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A new strategy for enteral nutrition using a deflection flexible visual gastric tube

A randomized crossover manikin trial

Jie Li, PhD[a], Yan-mei Feng, PhD[b], Dong Wan, PhD[c], Hui-sheng Deng, PhD[d], Rui Guo, PhD[c,*]

Abstract

Background: Enteral nutrition via gastric tube insertion is a routine clinical practice for critically ill patients, although complications due to blind manipulation are occasionally reported.

Methods: An 8.4Fr deflection flexible ureteroscope was delivered into a 15Fr conventional gastric tube to create a gastric visual guidance system. Twenty inexperienced physicians were randomly assigned to perform 5 repeated orogastric tube placements in a manikin using both the conventional method and the deflection visual gastric tube, for a total of 10 procedures per physician. Placement time, procedure-related complications, and participants' experience with both methods were recorded.

Results: Under real-time guidance, the visual gastric tube successfully reached the stomach. The procedure provided additional information on the anatomy of the esophagus and stomach. Placement time was significantly less in the visual group than in the conventional group (39.39 ± 2.11 seconds vs 49.82 ± 3.11 seconds; $P < .001$). Procedure-related complications were not observed in the visual group; however, the gastric tube was misplaced into the airway in 19 out of 100 cases (19%) in the conventional group. Furthermore, 17 out of 20 participants (85%) preferred the visual gastric tube guide over the standard method.

Conclusions: Results of this manikin model demonstrate that it is feasible to use the deflection flexible visual gastric tube to create a route for enteral nutrition and that such a procedure decreases placement time and procedure-related complications compared to the conventional procedure. These findings may point to a new strategy for gastric tube insertion in the future.

Abbreviations: Fr = French, pH = potential of hydrogen, SD = standard deviation.

Keywords: deflection flexible visual gastric tube, efficiency, enteral nutrition, feasibility, manikin

1. Introduction

Enteral nutrition is important for critically ill patients and is associated with reduced infection, reduced length of stay in the intensive care unit, and improved mortality.[1] Current clinical practice guidelines suggest initiating enteral nutrition within 24 to 48 hours of admission to the intensive care unit after stabilizing hemodynamics.[2]

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[a] Department of Urology, [b] Department of Respiratory Medicine, [c] Department of Critical Care Medicine, [d] Department of Geriatrics, The First Affiliated Hospital of Chongqing Medical University, China.

[*] Correspondence: Rui Guo, Department of Critical Care Medicine, the First Affiliated Hospital of Chongqing Medical University, Chongqing 400016, China (e-mail: guo-rui5@163.com).

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In critically ill patients who have difficulty swallowing and thus insufficient energy intake, gastric tube feeding is the first choice for nutritional support. The conventional method advances the gastric tube into the stomach blindly. As real-time visualization techniques are limited, serious complications, such as pneumothorax/hydropneumothorax, fatal internal jugular vein perforation, and misplacement into the brain, are occasionally reported.[3–6]

In this study, a clinically available 8.4Fr flexible ureteroscope with dual deflection of the distal tip upward to 180° and downward to 270° was delivered into a 15Fr conventional gastric tube to create a gastric tube visual guidance system. To the best of our knowledge, this is the first study to demonstrate gastric tube placement using such a system. We investigated the feasibility and efficiency of this video-assisted system in a manikin model.

2. Methods

2.1. Institutional review board and informed consent

This study was a randomized controlled crossover trial, and written informed consent regarding the study purpose was obtained from all participants. The Internal Review Board of the First Affiliated Hospital of Chongqing Medical University reviewed and approved the study protocol.

2.2. Deflection flexible visual gastric tube

Figure 1 shows the prototype of the deflection flexible visual gastric tube. This system was designed to integrate a commercially available 8.4Fr deflection flexible ureteroscope (Olympus

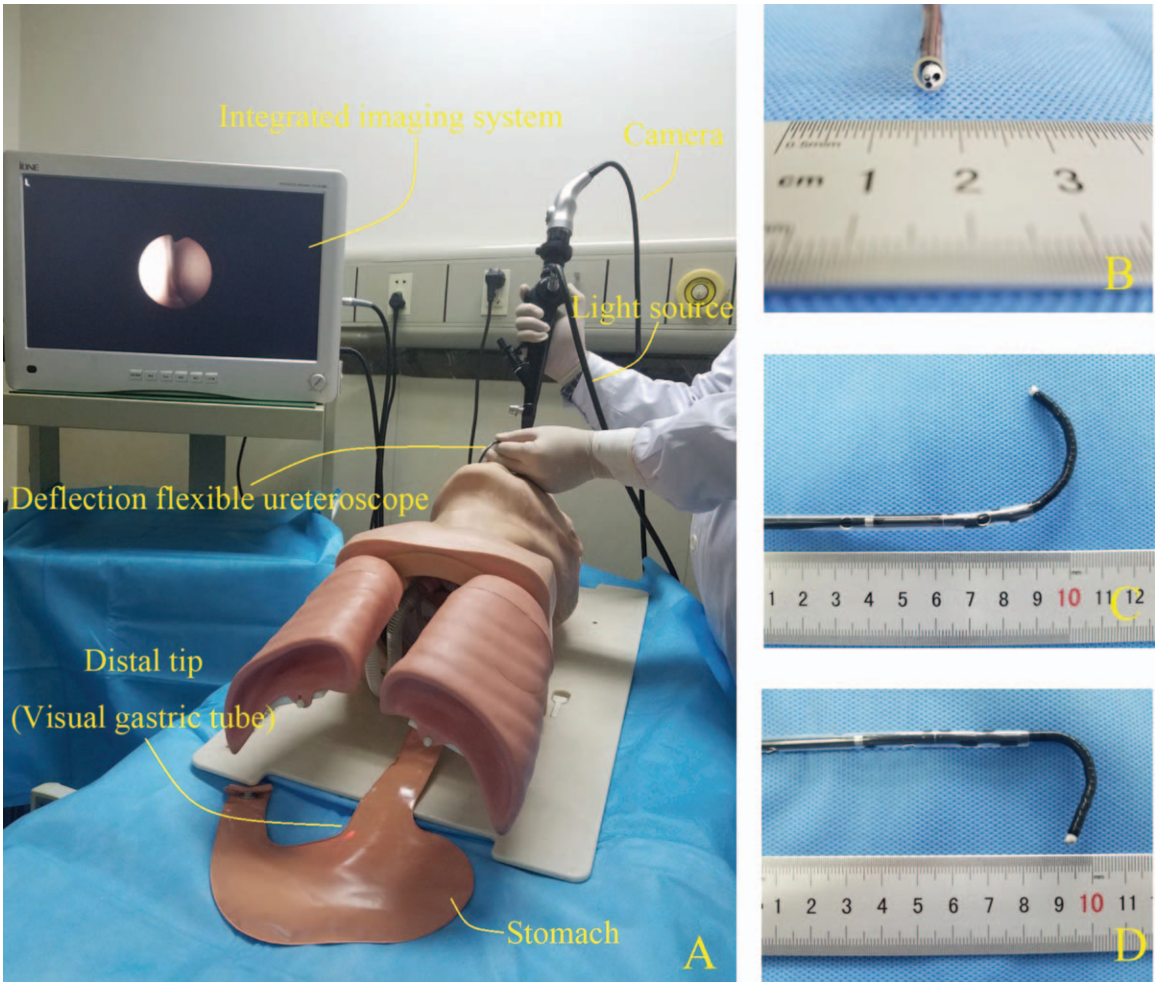

Figure 1. (A) The prototype of the deflection flexible visual gastric tube system, consisting of an integrated imaging system, cold light source, image camera system, 8.4Fr deflection flexible ureteroscope, and 15Fr conventional gastric tube. (B) At the distal end of the visual gastric tube is a working channel, objective lens, fiber-optic illumination, and gastric tube. Initiative deflection (C) upward and (D) downward allows intuitive orientation and visualization of the entire digestive tract.

URF-P5; Olympus, Tokyo, Japan) into a 15Fr conventional gastric tube (Fresenius Kabi India, Bad Homburg, Germany) to facilitate visual guidance during gastric tube insertion.

2.3. Experimental protocol

A human airway management trainer (Laerdal Medical, Stavanger, Norway) was used. However, because this model was not specifically designed for gastric tube placement, the entry to the esophagus was too narrow to insert the gastric tube smoothly. Thus, we used a breathing circuit connector (EM05-115Q; Excellentcare Medical, London, UK) to dilate the entry and facilitate gastric tube insertion (Fig. 2B and video S1 in the supplemental file, http://links.lww.com/MD/C244). Before the gastric tube was inserted, 500 mL water was injected into the stomach. Routine procedures were used in the conventional group, as described previously in detail.[7] In the conventional group, proper placement of the gastric tube was confirmed when the sound of air over the epigastric region was detected while air was instilled into the gastric tube. In the visual group, proper placement of the gastric tube was confirmed when the distal tip of the deflection flexible ureteroscope entered the stomach. Placement time was defined as the length of time between the gastric tube entering the oral cavity and confirmation of proper placement.

In this study, 20 physicians were assigned to perform gastric tube insertion using both the conventional method and the deflection flexible visual guidance system in a randomized order. All participants received 1 hour of training in using the flexible visual guidance system before participating. Five repeated gastric tube placements were performed in each group, and the median value was used as the placement time for each participant. If the placement time was >2 minutes, the attempt was considered a failure, and the participant continued making attempts until he or she was successful. Procedure-related complications were defined as misplacement of the gastric tube into the airway. All physicians had <1 year of postgraduate training, and none had any previous experience with gastric tube insertion (Fig. 3). The blind design of this study was similar to our previous work.[8]

2.4. Statistics

Data are presented as means ± SD. SPSS version 10.0 was used for data analysis. Comparisons of gastric tube placement time between the conventional and visual groups were made using paired *t* tests. The rate of procedure-related complications was compared between the groups using paired chi-square tests. *P* values < .05 were considered statistically significant.

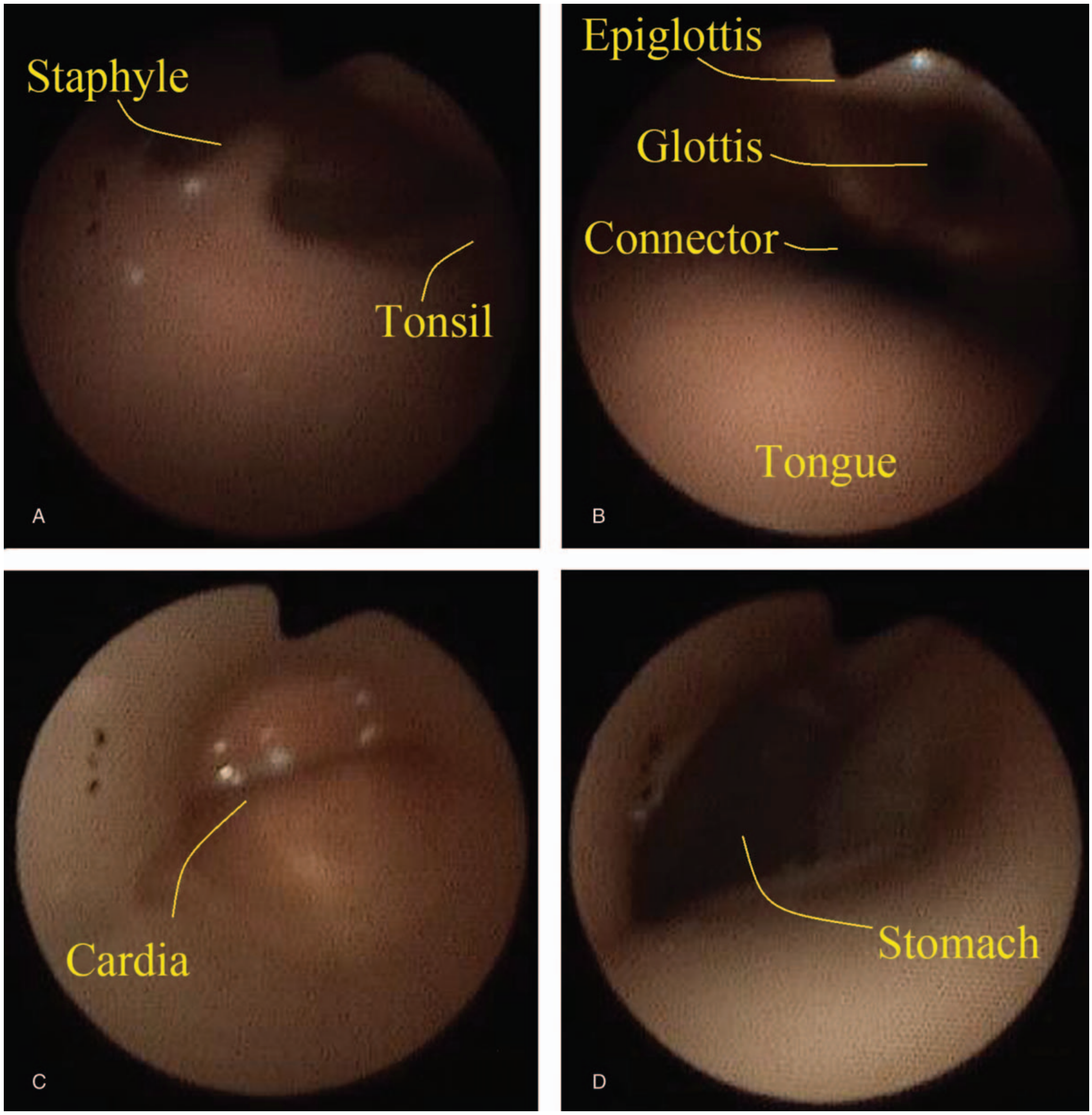

Figure 2. Visual guidance during gastric tube placement. The distal tip of this visual gastric tube was delivered into the (A) oral cavity, (B) esophagus, (C) cardia, and (D) stomach. (B) The structure of the epiglottis and glottis was visualized in case of misplacement. The whole procedure is easier to interpret in the full-motion video clip in video S1 (supplemental file, http://links.lww.com/MD/C244).

3. Results

3.1. Safety study

Gastric tube insertion was performed successfully in the visual group; however, 14 out of 100 trials (14%) in the conventional group failed. In the conventional group, misplacement of the gastric tube into the airway was observed in 19 out of 100 cases (19%); however, this complication was not observed in the visual group ($P < .001$; Table 1).

3.2. Visually guided gastric tube placement

Using real-time guidance, the distal tip of the gastric tube was sequentially entered into the oral cavity, esophagus, and stomach, providing information about the digestive tract (Fig. 2 and video S1 in the supplemental file, http://links.lww.com/MD/C244). This method allowed the physicians to determine when the gastric tube had successfully advanced into the stomach.

3.3. A comparison of placement time and participant experience between the conventional group and the visual group

Placement time was compared between the groups using paired t tests. Placement time was 39.39 ± 2.11 seconds in the visual group, which was significantly less than in the conventional group (49.82 ± 3.11 s; $P < .001$; Table 1). A total of 17 out of 20 participants (85%) preferred the visual gastric tube guide over the standard method.

4. Discussion

Using a manikin model, this study shows that visual gastric tube guidance with a commercially available deflection flexible

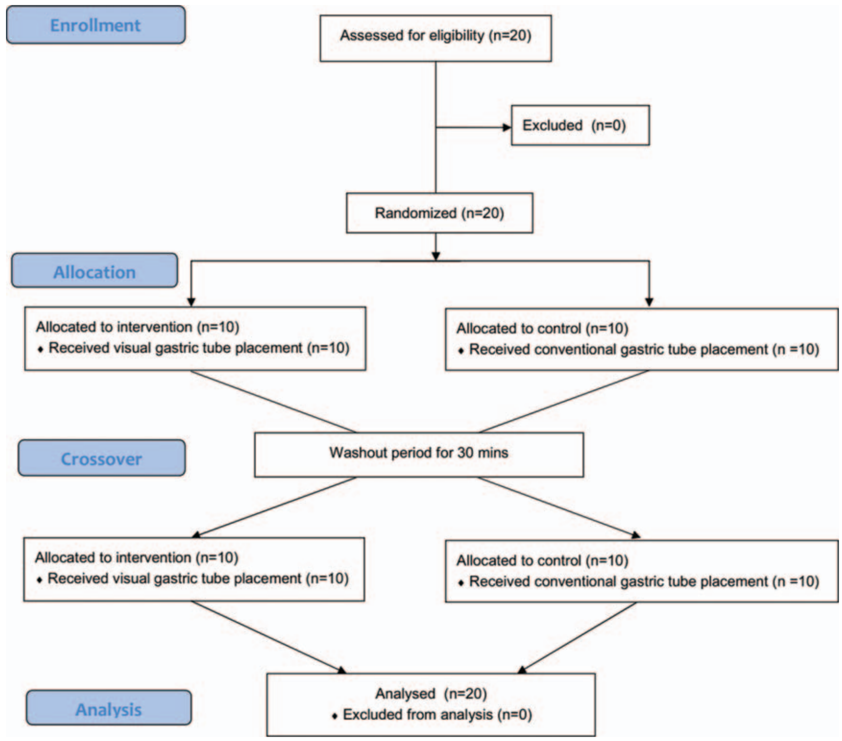

Figure 3. Study design flowchart.

ureteroscope is feasible. Using real-time guidance, this new strategy confirmed the proper positioning of a gastric tube, reducing placement time and procedure-related complications compared to the conventional method.

Nowadays, numerous alternatives can aid the confirmation of gastric tube placement to reduce the incidence of placement-related complications.[9] The most popular is the auscultation method. Auscultation alone is 60% to 80% reliable in terms of guiding the proper placement of the gastric tube.[10] Therefore, other methods are used to further guarantee correct gastric tube placement; these include evaluating the pH, carbon dioxide, and enzyme levels in aspirate fluid.[11–14] However, these indirect methods are time consuming and often inaccurate.

In some patients with difficult tube displacement, radiographic verification can be used.[15] However, not all hospitals can perform radiographic tests at bedside, and it can be risky to

Table 1

A comparison of the gastric tube placement time, success rate and procedure-related complication between the conventional group and visual group.

	Visual group			Conventional group		
Physicians	Placement time	Failure	Misplacement	Placement time	Failure	Misplacement
1	39.26	0	0	52.47	3	2
2	37.68	0	0	49.63	1	0
3	38.51	0	0	55.27	1	1
4	41.32	0	0	47.32	0	1
5	43.77	0	0	49.48	0	2
6	35.43	0	0	49.87	0	0
7	39.56	0	0	48.23	2	0
8	41.89	0	0	48.82	1	1
9	40.12	0	0	52.17	1	3
10	38.67	0	0	59.34	0	0
11	37.31	0	0	49.71	0	0
12	38.94	0	0	47.83	1	2
13	40.58	0	0	48.92	0	1
14	41.21	0	0	48.13	1	0
15	37.39	0	0	51.27	0	2
16	38.45	0	0	46.53	0	1
17	38.73	0	0	48.57	2	0
18	37.19	0	0	47.34	0	1
19	43.21	0	0	46.28	1	1
20	38.57	0	0	49.25	0	1

transport critically ill patients for x-ray examination. In addition, exposure to x-rays is unsuitable for some patients, especially those who are pregnant.

Endoscopy is the ideal choice for real-time guidance of gastric tube placement. However, a conventional electronic gastroscope is twice the size of a gastric tube; thus, it will further increase patient discomfort. For this reason, our research group developed a 0.9 mm microimaging fiber that was further delivered into a conventional gastric tube to realize visual guidance of gastric tube placement. A preliminary manikin study confirmed the feasibility and efficiency of this new system.[8] However, because the fiber tip cannot deflect manually, there is a potential for tissue damage during gastric tube insertion. In addition, this prototype is still in the experimental stages and there is a long way to go before it can be used in clinical practice.

In this study, a commercially available 8.4Fr deflection flexible ureteroscope was delivered into a 15Fr conventional gastric tube to create a gastric visual guidance system. As expected, the visual group spent less time inserting the tube than the conventional group, possibly because they could immediately confirm the placement of the distal tip. In addition, the conventional procedure required the injection of air into the tube to confirm the correct placement, which prolonged the time needed to ensure the success of this technique. Therefore, visually guided gastric tube insertion may help simplify the entire procedure and reduce placement time.

Compared to the conventional method, this new strategy can provide additional information on the anatomy of the esophagus and stomach (Fig. 2C and D), which is important for critically ill patients at high risk for gastric tube insertion. For example, in patients with paraquat poisoning and an unknown degree of esophageal corrosion, the gastric tube must be inserted carefully to avoid perforating the esophagus. In patients with liver cirrhosis and invasive mechanical ventilation, it is not ideal to undertake enteral nutrition because the status of suspected esophageal varices is unknown and a rash insertion may cause a life-threatening acute upper gastrointestinal hemorrhage. This bedside visual gastric tube can help to quickly screen the degree of esophageal corrosion and varices, assisting physicians in balancing the benefits and risks of gastric tube placement. Moreover, early screening is important for managing digestive diseases. This new system is similar to electron ultrafine gastroscopy, which can provide additional anatomical information beyond gastric tube guidance alone. Therefore, this visual method has still further applications compared to the conventional method.

5. Study limitations

This study used a manikin to investigate the feasibility and efficiency of gastric tube placement using an 8.4Fr deflection flexible ureteroscope. Further studies are needed to evaluate the difference between oral gastric and nasogastric tube insertion using this new technique. Future evaluations should use real patients, especially to evaluate efficiency and safety. In addition, further experience should be gained with more participants and using repeated procedures to investigate this new system.

6. Conclusions

A deflection flexible ureteroscope was able to provide real-time guidance of gastric tube insertion in a manikin, leading to a decrease in tube placement time and procedure-related complications. Moreover, it provided information on the anatomy of both the esophagus and stomach that could be further used for diagnostic purposes. Therefore, this new strategy may provide an alternative to gastric tube placement in the future.

Author contributions

Data curation: Jie Li, Yan-mei Feng, Rui Guo.
Formal analysis: Jie Li, Yan-mei Feng, Rui Guo.
Investigation: Jie Li, Yan-mei Feng, Hui-sheng Deng, Rui Guo.
Writing – review & editing: Jie Li, Yan-mei Feng, Dong Wan, Hui-sheng Deng, Rui Guo.
Conceptualization: Yan-mei Feng, Dong Wan, Hui-sheng Deng, Rui Guo.
Methodology: Yan-mei Feng, Dong Wan, Hui-sheng Deng, Rui Guo.
Project administration: Yan-mei Feng, Dong Wan, Hui-sheng Deng, Rui Guo.
Resources: Dong Wan, Hui-sheng Deng, Rui Guo.
Supervision: Dong Wan, Hui-sheng Deng, Rui Guo.
Validation: Dong Wan, Rui Guo.
Funding acquisition: Rui Guo.
Visualization: Rui Guo.
Writing – original draft: Rui Guo.

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