evaluated for each endoscope for transnasal insertion. Patients with a past history of surgical resection in the upper gastrointestinal tract and those in whom biopsy or another procedure had been performed were excluded from the analyses to avoid effects of these factors on examination time or VAS scores.

Statistical analysis

Statistical analyses were performed using Student's *t*-test, χ^2 test, and Fisher's exact test. For multivariate analysis, the least-squares method was employed using dummy variables for nominal variables. All analyses were performed using JMP software (SAS Institute Inc., Cary, NC, United States). $P < 0.05$ was considered significant.

RESULTS

Among the 882 patients, 91 patients were excluded because of invalid responses or missing data. Thirty-nine patients were excluded because of past history of surgery in the upper gastrointestinal tract (n = 19) and biopsy during the examination (n = 20). One asymptomatic patient in whom anisakiasis was coincidentally discovered and who underwent endoscopy for removal of this parasite was also excluded from the analysis. In total, data of 751 patients were analyzed, as shown in Figure 2. Among

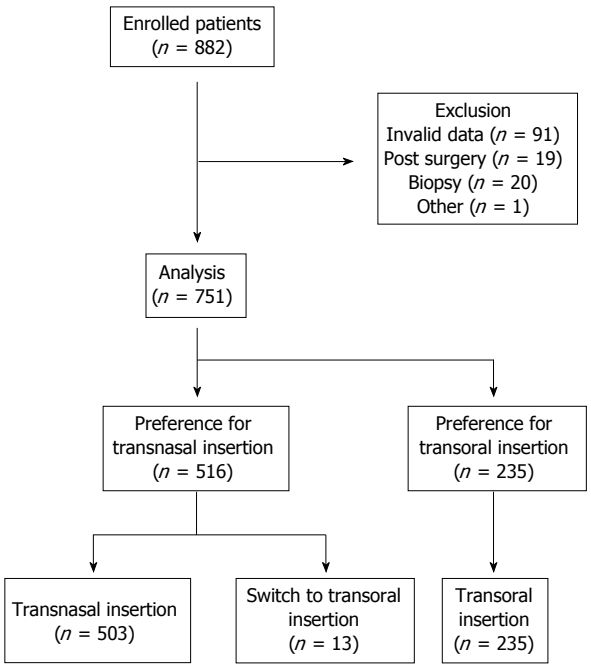

Figure 2 Flowchart of patient involvement in this study.

them, 516 patients (68.7%) preferred transnasal insertion and 235 patients (31.3%) preferred transoral insertion. Thirteen patients who preferred transnasal insertion were switched to transoral insertion after failure of transnasal insertion. EGD was performed more than once in 665 patients (88.5%).

Characteristics of patients and outcomes are shown in Table 2. Rates of preference for transnasal insertion were significantly higher in male patients (male/female 299/204 *vs* 118/117 for transnasal *vs* transoral insertion, respectively; $P < 0.05$) and younger patients (56.8 ± 11.2 years *vs* 61.3 ± 13.0 years; $P < 0.05$). Examination time for transnasal insertion was significantly longer than that for transoral insertion, although no significant difference was found between VAS scores for transnasal and transoral insertion (3.9 ± 2.3 *vs* 4.1 ± 2.5; NS).

For multivariate analysis of VAS scores, six parameters were employed: gender, age, experience of previous EGD, operator, type of endoscope, and examination time. Results of multivariate analysis of VAS scores for transnasal and transoral insertion are shown in Tables 3 and 4, respectively. For transnasal insertion, gender (posi-

Table 2 Characteristics of patients

	Transnasal insertion (n = 503)	Transoral insertion (n = 235)	P value
Gender M/F	299/204	118/117	< 0.05
Age (yr)	56.8 ± 11.2 (25-84)	61.3 ± 13.0 (27-88)	< 0.05
1st examination Y/N	54/449	19/216	0.29
Operator A/B	326/177	143/92	0.32
Endoscope			0.36
A	58	31	
B	110	52	
C	119	58	
D	112	61	
E	47	17	
F	57	16	
Examination time (s)	343.4 ± 59.4 (210-630)	324.5 ± 59.8 (196-600)	< 0.05
VAS	3.9 ± 2.3 (0-10)	4.1 ± 2.5 (0-10)	0.90

VAS: Visual analog scale; M: Male; F: Female.

Table 3 Multivariate analysis for visual analog scale in transnasal insertion

	Parameter estimate ± SE	P value
Gender (F)	0.780 ± 0.100	< 0.05
Age	-0.0193 ± 0.00886	< 0.05
1st examination (N)	0.252 ± 0.160	0.12
Operator (A)	-0.341 ± 0.110	< 0.05
Scope (E)	-0.719 ± 0.281	< 0.05
Examination time	0.00270 ± 0.00180	0.134

tive correlation with female gender), age, operator, and endoscope (negative correlation with endoscope E) were independent significant predictors of VAS scores. On the other hand, gender (positive correlation with female gender), age, and endoscope (positive correlation with endoscope C) were independent significant predictors of VAS scores for transoral insertion.

Multivariate analysis was also performed using EFI and tip diameter as alternative features of the endoscopes. Although both EFI and tip diameter were independent significant predictors of VAS scores for transoral insertion, only EFI was an independent significant predictor of VAS scores for transnasal insertion as shown in Table 5.

DISCUSSION

The appropriate usage of ultrathin endoscopes in the transoral and transnasal insertion techniques remains controversial[24]. In addition, although various ultrathin endoscopes are presently available, predictors of EGD-associated discomfort are unclear. This study demonstrated that both tip diameter and flexibility of ultrathin endoscopes can be predictors in reducing EGD-associated discomfort, especially for transnasal insertion.

Greater flexibility of the endoscope may lead to poorer handleability, resulting in prolonged examination time, which may in turn increase the discomfort accompanying EGD. However, although the most flexible endoscope (endoscope E) in this study required the longest

Table 4 Results of multivariate analysis of visual analog scale scores for transoral insertion

	Parameter estimate ± SE	P value
Gender (F)	0.575 ± 0.156	< 0.05
Age	-0.0343 ± 0.0125	< 0.05
1st examination (N)	-0.00289 ± 0.294	0.99
Operator (A)	-0.297 ± 0.177	0.10
Scope (C)	0.634 ± 0.313	< 0.05
Examination time	-0.00159 ± 0.00291	0.59

Table 5 Parameters of endoscopic flexibility index and tip diameter by multivariate analysis for visual analog scale

	Transnasal insertion	Transoral insertion
EFI	0.0125 ± 0.00563 (P < 0.05)	0.0212 ± 0.00966 (P < 0.05)
Tip diameter	0.450 ± 0.338 (P = 0.18)	1.33 ± 0.561 (P < 0.05)

EFI: Endoscopic flexibility index.

examination time among the six endoscopes, VAS scores were lowest for EGD using this endoscope for transnasal insertion. This result indicates that prolonging the examination for a certain amount of time may be acceptable in terms of the level of tolerable discomfort.

In a high proportion of regular patients in this study, EGD had been periodically performed in the past. Almost all patients selected the insertion route based on their experience with discomfort in previous examinations. Consequently, although no significant difference in VAS scores was observed between transoral and transnasal insertion, patient characteristics and preferences showed their propensity for discomfort with either one technique or the other. Table 2 shows the trend toward preference for transnasal insertion among males and younger patients. We speculate that younger patients preferred transnasal insertion to suppress a stronger gagging reflex that is reported by Enomoto *et al*[25]. By contrast, smaller female patients may have preferred transoral insertion because of their narrower nasal cavities, which are more prone to discomfort caused by transnasal insertion. However, VAS scores are reported to be affected by gender[26]. Additionally, there might be a gender deference in diminishing of gagging reflex or nasal pain by aging. We need further accumulation of data for appropriate insertion route in each gender or age-groups.

One limitation of this study is its unequal allocation of patients to each endoscope because of the system utilized in our institute. Moreover, the objectivity and reproducibility of VAS and EFI are questionable. EFI is affected by the weight of the endoscope, whose mass/length is not homogenous. However, this parameter can be a surrogate marker that can be evaluated simply and non-destructively.

In summary, this study demonstrated that flexibility of the ultrathin endoscope can be a reliable predictor of reduction in transnasal EGD-associated discomfort. Although further analysis of details concerning appropriate location and degree of flexibility is required, patient com-

pliance can be improved for follow-up and surveillance EGD by utilizing less uncomfortable tools.

COMMENTS

Background

As gastrointestinal endoscopic technology has advanced considerably with improvements in resolution and image enhancement, importance of surveillance esophagogastroduodenoscopy (EGD) to detect superficial neoplasms in early stage has been emphasized more than ever to achieve curative resection.

Research frontiers

Although EGD using an ultrathin endoscope has been accepted as a minimally invasive modality, the effects of choice of insertion route and ultrathin endoscope types have not been evaluated.

Innovations and breakthroughs

The authors' study using six types of ultrathin endoscopes demonstrated that flexibility of the ultrathin endoscope can be a reliable predictor of reduction in transnasal EGD-associated discomfort.

Applications

To decrease unsedated EGD-associated discomfort, transnasal insertion of ultrathin endoscopy should be chosen for younger males. A flexible ultrathin endoscope can reduce transnasal EGD-associated discomfort for the other people.

Terminology

Endoscopic flexibility index is a surrogate marker that can be evaluated simply and non-destructively.

Peer review

This is the first report of comparison of the difference between several models of ultrathin endoscope. The conclusion that the discomfort is associated with the flexibility of the endoscope is a novel and unique.

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