Ultra-thin caliber endoscopes in daily practice: uses for therapeutic application and beyond on the basis of review of 1028 procedures

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Background and study aims: Ultra-thin caliber endoscopes (UTCEs) are versatile and applicable in various conditions. However, only limited data exist on the actual daily clinical use of UTCEs. The aim of our study was to determine indications for UTCEs in a large patient cohort. In turn, our 2 main objectives were (1) to evaluate patient comfort and safety and (2) to determine benefits and potential advantages associated with the use of UTCEs in this same cohort.

Patients and methods: We performed a retrospective analysis of our prospective database of 1028 procedures with UTCEs in 457 patients. All procedures were carried out in the Department of Gastroenterology and Hepatology, VU University Medical Center, in Amsterdam, the Netherlands, between May 2008 and May 2014. In these procedures, either the Fujinon (Tokyo, Japan) EG-530N UTCE or the Olympus (Tokyo, Japan) GIF N-180 UTCE was used.

Results: Mean (standard deviation [SD]) age of patients was 64 (20) years, and most (60 %) of the patients were men. Most (61 %) of the underlying diseases, requiring endoscopic procedures, were found in the esophagus. Of the procedures performed, 91 % were successful, and 82 % were therapeutic. In comparison with regular endoscopes, the most important advantage of the UTCE was the ability to pass a stenosis (37 %), followed by nasogastric feeding tube placement (13 %). Newer and more innovative uses of the UTCE were percutaneous endoscopic gastrostomy (PEG)-jejunal extension placement with endoscope introduction through existing PEG tract, retrograde esophageal introduction through existing PEG tract, inspection of colonic neovagina stenosis, and direct inspection of the common bile duct.

Conclusions: In everyday clinical practice, the UTCE has specific advantages over conventional endoscopes because of its small caliber. The 3 main advantages are (1) introduction of high-grade strictures; (2) introduction of fistulas, including PEG fistula; and (3) increased patient comfort. The endoscopist should appreciate these advantages and consider use of the UTCE accordingly.

Introduction

Ultra-thin caliber endoscopes (UTCEs) were designed for transnasal esophagogastroduodenoscopy, with possible enhanced patient tolerability and safety. A UTCE can be used easily in unsedated patients as a diagnostic tool, which is particularly useful for critically ill patients and in outpatient clinics. A UTCE can also be used to evaluate a variety of conditions, such as abdominal pain, dysphagia, dyspepsia, heartburn, and odynophagia [1]. In addition, both screening and surveillance of Barrett esophagus and gastric cancer are possible in an ambulant setting, without sedation, as is detailed examination of the nasopharynx, oropharynx, and hypopharynx. As a therapeutic tool, a UTCE can aid in the placement of feeding tubes or percutaneous endoscopic gastrostomy (PEG) tubes and PEG extensions into the jejunum, in the placement of esophageal dilators, or in the positioning of a pH or impedance meter [2]. As such, a UTCE might be of more value in daily endoscopic practice than until recently assumed. In various studies to date, investigators have examined UTCE use in specific settings, such as Barrett esophagus surveillance, diagnosis of early gastric cancer or examination of varices in patients with cirrhosis, or gastrointestinal strictures [3–6]. However, there are only limited data about actual clinical use of the UTCE in daily practice [7,8].

In the current study, we evaluated actual clinical use of UTCEs in a large patient cohort with 2 main objectives: (1) evaluate patient comfort and safety and (2) determine benefits and potential advantages.

Patients and methods

Two researchers (L. H. O. and J. C. G.) retrospectively reviewed the reports of all patients in the VU University Medical Center (Amsterdam, the Netherlands) endoscopic database in whom endoscopy was performed with a Fujinon (Tokyo, Japan) EG-530N (diameter, 5.9 mm; working channel, 2.0 mm) or Olympus (Tokyo, Japan) GIF N-180 (diameter, 4.9 mm; working channel, 2.0 mm) endoscope between May 2008 and May 2014. In general at the VU University Medical Center, regular gastroscopes are used for upper gastrointestinal tract studies and regular colonoscopes are used for lower gastrointestinal tract procedures. Only when the endoscopist expects difficulty with the regular endoscope is a UTCE used.

Patients younger than 18 years of age were excluded from study. We recorded patients' sex and date of birth, procedure date and indications, underlying disease, use of conscious sedation or fluoroscopy, complications (during or immediately after the procedure), and potential advantages of the use of a UTCE over conventional endoscopes. In our definition, potential advantages included the following: passage of stenosis; direct nasogastric feeding tube placement; placement or changing of jejunum extension through existing PEG fistula; nasogastric inspection for improved patient comfort and safety; stent placement under direct sight; retrograde introduction of the esophagus through PEG fistula; nasogastric introduction with ear, nose, and throat tumor; confirmation of bronchoesophageal fistula by direct cannulation; placement of feeding tube through PEG; and measurement of tumor length before stent placement.

Patient comfort was determined if it was mentioned in the endoscopic report when the UTCE was specifically used for improved comfort and safety. We considered a safe endoscopy with the use of a UTCE as the absence of a complication.

In addition, we recorded whether the procedure was performed successfully, which was defined as completion of the required procedure (eg, placement of feeding tube was required and placed during the procedure). Failure was defined as not completing the required procedure (eg, placement of a PEG tube was not possible, regardless of the cause).

Statistical analyses

Data analysis was performed by using SPSS version 19.0 (IBM SPSS Inc, Chicago, Illinois, United States). Study parameters were evaluated for normal distribution. Parametric variables are given as mean (standard deviation [SD]). Continuous, nonparametric variables are given as median (interquartile range). Differences between variables were tested with the chi-square test. Statistical significance was set at $P<0.05$.

Results

In the study period, 1028 procedures were performed with a UTCE in 457 patients. One patient had 51 procedures; 9 patients, ≥10; 29 patients, ≥5; 141 patients, between 4 and 2; and 277 patients, 1 procedure. The patient who had 51 procedures was a male born in 1942 who was diagnosed with a T4N0 supraglotic larynx cancer in 2005. The complicated treatment of his cancer resulted in a high-grade esophagus stenosis, which required 51 Savary dilations during the study period. In 2011, this patient developed liver metastases, for which he denied treatment. In 2012, he died due to pneumonia. The number of procedures with a UTCE remained stable over the years: 166, 181, 152, 189, and 165 procedures in 2009, 2010, 2011, 2012, and 2013, respectively (data shown for complete years).

As can be seen in **Table 1**, most of the endoscopic procedures were performed in males (60%). At the time of the procedure, mean (SD) age of patients was 64 (20) years. For most procedures (77%), the route of introduction was oral. Nasal introduction was most common for feeding tube placement (117 of 214 procedures) (data not shown). The Fujinon EG-530N gastroscope was used in 70% (n=720) of procedures, and the Olympus GIF N-180 gastroscope was used in the remaining 30% (n=308) (data not shown).

Table 2 shows the range of underlying diseases of patients undergoing a procedure with a UTCE. Most underlying diseases were related to esophagus disease (61%). About one-third of the diseases could not be classified to only 1 specific part of the gastrointestinal tract or were not due to gastrointestinal disease.

Table 3 shows the indications for the 1028 procedures with UTCEs. Regarding our first objective in the study, patient comfort and safety, we found it remarkable that in only a minority (1.4%) of patients was UTCE used specifically for improved patient comfort. It was also remarkable that most (82%) of the patients received conscious sedation (with midazolam). The remaining patients (18%) did not receive any form of sedation.

Regarding patient safety, we registered few intraprocedural or direct postprocedural complications. During 6 procedures (0.6% of all procedures), 6 patients experienced respiratory problems. Three patients experienced a desaturation, and 2 of these required administration of flumazenil. The other 3 patients had more severe respiratory problems. The first patient, with a dens fracture, required placement of a feeding tube. After an uneventful transnasal introduction and tube placement, the patient developed a stridor and experienced an acute desaturation to 70% while sedated with 2 mg of midazolam. He remained responsive during the episode of respiratory insufficiency and recovered quickly. However, he was admitted to the medium care unit, remained there for less than 12 hours, and was discharged without pulmonary complaints. The second patient had an obstruction of the trachea due to preexisting bleeding. The third patient suffered from a severe respiratory complication, which was interpreted as a laryngeal spasm requiring manual ventilation for 3 minutes. One patient was noted to suffer from dental damage.

A continued review of **Table 3** shows that most (82%) of the procedures were indicated for therapeutic reasons, with almost

Table 1 Patient characteristics and procedure variables for 457 patients undergoing 1028 procedures with ultra-thin caliber endoscopes.

Age, mean (SD), y	64 (20)
Sex, male, no. (%)	621 (60)
Use of conscious sedation, no. (%)	848 (82)
Use of fluoroscopy, no. (%)	151 (15)
Route of introduction, no. (%)	
Oral	794 (77)
Nasal	151 (15)
Through existing PEG fistula	48 (5)
Rectal	35 (3)
Procedure successful, no. (%)	939 (91)

SD, standard deviation; PEG, percutaneous endoscopic gastrostomy.
Parametric variables were given as mean (SD). Normal distribution was tested with the Kolmogorov-Smirnov test.

Table 2 Underlying diseases, by gastrointestinal tract location, of 457 patients undergoing 1028 procedures with ultra-thin caliber endoscopes.

Esophagus, no. (%)	626 (61)
Benign esophagus stenosis after (total) laryngectomy	241
Benign stenosis after esophagus resection	177
Esophageal cancer	131
Benign peptic esophagus stenosis	25
Malignant stenosis after esophagus resection	13
Zenker diverticula	10
Esophageal damage due to caustic damage	8
Stenosis due to antireflux surgery	6
Esophageal stenosis due to graft-vs-host disease	5
Tracheoesophageal fistula	5
Schatzki ring	3
Barrett	1
After surgery for esophagus atresia	1
Stomach, no. (%)	32 (3)
Stomach cancer	21
Upper gastrointestinal bleeding	9
After gastric banding	2
Small bowel, no. (%)	20 (2)
Inflammatory bowel disease	10
Duodenal cancer	8
Short bowel syndrome	2
Colon, no. (%)	42 (4)
After (partial) colon resection	30
Rectal cancer	7
Stenosis of colon neovagina	2
Stenosis of colon due to endometriosis	2
Traumatic rectum stenosis	1
Hepatobiliary, no. (%)	15 (1)
Pancreas cancer	10
Cholangiocarcinoma	3
Related to gallstones	2
Other, no. (%)	293 (29)
Related to feeding	93
Ear, nose, throat cancer	68
No gastrointestinal disease	45
Post-radiation stenosis	37
Motility disease	18
Cancer of mediastinum	10
Lung cancer	8
Leukoplakia	7
Anemia	6
Morbus Wegener	1

If patients underwent more than 1 procedure with an ultra-thin caliber endoscope, each separate procedure was scored.

half being for Savary dilation; 21%, for feeding tube placement; and 11%, related to PEG tube change or placements. We found that conscious sedation was used less often in 3 particular procedures. Two of those procedures were carried out for nontherapeutic reasons: improved patient comfort (11 of 14 procedures) and inspection of PEG tube (7 of 10 procedures). One of those procedures was conducted for a therapeutic reason: change of jejunum extension of PEG tube (32 of 34 procedures). Nasal introduction was used primarily for therapeutic feeding tube placement (117 of 151 nasal introductions), but this route was not chosen often for other indications.

Findings displayed in **Table 3** also provide information pertinent to our second objective in the study, benefits and potential advantages of UTCE. Some of the findings reported earlier in this article regarding our first objective, patient comfort and safety, tie in to our second objective. That is, use of the UTCE was beneficial primarily for (1) therapeutic or (2) nontherapeutic diagnostic reasons. A benefit gleaned from our analysis was related specifically to Savary dilation and inspection of the esophagus. Of the dilations reviewed, 45% (220 of 484) of procedures were performed after oncologic ear, nose, and throat surgery. As we reported earlier in the article, the UTCE is also importantly beneficial in placement of feeding tubes and in PEG-related indications. A summary of new indications for UTCE, obtained from our review, is given in **Table 4**.

In more than half of the procedures, the UTCE had a specific advantage over conventional gastroscopes (**Table 5**). The main advantage was its small diameter, which made it possible to inspect strictures or stenoses, as well as to place feeding tubes or stents through stenosis with a small diameter. Other advantages included introduction of the stomach through an existing PEG fistula with increased patient comfort and safety. Further details regarding the advantages of the UTCE over regular endoscopes are shown in **Table 5**.

Discussion

Procedures with the use of a UTCE form only a small part of everyday endoscopic practice. Nonetheless, these versatile endoscopes have several unique characteristics, warranting a much wider use.

In the current study, we described 1028 procedures performed in adult patients over 6 years. We focused on 2 objectives with the use of a UTCE: (1) patient comfort and safety and (2) benefits and potential advantages. For our first objective, findings indicated that the UTCE was safe, with very few complications noted. However, we found that the UTCE was not often used specifically for improved patient comfort. For our second objective, we found that the most important advantage of the UTCE in our hands was inspection and treatment of stenosis in the gastrointestinal tract.

The UTCE was first described in the late 1970s and early 1980s [9, 10]. However, the first comparison of the UTCE with a conventional gastroscope occurred 20 years later [11]. To date, there are only a few studies in which the daily and clinical uses of UTCE are described [7, 8]. In a study from Canada, the UTCE was used for routine diagnostic upper endoscopy in 231 patients. In general, the UTCE was better tolerated than the conventional gastroscope [8]. In India, 50 procedures with the use of the UTCE were recorded between 2004 and 2007. Of these procedures, 25 were performed for endoscopy-assisted nasogastric tube placement. The other 25 were related to strictures, trismus, and neurologic damage [7].

The small caliber of the UTCE is its main advantage, because it allows for passage, inspection, and treatment of stenosis in the gastrointestinal tract. Mulcahy and Fairclough [5] described 15 patients, 12 of whom had an esophageal stenosis and 3 of whom had a stenosis in the colon related to Crohn disease. The study of Aydinli and colleagues [6] showed similar results, in that there were more upper than lower intestinal stenoses, with a larger group of patients. In some countries (Japan and France), the UTCE is also used specifically for diagnostic purposes [12]. In our center, as well as from our experience with our Dutch colleagues in the Netherlands, a UTCE is not often used for improved patient safety. We are uncertain as to why the UTCE is not used more frequently. Perhaps costs, frailty of the endoscope, or unfamiliarity

Table 3 Indications for 1028 procedures with ultra-thin caliber endoscopes, categorized according to route of introduction (oral, nasal, or other [anal, PEG, or colostoma]) and whether conscious sedation was used.

	Total, no. (%)	Oral		Nasal		Other
		No sedation	Conscious sedation	No sedation	Conscious sedation	Sedation N/A
Nontherapeutic						
Diagnostic	75 (7.3)	21	34	2	15[NS]	3
Inspection of upper gastrointestinal stenosis	30 (2.9)	9	21	0	0[NS]	0
Inspection of stenosis in colon	16 (1.6)	0	0	0	0[NS]	16
Improved patient comfort	14 (1.4)	10	3	1	0[NS]	0
Patient complaints of esophageal passage	12 (1.2)	10	2	0	0	0
Inspection of PEG tube	10 (1.0)	5	1	2	1[NS]	1
Inspection of bronchoesophageal fistula	5 (0.5)	0	5	0	0[NS]	0
Inspection of common bile duct	2 (0.2)	0	2	0	0[NS]	0
Inspection of colostoma with stenosis	2 (0.2)	0	0	0	0[NS]	2
Therapeutic						
Savary dilation	484 (47.1)	3	463	1	11*	6
Feeding tube placement	214 (20.8)	27	66	23	94[NS]	4
PEG	114 (11.1)					
Push-PEG tube placement	52	5	47	0	0	0
Change of jejunum PEG tube	34	0	2	0	0	32
Jejunum PEG tube placement	22	3	5	0	0	14
Placement of feeding tube through PEG fistula	4	0	0	0	0	4
Buried bumper syndrome	1	0	1	0	0	0
Pull-PEG tube placement	1	0	1	0	0	0
Stent placement	34 (3.3)	2	31	0	1	0
APC treatment of malignant stenosis	1 (0.1)	0	0	0	0[NS]	1
Unclassified	15 (1.5)	6	9	0	0[NS]	0

PEG, percutaneous endoscopic gastrostomy; N/A, nonapplicable; APC, argon plasma coagulation.
Difference in sedation between oral and nasal introduction was tested with the chi-square test.
[NS] No significant difference.
* Significant difference ($P<0.05$).

Table 4 Innovative uses of ultra-thin caliber endoscopes, determined from review of 1028 procedures.

PEG-J (jejunal extension) placement: endoscope introduction through existing PEG tract
Retrograde esophageal introduction through existing PEG tract
Inspection of colonic neovagina stenosis
Direct inspection of common bile duct

PEG, percutaneous endoscopic gastrostomy.

Table 5 Advantages of ultra-thin caliber endoscopes over regular endoscopes.

	No. (%)
Unspecified	417 (40)
Passage of stenosis	379 (37)
Direct nasogastric feeding tube placement	129 (13)
Placement or changing of jejunum extension through existing PEG fistula	51 (5)
Nasogastric inspection for improved comfort and safety	23 (2.2)
Stent placement under direct sight	16 (1.6)
Retrograde introduction of the esophagus through PEG fistula	6 (0.6)
PEG tube placement made possible, making surgical jejunostomy unnecessary	3 (0.3)
Confirmation of bronchoesophageal fistula by direct cannulation	2 (0.2)
Placement of feeding tube through PEG	2 (0.2)

PEG, percutaneous endoscopic gastrostomy.

of endoscopists with the advantages of the UTCE limit the more common use of this versatile scope. The exact place of the UTCE for therapeutic use remains to be clarified.

Several procedural applications and characteristics of the UTCE are also noteworthy. The UTCE permits visualization and inspection of the common bile duct. This procedure was first described 20 years ago in a pregnant patient [13], and, to date, there are 2 studies in which direct inspection of the common bile duct has been described [14, 15]. Another important field of use for the UTCE is PEG tube placement and care, including the direct placement of jejunum extensions. A potential advantage of UTCE is that it can be safer to use than regular endoscopes in elderly patients and patients with comorbidities [11]. In our series, 82% of patients received conscious sedation. It should be noted that when a patient is undergoing dilation, the actual dilation, rather than the endoscopic procedure, requires sedation.

In our series, there were few complications, occurring in only 0.6% of procedures. The 6 complications were respiratory problems after a UTCE procedure. Although we did not register major complications, perforation with a UTCE has been described [16]. A downside of the UTCE is its small working channel, rendering smaller biopsy specimens than obtained with the conventional gastroscope. However, diagnostic performance of the UTCE remains similar to that found for the conventional gastroscope [17]. Image quality is inferior to that obtained with the conventional gastroscope. However, we believe this to be of little consequence in daily practice. In fact, comparison of use of the UTCE versus a conventional endoscope in Barrett esophagus sur-

veillance, in which visual quality is particularly important, yielded similar results [2].

A limitation of this study was the retrospective analysis of our prospective database. The advantages of the UTCE were scored retrospectively, possibly biasing the results. Our percentage for the category of unspecified advantage of the UTCE over a regular endoscope is high (41 %). However, in case of doubt of whether a specific advantage existed, we scored the data as unspecified. This percentage is therefore conservative and likely an overestimation. We did, however, include more than 1000 procedures carried out over a long period (6 years). Furthermore, we had only 2 investigators score the procedures, decreasing the interobserver bias.

In conclusion, UTCE can benefit a broad range of patients, potentially reducing the need for surgical or fluoroscopic treatment. Use of the UTCE makes it possible to inspect and treat high-grade strictures, place feeding tubes beyond these strictures, and increase patient comfort during endoscopy. We believe that the UTCE should be available in every endoscopic unit, and that endoscopists should be aware of the specific advantages of the UTCE and able to use the UTCE accordingly.

Competing interests: None.

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