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ORIGINAL ARTICLE

Comparison of rigid and flexible endoscopy for removing esophageal foreign bodies in an emergency☆

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KEYWORDS
esophageal foreign body;
flexible endoscopy;
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Background/Purpose: Despite the effectiveness of endoscopies in removing ingested foreign bodies (FBs) impacted in the esophagus, the merits and limitations of flexible endoscopy (FE) and rigid endoscopy (RE) remain unclear. Therefore, this study compares the advantages and disadvantages of both endoscopic procedures from a clinical perspective.
Methods: A retrospective review was made of 273 patients suspected of esophageal FBs in emergency consultations of a tertiary medical referral center from March 2010 to March 2014. All patients received routine physical examinations, otolaryngological examinations, and X-rays of the neck and chest. The door-to-endoscopy time, procedure time, postendoscopic hospital stay, successful removal rates, and complications were analyzed as well.
Results: In this study, the most common esophageal FBs were fish and animal bones (76%) in adults and coins (74%) in children. The patients with existing esophageal FBs had significantly more frequent symptoms of dysphagia and signs of linear opacity as detected with lateral neck radiography than those without FB. Additionally, the door-to-endoscopy time, procedure time, and postendoscopic hospital stay was significantly shorter in FE patients than in RE patients. However, both RE and FE patients had high rates of successful FB removal (95%) and low complication rates (2%).
Conclusion: Both FE and RE remove esophageal FBs successfully, as evidenced by their high success rates, low complication rates, and high detection rates. Although FE under local anesthesia is a less time-consuming procedure for adults, RE under general anesthesia may be preferable for children and can serve as an alternative to FE.

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Introduction

Ingestion of a foreign body (FB) is a common clinical problem in emergency consultations with otolaryngologists. Although most ingested FBs pass through the body spontaneously,[1] sequelae of FB impaction may be severe and even life-threatening if diagnosis and treatments are delayed.[2,3] Therefore, FBs must be identified and removed as soon as possible.[4] Biplane plain radiography is routinely used as the initial diagnostic image study for suspected esophageal FBs, with this procedure having a 0.5% false negative rate and a 20% false positive rate in a previous study.[5] Despite its effectiveness in detecting FBs with a sensitivity rate of 100% and a specificity rate of 93.7%,[5] computed tomography scanning (especially 3-dimensional reconstruction) may be cost inefficient in a routine emergency setting. Therefore, the efficacy and timing of endoscopic intervention, especially as to whether rigid endoscopy (RE) or flexible endoscopy (FE) is a more effective clinical procedure, warrants further study.

In clinical practice, otolaryngologists at National Taiwan University Hospital (NTUH), Taipei, Taiwan remove esophageal or airway FBs via RE, a procedure with a success rate of 99.9% and a complication rate of 0.2%.[6,7] Despite FE recently demonstrating a high success rate of FB removal with a low complication rate,[4,8–12] no uniform methodology is accepted as the exact only management of all cases with esophageal FBs, and each technique carries its own risks and benefits. In general, the proximal esophagus, especially at the upper esophageal sphincter, is more easily approached by RE, whereas FE is superior for visualizing the distal esophagus, stomach, and duodenum. Gmeiner et al[4] advocated FE due to better overall patient comfort, shorter procedure time, lesser postinterventional dysphagia, and the procedure could be done with conscious sedation. However, the advantage of RE is a wider lumen for instruments in manipulating and extracting nonfood, larger size FBs.[13]

In Taiwan, the optimal procedure for esophageal FB generally depends on the available hospital facilities, the doctor, or patient preference at emergency stations. Therefore, this study describes our clinical experiences with FE or RE management practices when treating esophageal FBs from the perspectives of patients, physicians, and safety concerns.

Patients and methods

Patient selection

From March 2010 to March 2014, 2393 patients visited or consulted with otolaryngologists for FB ingestion at the emergency station of NTUH, which is a tertiary referral medical center in northern Taiwan. Among them, 286 patients received endoscopic examination eventually. Three patients who had received endoscopic intervention at other hospitals were excluded. Another 10 patients who presented with chest pain and suspected perforated esophagus were excluded and were taken over by chest surgeons.[14] Therefore, 273 patients were eligible for analysis in this study (Figure 1).

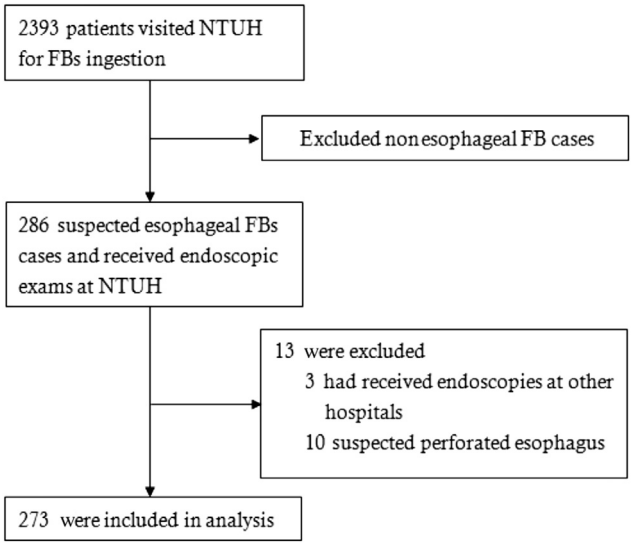

Figure 1 Enrollment diagram. FB = foreign body; NTUH = National Taiwan University Hospital.

The study protocol was assessed and approved by the Ethics Committee of NTUH. According to an NTUH mandate, otolaryngologists are required to perform the initial examination of patients suspected of FB ingestion. Patients received detailed history taking, otolaryngological local examinations, neck and chest radiographs (including anteroposterior and lateral views), and further endoscopic examinations (either FE or RE). Suspicion of esophageal FBs is one of the most common indications for both RE and FE. However, contraindications for FE are inadequate patient cooperation and a suspected perforated viscus. By contrast, patients who have cervical spine abnormalities, trismus, particular anesthetic risks, or a suspected perforated esophagus are contraindicated for RE. Without any of the above contraindications, patients could make their own decision or preference to receive either FE by gastrointestinal physicians under local anesthesia (LA) or RE by the otolaryngologists under general anesthesia (GA).

FE and RE

Since FE under GA is only performed at specified times in our hospital, patients treated at our emergency room (ER) are only given the option of RE under GA and FE under LA.

The requirements for FE were 6 hours *nil per os* and a hyoscine (Buscopan, 20 mg) injection before procedures. In our hospital, gastrointestinal physicians perform flexible endoscopies (Olympus GIF Q260 Gastroscope, Tokyo, Japan) to remove esophageal FBs using various accessary instruments such as forceps, endoscopic nets, baskets, and using techniques such as "push food to stomach". Patients tried oral feeding 2 hours after FE procedures and were discharged from the emergency station if the postendoscopic course was smooth.

The RE procedure also required $\geq$ 6 hours *nil per os* time before endoscopy. The patients received basic preoperation examination, including blood tests, electrocardiography, and waited for an available emergent operation

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room. After RE, the patients were admitted to the otolaryngology ward. Patients who tried oral intake 6 hours after RE, and if it went smoothly could be discharged and appointed an outpatient clinic follow-up a few days later. If esophageal perforation was suspected during endoscopy or at postendoscopic radiography, the patient received nasogastric tube insertion for feeding and prophylactic intravenous antibiotics.

If the initial endoscopic intervention failed, the procedure was converted into the other endoscopic procedure or open surgery either by an otolaryngologist or chest surgeon.

Data collection

Patient's medical records were retrospectively reviewed for their demographics, clinical presentations, radiography findings, endoscopy procedure time (divided into three parts: door-to-endoscopy time, i.e., time between patient registered at the emergency station and endoscopy start time; procedure time, i.e., time between endoscopy start and end time; and postendoscopic hospital stay, i.e., time between endoscopy end time and patient discharged from our hospital), endoscopic findings, FB type, FB location (distance from upper incisors or location divided into upper, middle and lower esophagus from endoscopic report), and postendoscopic managements (e.g., nasogastric tube insertion or intravenous antibiotics use). Patients who revealed no esophageal FB in endoscopic examinations were followed up at the outpatient department 1 week after the procedure. Patients lost to follow-up were reconfirmed by telephone regarding their swallowing and feeding conditions.

Major complications included perforations with or without mediastinitis, retropharyngeal abscess, and aortoesophageal fistulas. A perforation was diagnosed based on clinical and radiologic evidence. Radiologic evidence included retropharyngeal air, widening of the retropharyngeal soft tissue, leakage of contrast in fluoroscopic studies, and extraluminal location of the FB using computed tomography. Minor complications included lacerations, hematoma, or ulcer of the esophageal mucosae.[3]

Statistical analysis

The RE and FE were compared with respect to procedure time, and then analyzed with Student *t* test. The RE and FE were then compared in terms of door-to-endoscopy time and postendoscopic hospital stay, and then analyzed with Mann–Whitney *U* test. Additionally, dichotomous variables were compared using the Fisher exact test. A difference was regarded as significant when $p < 0.05$.

Results

Two hundred and seventy three patients, including 113 (41.4%) males and 160 females (mean age of 48.7 $\pm$ 20.6 years) with suspected esophageal FBs, were enrolled in this study.

In the RE group, five patients with FBs that could not be removed were converted to open surgeries (3 patients) and FEs under GA (2 patients) successfully. The causes of the RE failures were migration of the FB to the lower esophagus during operation (1 case), penetration of the FB out of the esophageal lumen (3 cases), and obscuration of the FB by esophageal wall hematoma in the lower esophagus (1 case). As for the FE group, five patients whose FBs failed to be removed were shifted to open surgeries (2 patients), RE (1 patient), and FE under GA (2 patients) smoothly. The causes of the FE failures were patient's intolerance of LA (2 cases), blood obscured the endoscopic field at upper esophageal sphincter (1 case), food impaction over esophageal stricture site (1 case), and an extralumenal FB (1 case).

Esophageal FB management: adults versus children

The patients were categorized as adults (age $\geq$ 18 years) or children (age $<$ 18 years). The ratio of RE/FE in children (89/11%) was significantly higher than that in adults (43/57%). Food FB/non-FB ratio was significantly higher in adults (90/10%) than in children (13/97%). Additionally, adults and children did not significantly differ in failure rate or complication rate (Table 1).

Clinical parameters: real FB versus no FB during endoscopic examination

The patients were categorized into real FB group (i.e., an existing FB found during endoscopy) and no FB group (i.e., no actual FB found during endoscopy; Table 2). As for clinical presentations, the real FB group and no FB group did not significantly differ in lumping sensation over throat or odynophagia. However, the real FB group (59.2%) had a significantly higher incidence of dysphagia compared to the no FB group (29.9%). Regarding neck radiographic findings, the real FB group (72.7%) had a significantly higher incidence of linear opacity (Figure 2A) compared to the no FB group (33.8%). The two groups did not significantly differ in air-column sign (i.e., air column over the upper esophagus, Figure 2B) or soft tissue swelling sign (i.e., the width of the esophagus was larger than half the width of the cervical spine vertebral body at the same level, Figure 2C).

Rigid endoscopy versus flexible endoscopy

One hundred and thirty one patients received REs, while 142 patients received FEs. The RE (5/107; 4.7%) and FE (5/103; 4.8%) did not significantly differ in failure rate. Additionally, the complication rate did not significantly differ between the RE group (5/131; 3.7%) and the FE group (1/142; 0.7%; Table 3).

The door-to-endoscopy time was significantly longer in the RE group (424 minutes, 7 hours) than in the FE group (363 minutes, 6 hours). The duration of the procedure was also significantly longer in the RE group (21 $\pm$ 18 minutes) than in the FE group (9 $\pm$ 6 minutes). Additionally, RE (708 minutes, 11.8 hours) and FE (161 minutes, 2.7 hours) significantly differed in postendoscopic hospital stay.

RE versus FE as a diagnostic tool

Sixty-three patients without FB during endoscopy (RE:24; FE:39) had normal swallowing function without fever,

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Table 1 Comparison of esophageal foreign bodies: adults versus children.

	Adults[a]	Children[a]	p^*
Age (y)	53.8 ± 14.9 (18–86)	5.3 ± 4.0 (1–17)	
RE	105 (43)	26 (89)	<0.01
FE	139 (57)	3 (11)	
Food FB	165 (90)	3 (13)	<0.01
Nonfood FB	18 (10)	23 (97)	
Failure (RE/FE)	9 (5/5)	0	>0.05
Complication (RE/FE)	6 (5/1)	0	>0.05

Data are presented as *n* (%) or mean ± SD.
FB = foreign body; FE = flexible endoscopy; RE = rigid endoscopy.
* Fisher's exact test.
[a] Adults, ≥ 18 years old; children, < 18 years old.

Table 2 Comparison of patients with real esophageal FBs and those without FB during endoscopy.

	Real FB	No FB	p^*
N	206	67	
Lumping sensation over throat	95.6	97	>0.05
Dysphagia	59.2	29.9	<0.001
Neck X-ray (AP/Lat)			
Linear opacity	72.7	33.8	<0.001
Air-column	71.5	63.1	>0.05
Soft tissue swelling	86	73.8	>0.05

Data are presented as %.
FB = foreign body; *N* = case numbers.
* Fisher's exact test.

dysphagia, or persistent odynophagia at the outpatient department 1 week after endoscopy or reconfirmed by telephone 2 months after discharge from hospital (Table 3).

Discussion

Mis-swallowing of FBs is commonly encountered in emergency consultations. The ingested FB type is associated with patient ages and different diet cultures. In this study, children often ingested coins (nonfood FB), while adults often swallowed fish and animal bones accidentally (food FB), which is consistent with other studies of Asian populations.[8] The incidence of esophageal FB in our hospital continuously declined from 200 annually in the 1970s, to 100 annually in the 1980s,[6] and to 60 annually in 2010s, which may be owing to improved patient education, children care, and endoscopic ability in primary and secondary care hospitals. The most frequently impacted site of FB was at the C6 level on neck radiography and 17.9 ± 3.8 cm from the incisors during endoscopy. The location closely matched the inlet of the upper esophagus sphincter over the cricopharyngeal muscle. Patient age ranged widely from 1 year to 86 years. Children between 1 year and 3 years are common victims for many reasons: exploration of the environment through the mouth, lack of molars to chew food properly, inability to distinguish between edible and inedible objects, and are easily distracted while eating.[15] Edentulous adults are also at a high risk of ingesting FBs, including an obstructing food bolus or their dental prosthesis.[1] Degenerated swallowing coordination can also contribute to the cause of elderly victims of esophageal FBs. In this study, children over the age of 1 year were at risk of esophageal FB impaction. Children comprised 12% of all esophageal FB cases, and elderly individuals (≥ 60 years) comprised 33%. The largest proportion of esophageal FB cases were in their middle age years, possibly owing to the diet culture in Taiwan. Most people in Taiwan have a snack,

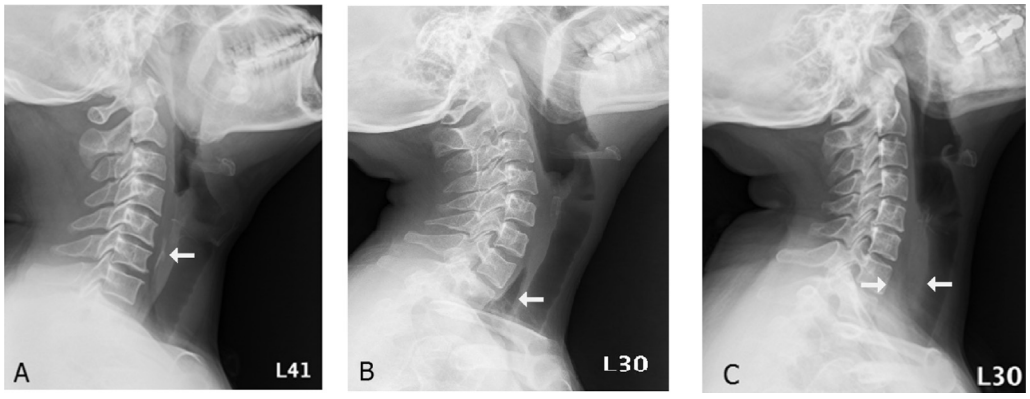

Figure 2 Different signs of esophageal foreign bodies in neck radiography (indicated by arrows). (A) linear opacity; (B) air-column; and (C) soft tissue swelling.

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Table 3 Comparison of rigid endoscopy (RE) and flexible endoscopy (FE) management of esophageal FB.

	RE	FE	*p*
Children, *n*/*N*	26/131 (20)	3/142 (2)	<0.001*
Failure rate	5 (3.8)	5 (3.5)	>0.05*
Major complication	1 (0.7)	0	>0.05*
Minor complication	4 (3)	1 (0.7)	>0.05*
Door-to-endoscopy time (min)	424	363	<0.01**
Procedure time (min)	21 ± 18	9 ± 6	<0.01***
Post-endoscopic hospital stay (min)	708	161	<0.01**
No FB found during endoscopy (*N*)	24	39	>0.05*
False negative rate	1 (0.7)	0	>0.05*
False positive rate	0	0	>0.05*

Data are presented as *n* (%) or mean ± SD unless otherwise indicated.
FB = foreign body; *N* = case numbers.
* Fisher's exact test.
** Mann–Whitney *U* test.
*** Student *t* test.

occasionally accompanied by alcoholic beverages, before going to bed. Chinese soups are normally simmered with animal bones. Under such conditions, individuals easily misswallow food or bones, especially when they are relaxing or drunk.[6] This study revealed that RE is performed more frequently in children than in adults because GA is required for interventional procedures and our ER provides the option of RE under GA or FE under LA mainly. Besides, the different type of foreign bodies (97% nonfood FB in children) might also determine the choice of RE with better wide viewing and easy instrument manipulation. Adults and children did not significantly differ in failure rate or complication rate, which is compatible with the previous study.[16] These findings suggest that either RE or FE is appropriate for both adults and children for removing esophageal FBs in an emergency.

A previous study demonstrated that the immediate onset of symptoms, dysphagia, and the absence of pharynx localization of impaction were predictive of a positive FB finding.[17] Pharyngeal innervation by the vagus and glossopharyngeal nerves provides a better sensation than in the esophagus, which is innervated less densely by the vagus and cervical sympathetic nerves.[18] By contrast, our results demonstrate that dysphagia is an important positive predictor for real existing esophageal FBs while the lumping sensation over throat and odynophagia are not.

Capable of confirming the FB location, size, shape, and number of ingested FBs, biplane radiographs also help to exclude aspirated objects. This study demonstrated that linear opacity in radiography is a better predictor than soft tissue swelling and air-column signs. The passage of FBs, especially sharp objects, generally cause mucosal erosion over the upper aerodigestive tract, leading to symptoms like a lumping sensation over the throat, odynophagia, and signs of soft tissue swelling and air-column at neck radiography, even after the FB has passed into the stomach. This finding explains why dysphagia and linear opacity at neck radiography are more reliable predictors for actual esophageal FBs.

Regarding of the comparison between FE and RE, this study demonstrated 0% false positive rate in both methods and one false negative case in RE (Table 3). Restated, both RE and FE were more effective than imaging studies in terms of diagnosing esophageal FBs in our series. Importantly, the endoscopy allows removal of FBs during examination, which makes it the most reliable diagnostic and therapeutic procedure, and prevents major complications if missing esophageal FBs. Therefore, our results suggest that all patients with dysphagia or linear opacity in neck radiography should receive an endoscopy examination (either RE or FE) directly without delay.

This study also demonstrated that the door-to-endoscopy time, procedure time, and postendoscopic hospital stay were all shorter in FE than in RE. The difference may be contributed to the extra waiting time for an available operating room in RE. The RE procedure lasted longer than the FE procedure,[9] possibly owing to general anesthesia preparation. The patients who received RE under GA required admission at least overnight in our hospital. Therefore, the postendoscopic hospital stays for RE lasted longer than that for FE. In summary, RE had a longer total time-consuming treatment course than FE.

While possibly helpful for proximal FBs impacted at the level of the upper esophageal sphincter or hypopharyngeal region, RE under GA protects the airway safely.[1] Rigid endoscopy could also easily expand the infolding of esophageal mucosa to find entrapped FBs. Flexible endoscopy under conscious sedation with overtubes has a high success rate in recent studies.[1,4,8] Pediatric endoscopy often uses GA and endotracheal intubation to prevent airway obstruction because of smaller and more compliant airways.[1,19] Additionally, pediatric esophageal FBs are often nonfood FBs (e.g., coins), which can cause respiratory symptoms and airway obstruction and require urgent and complete airway protection.[20]

Rigid endoscopy under GA and FE under LA did not significantly differ in the failure rate of FB removal, which is consistent with the results of previous studies.[4,8,9] However, in previous studies,[4,9,21] both LA and GA were used in FE. In this study, FE was performed mainly under LA, which could achieve the same success rate as RE under GA. This finding suggests that FE is a highly promising diagnostic procedure for use by ER units since it usually only requires LA. A previous study revealed a higher complication rate in RE than in FE.[4] In this study, complications occurred in five patients via RE (3.7%, 5/131, including 1 esophageal perforation complicated with empyema, which was confirmed with open surgery and 4 minor complications), and one patient via FE (0.7%, 1/141, minor complication). Complication rates did not significantly differ between RE and FE, probably because our hospital had well-trained otolaryngologists for RE or different FB types (i.e., more food FB than a Western diet culture). Analysis of the failed cases indicates that RE is superior for FB located at the upper esophagus especially lodged over the inlet sphincter, but inferior over the lower esophageal FB, which was vice versa for the FE. Restated, both RE and FE have a high success rate and a low complication rate.

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Previous studies[22] showed risk factors of complications included the duration of impaction (especially > 24 hours or 48 hours), sharp and bony FBs, larger size of FBs (especially > 3 cm), symptoms, advanced age, and impaction at upper esophageal sphincter. Patients with risk factors or signs of esophageal perforation (e.g., neck swelling, erythema, tenderness, or crepitus)[1] should be considered for computed tomography scan before endoscopic examination and prepared for surgery by an external approach. Endoscopic techniques like gentle pressure applied to the center of the food bolus, reduction of bolus size by piecemeal removal, orienting the sharp-pointed object with its point trailing during extraction, by using an overtube or a protector hood in the FE[1] were used to avoid complications. Emergency endoscopies were performed in patients with esophageal food bolus impactions (especially sharp-pointed FBs or animal bones), disk batteries and magnets ingestion, or evidence of complete esophageal obstruction to prevent further esophageal injury. Besides, a proteolytic enzyme, like papain, should never be used because of possible mucosal erosion and esophageal perforation.[1]

Despite its contributions, this study has certain limitations. This study is limited by flaws inherent in a single center with retrospective analysis. The choice of a patient to receive ether RE or FE was not randomized. The doctors who performed RE and FE were randomized, which may have biased their endoscopy experiences.[23] Additionally, FE was not performed under GA regularly. Our hospital was a tertiary referred medical center from primary and secondary care hospitals, explaining why the patient's population was not randomized.

Conclusion

This study has demonstrated that RE and FE are appropriate for esophageal FB removal with high success rates and low complication rates. FE under LA is promising for use in both diagnostic and therapeutic tools, especially for adult esophageal FBs. Furthermore, RE is feasible for children, owing to a more secured airway protection and easy management for nonfood FB.

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