

## Research Article

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# Use of accessory devices in the endoscopic removal of esophageal foreign bodies

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### Abstract

**Background/Aims:** The accessory devices used for esophageal foreign body removal have not been thoroughly investigated. This study investigated the appropriate use of endoscopic accessory devices for removing esophageal foreign bodies.

**Methods:** Patients who underwent endoscopic removal of esophageal foreign bodies were included. Demographic, clinical outcome, and endoscopic data, including the accessory devices used, were collected and analyzed.

**Results:** After exclusion, 175 patients (189 cases) were included in this study. Fish bones were the most common foreign body (n=70, 37.0%), followed by food bolus (n=47, 24.9%), seashell (n=16, 8.5%), and animal bone (n=14, 7.4%). Retrieval forceps were most frequently used for fish bone (95.7%), seashell (87.5%), animal bone (64.3%), and press-through-package (92.3%), while a net was used for food bolus (57.4%), hexagonal stone (50.0%), and dental prosthesis (60.0%). Two or more accessory devices were used in 15 cases (7.9%). Protective devices (transparent cap or overtube) were used in 80 cases (42.3%), and there was a difference in device preference among endoscopists.

**Conclusions:** Various accessory devices are used in esophageal foreign body removal. The choice of an appropriate accessory device according to the foreign body is essential for shorter procedure times, improved safety, and reduced use of unnecessary accessory devices.

### Introduction

Swallowing a foreign body or food impaction in the esophagus is a common problem encountered by emergency department physicians and gastroenterologists [1]. More than 80% of swallowed foreign bodies naturally pass through the gastrointestinal tract without special treatment, but 10–20% require endoscopic removal, and less than 1% require surgery [2-4]. The common sites for foreign bodies in the esophagus are the upper esophageal sphincter, aortic arch, and gastroesophageal junction. According to Asian studies, the most common foreign body in the esophagus is the fish bone. Food bolus, coin, animal bone, metal, toothbrush, and press-through-package (PTP) have also been reported [5-7].

Esophageal foreign bodies are often accompanied by minor adverse events, such as mucosal erosion and hematoma. However, in rare cases, severe adverse events such as esophageal perforation, mediastinitis, paraesophageal abscess, tracheo-esophageal fistula, and aorto-esophageal fistula may occur; in such cases, prompt removal of the foreign body is necessary [4-6]. Endoscopic treatment of esophageal foreign bodies is an effective and safe method with a more than 95% success rate [7-8]. Several accessories are necessary for endoscopic removal, including biopsy forceps, retrieval forceps, snare, net, basket, transparent cap, and overtube. The overtube helps to protect the mucous membrane and maintain the airway, and the transparent cap helps to protect the mucous membrane and secure visibility [9]. Previous studies have reported on the most

frequently used devices for esophageal foreign body removal [5,7,10,11]. However, the analysis of the accessories used concerning the type of foreign bodies is insufficient. The selection of appropriate accessory devices should be based on the type, shape, and size of the esophageal foreign body, as well as the patient's condition. Still, the selection mostly depends on the experience of the endoscopist.

Therefore, in this study, we analyzed the clinical outcomes of patients who underwent endoscopic removal of esophageal foreign bodies and investigated the effective use of accessory devices.

## Patients and methods

### Patients

Between January 1, 2005, and March 31, 2020, patients who underwent endoscopic removal of esophageal foreign bodies at the National Health Insurance Ilsan Hospital were selected. Among the patients, those with stenosis due to malignancies and those under the age of 12 years were excluded. We also excluded patients for whom the type and size of the esophageal foreign body and detailed records of the procedure were unavailable.

### Data collection and analysis

The patient's medical records, including endoscopy results and photographs, were retrospectively reviewed. We evaluated the type and size of the foreign body, location of the foreign body, route to the hospital, whether hospitalization occurred, esophageal comorbidities of the patients, the endoscopist, and time from symptom onset to the hospital visit. The time from hospital visit to endoscopy and the occurrence of complications were investigated. Types of foreign bodies with only one case were classified as 'other'. Adverse events related to the procedure were defined as severe cases if additional treatment (hemostasis or clipping) or hospitalization was required. Erosion of the esophageal mucosa, shallow ulcers, and minor bleeding that did not require hemostasis were not considered adverse events. The accessory devices used to remove foreign bodies were classified as follows: retrieval forceps, snare, net, and basket. The transparent cap and overtube were classified as accessory devices for protecting the esophagus, and their use was confirmed. An accessory device that succeeded in removing foreign body was identified for each foreign body. In addition, when multiple accessory devices were used, we noted which accessory device was ultimately used to remove a foreign body. Endoscopists who performed less than 10 procedures were classified as 'other', and the use of transparent cap and overtube was investigated for each endoscopist.

Categorical data are presented as numbers and percentages. Endoscopy procedure time is expressed as the mean value. The time from symptom onset to a hospital visit and from a hospital visit to endoscopy are expressed as median values. All statistical analyses were performed using SPSS software (version 23.0; IBM Corp., Armonk, NY, United States).

### Ethical statements

The study design was reviewed and approved by the Institutional Review Board of National Health Insurance Service

Ilsan Hospital (NHIMC 2020-03-061). The current study had a retrospective design; therefore, the requirement for obtaining patient informed consent was waived by the board. All experiments and methods were conducted in accordance with the Declaration of Helsinki.

## Results

### Baseline characteristics of the patients

A total of 202 patients underwent endoscopic removal of esophageal foreign bodies between January 1, 2005, and March 31, 2020. Among them, 175 patients (189 cases) were included in this study, excluding those under 12 years of age ( $n=7$ ) and those with incomplete medical records ( $n=15$ ) or stenosis due to malignancies ( $n=5$ ). Eighty-two (46.9%) of the patients were men, and 93 (53.1%) were women (Table 1). The mean age was  $59.33 \pm 16.62$  years, with 29 patients in their 40s (16.6%), 47 patients in their 50s (27.0%), 30 patients in their 60s (17.1%), 34 patients in their 70s (19.4%), and 19 patients (10.8%) in their 80s or older. Concomitant esophageal disease was present in 15 patients. There were esophageal strictures due to corrosive esophagitis in 8 patients, stricture at the surgical anastomosis site in 4 patients, esophageal stricture of unknown cause in 1 patient, esophageal stricture in 1 patient after esophageal varices treatment, and achalasia in 1 patient.

### Clinical features of the patients

Foreign bodies were located in the upper esophagus in 116 cases (61.3%), middle esophagus in 40 cases (21.2%), lower esophagus in 31 cases (16.4%), and entire esophagus in 2 cases (1.1%) (Table 2). Regarding the route of a visit to the hospital, 128 cases (67.7%) came from the emergency center, 56 cases (29.6%) came from the outpatient department, and 5 cases (2.7%) occurred during hospitalization. After endoscopic foreign body removal, hospitalization was required in 49 cases (25.9%), and in 140 cases (74.11%), the patient was discharged home. The median time from symptom onset to hospital visit was 4 hours, and the median time from a hospital visit to endoscopy was 2 hours. The mean procedure time for endoscopic esophageal foreign body removal was 8.5 minutes. Adverse events were pneumomediastinum in 2 cases, deep ulcer in 2 cases, and esophageal mucosal laceration in 1 case. Two cases of pneumomediastinum recovered with conservative treatment without surgery.

### Type and size of foreign body

The types of foreign bodies were fish bone in 70 cases (37.0%), food bolus in 47 cases (24.9%), seashell in 16 cases (8.5%), animal bone in 14 cases (7.4%), and PTP in 13 cases (3.7%) (Table 3). The mean size of the foreign material was 2.56 cm. The mean size of the fish bones was 2.41 cm, the food bolus was 3.64 cm, and the dental prosthesis was the largest at 5.00 cm. The foreign bodies in 7 cases classified as 'other' were rubber packing, guitar pick, button, ring, plastic fragment, toothbrush, and beverage container fragment.

### Successfully used accessory devices for each foreign body type

The most commonly used accessory device for foreign body removal was retrieval forceps ( $n=123$ , 65.1%), followed by net ( $n=42$ , 22.2%), snare ( $n=13$ , 6.9%), and endoscopic push ( $n=10$ ,

5.3%) (Table 4). Regarding the foreign body, 67 of 70 cases (95.7%) of fish bone were successfully removed using retrieval forceps. The net was successfully used in 27 of 47 cases (57.4%) of food bolus, and of these cases, the retrieval forceps were also used in 3 cases. In 8 cases, after removing some part of the food bolus with a net or a snare, the food was pushed into the stomach with an endoscope. Retrieval forceps were used in 87.5%, 64.3%, and 92.3% of cases of seashells, animal bone, and PTP, respectively, while the net was used in 50% and 60% of cases of hexagonal stone and dental prostheses, respectively (Table 4) (Figure 1).

### Use of transparent cap or overtube

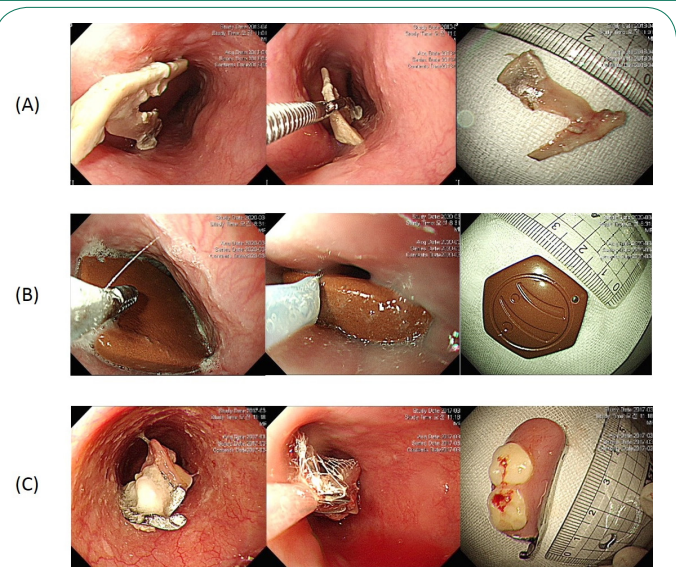
A transparent cap was used in 20 cases (10.6%), and an overtube was used in 60 cases (31.7%), with both being used in a total of 42.3% of cases (Table 4). The percentage of transparent cap or overtube use was 100% for dental prostheses, 68.8% for seashells, 64.3% for animal bones, 60.0% for crab shells, and 47.1% for fish bones (Figure 2). Additionally, the use of a transparent cap or overtube differed among the endoscopists (Table 5). Endoscopist A used the transparent cap and overtube in 2.5% and 52.5% of cases, respectively, whereas endoscopist G used the transparent cap and overtube in 57.1% and 28.6% of cases, respectively. Endoscopist E did not use a transparent cap, and used an overtube in only 13.6% of cases.

### Multiple accessory devices

There were 15 cases (7.9%) of multiple device use because the foreign body could not be removed with the first accessory device. The fish bone was removed with a net in 2 cases where retrieval forceps failed, and in 2 cases where a snare failed, retrieval forceps were successful. Hexagonal stone was successfully removed with a snare and a net, respectively, in 2 cases in which retrieval forceps failed. In one case, after unsuccessful attempts with retrieval forceps and a net, the foreign body was removed with a snare. PTP was successfully removed with a snare and retrieval forceps, respectively, in 2 cases of net failure. Removal of a dental prosthesis was successful with a net in 2 cases of failure with retrieval forceps and a snare, respectively.

**Table 1:** Baseline characteristics of the patients.

	No.	%
Male	82	46.90%
Female	93	53.10%
Age (mean), yeats	59.33 ± 16.62	
Age		
<40	16	9.10%
40-49	29	16.60%
50-59	47	26.90%
60-69	30	17.10%
70-79	34	19.40%
≥80	19	10.80%
Underlying esophageal disease		
E. stricture due to corrosive agents	8	
Stricture of anastomosis	4	
E. stricture (idiopathic)	1	
E. stricture due to previous varix treatment	1	
Achalasia	1	



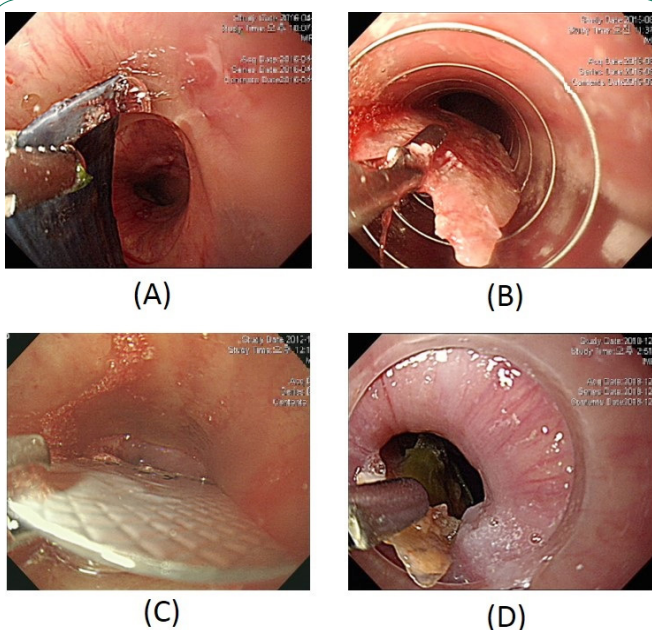
**Figure 1:** Endoscopic removal of esophageal foreign bodies using various accessory devices. (A) A 3 cm sized chicken bone was removed using alligator forceps. (B) Attempts to remove a 3.5 cm sized thick hexagonal stone with alligator forceps failed, but it was successfully removed using snare. (C) A 5 cm sized dental prosthesis was removed using a net.

**Table 2:** Clinical features of foreign body cases.

	No.	%
Location		
Upper esophagus	116	61.3%
Mid esophagus	40	21.2%
Distal esophagus	31	16.4%
Whole esophagus	2	1.1%
Visiting route		
Emergency center	128	67.7%
Outpatient department	56	29.6%
During admission	5	2.7%
Admission after endoscopy		
Admission	49	25.9%
No admission	140	74.1%
Median time from symptom onset to hospital visit, hours	4 (0.5–288)	
Median time from hospital visit to endoscopy, hours	2 (0.5–72)	
Mean endoscopic procedure time	8.52 ± 8.64 (2–60)	
Complications, mins		
Pneumomediastinum	2	
Deep ulceration	2	
Mucosal laceration	1	

**Table 3:** Types and size of foreign bodies.

Types	No.	%	Size (cm)
Fish bone	70	37.0%	2.41 ± 0.08
Food bolus	47	24.9%	3.64 ± 0.47
Seashell	16	8.5%	2.47 ± 1.24
Animal bone	14	7.4%	2.66 ± 0.18
Press-through-package	13	6.9%	2.21 ± 0.16
Hexagonal stone	8	4.2%	3.12 ± 0.13
Crab shell	5	2.6%	1.70 ± 0.34
Dental prosthesis	5	2.6%	5.00 ± 1.31
Coin	2	1.1%	2.50 ± 0.25
Drug tablet	2	1.1%	2.25 ± 0.25
Others	7	3.7%	3.86 ± 3.70
Total	189	100.0%	2.56 ± 1.98



**Figure 2:** Use of an overtube and transparent cap in esophageal foreign body removal. (A) A sharp seashell in the overtube. (B) A pointed fish bone in the overtube. (C) A press-through-package in the overtube. (D) A pointed fish bone in the transparent cap.

### Discussion

In this study, endoscopic removal of esophageal foreign bodies was a safe and effective treatment method. Severe adverse events occurred in 5 of 189 cases, and all patients recovered with conservative treatment. In addition, the effective use of accessory devices was analyzed, and accessory devices that can be tried first for each foreign body are presented. Most fish bones can be removed with retrieval forceps, and in cases of failure, a net or snare can be used. A net is recommended for food bolus, and retrieval forceps can be used for seashells and crab shells. For hexagonal stones and dental prostheses, using the net first is recommended. In this study, a transparent cap or overtube was additionally used in 42.3% of cases, and the rate of transparent cap and overtube use was different for each endoscopist. The use of a transparent cap and overtube was determined by the experience and preference of the endoscopist, and they were used in relatively many procedures.

Few studies have been conducted on endoscopic accessory devices for different esophageal foreign bodies. In a Japanese study, retrieval forceps and transparent caps were used the most (83.3%) for the removal of PTP. Retrieval forceps were used for food impaction in 76.5% of cases. Retrieval forceps and transparent caps were used in 73.9% of the dental prosthesis cases. Retrieval forceps and transparent caps were used in 88.8% of fish bones [10]. In a Chinese study, retrieval forceps were used the most (46.6%), followed by the snare (23.6%) [11]. In Korean studies, retrieval forceps were used in 61.9%-87.3%, and baskets, snare, or nets were used in 19.0% of cases [5,7].

In endoscopic foreign body removal, the choice of an accessory device is mainly determined by the foreign body's type, shape, and size, the endoscopist's experience and preference, and the patient's status [12]. The standard-type biopsy forceps have a narrow grip and are difficult to grip firmly; as such, it is not recommended for foreign body removal [13]. Retrieval forceps, such as alligator forceps and mouse-tooth forceps, have the advantage of holding the foreign body firmly. The net is particularly effective for small and round foreign bodies. A polypectomy snare is also used to remove foreign bodies. The basket developed for gallstone removal is composed of four wires; thus, it is advantageous for removing round-shaped foreign bodies that cannot be removed with snares or retrieval forceps [13].

Sharp foreign bodies include fish bones, seashells, toothpicks, pins, and needles. Retrieval forceps and snares are mainly recommended for removing such foreign bodies, and a basket or net can also be used [9,12]. In this study, 95.7% of fish bones, 87.5% of seashells, and 80.0% of crab shells were successfully removed using retrieval forceps. In 2 cases of fish bones and 1 case of seashells where removal with retrieval forceps failed, removal was successful with a net. An overtube, transparent cap, or hood is recommended to prevent damage to the esophageal mucosa when removing sharp foreign bodies [12]. In this study, overtube or transparent cap was used in 47.1%, 68.8%, and 60.0% of cases for fish bones, seashells, and crab shells, respectively.

Food bolus impaction is the most common cause of esophageal foreign body in Western countries and was the second most common cause in this study. The purpose of treatment is to clean the esophagus and prevent complications by extracting the bolus or moving it to the stomach. Extraction of the food bolus is usually attempted if the food bolus is large or firm. Care should be taken while removing pieces of food bolus from the hypopharynx to avoid aspiration [14]. The accessory devices used for the removal of food bolus include retrieval forceps, snares, nets, and baskets. In this study, the net was predominantly used for food boluses. An overtube can be used when the endoscope is repeatedly inserted to remove pieces of the food bolus or when there is a risk of aspiration [12]. In this study, the overtube was used in 3 cases, the push technique was used in 17 cases, and food was removed with the push technique alone in 9 cases. Several studies have reported using the push technique to move an esophageal food bolus into the stomach [1,15,16]. When removing food boluses with this method, careful observation is required for strictures in the distal portion of the esophagus where the blockage occurred. If there is a stricture, pushing too hard can cause perforation of the esophagus.

Foreign bodies, such as coins or buttons, which are short in length and not sharp, can be removed relatively easily with retrieval forceps or a snare, and a net is effective for foreign bodies about the size of a battery [17]. In this study, coins were

safely removed with retrieval forceps without using a transparent cap or overtube in 2 cases. Some patients in Korea believe that hexagonal stone benefits their health, and some patients in this study swallowed hexagonal stone while holding it in the mouth, causing it to get stuck in the esophagus. A hexagonal stone is thicker than a coin. As such, it is not easy to hold with retrieval forceps. In this study, 4 of 8 cases of hexagonal stones were successfully removed using a net. Therefore, if possible, a net is recommended for removing round foreign bodies thicker than coin, such as hexagonal stone.

Different accessory devices can be used to remove long foreign bodies depending on the shape and characteristics of them. Still, in general, a snare or a net is used primarily. In this study, 5 dental prostheses were removed endoscopically. The mean size of the dental prostheses was 5 cm. In 3 cases, the prosthesis was removed with a net. In two of these cases, removal was successful with a net after unsuccessful attempts with retrieval forceps or a snare. In all 5 cases, a transparent cap or an overtube was also used.

PTP has a sharp tip, and there is a risk of damage to the esophageal mucosa during the removal procedure. Sugawa *et al.* recommended that an overtube or hood be used together, with removal by a net [4]. However, in a retrospective study by Kamiya *et al.*, 83.3% of PTPs were safely removed using a transparent cap and retrieval forceps [10]. To capture a foreign body, a net needs some space because the net needs to be unfolded to capture the foreign body. Because retrieval forceps can retrieve foreign bodies even in a narrow space, PTP removal with retrieval forceps is considered efficient.

An overtube is the most common indication for endoscopic esophageal foreign body removal. The advantages of the overtube are that it prevents damage to the esophageal mucosa during sharp foreign body removal, reduces the risk of aspiration by protecting the airway, and enables repeated endoscope insertion and foreign body removal when there is a large amount of esophageal foreign body [18]. The transparent cap widens the narrow space allowing foreign bodies to be checked, and it helps to secure a wider treatment space. In addition, it is possible to prevent damage to the esophagus by placing the tip of a sharp foreign body inside the cap to avoid direct contact with the esophageal mucosa when removing the foreign body. In a randomized controlled study, Zhang *et al.* reported that a transparent cap reduced the procedure time and helped to secure the field of vision during the removal of a foreign body from the upper esophagus [19].

The clinical significance of this study is as follows. Our study showed the protective accessory devices used to remove various foreign bodies. In addition, the accessory devices used for the removal of different foreign bodies were described in detail. Thus, this study demonstrated the first attempted device and the device that ultimately achieved the successful removal of the foreign body. All endoscopists had sufficient experience; fellows were not included in this study. Endoscopists A, B, C, and E rarely used transparent cap and preferred the overtube; endoscopist A, who performed the most procedures, preferred the overtube and used it in 52.5% of cases. Endoscopists D and F used a transparent cap and overtube in a similar ratio. Endoscopist G had a high preference for the transparent cap, and 57.1% of them used the transparent cap. Studies on the frequency of transparent cap and overtube use in endoscopic esophageal foreign body removal are limited to date. Park *et al.* reported that an overtube was used in 9.4% of cases [7]. In this study,

10.6% of the transparent caps and 31.7% of the overtubes were used. We considered it meaningful to report the difference in the frequency of use and preference between endoscopists. In 15 cases, the removal of the foreign bodies with the first accessory device failed, and they were removed using another accessory device. In other words, depending on the foreign body's size and shape and the patient's condition, there were cases where several accessory devices had to be tried. Therefore, the accessory device should be carefully determined according to the size and shape of the foreign body, the status of the patients, and the endoscopist's experience, and efforts to minimize the use of multiple accessory devices are required.

### Limitations

There are several limitations to the present study. First, this study was limited by its retrospective cross-sectional and single-center design; thus, the results of our study should be interpreted with caution. Second, the accessory device was determined according to the endoscopist's experience. Moreover, the accessory devices provided in the endoscopy room of our institution are different from those available in other institutions. Therefore, there is a limitation to the generalizability of our results. However, for each foreign body, even the accessory devices in the case of failure are presented in detail, and the accessory devices that were successfully used are shown.

### Conclusion

In conclusion, endoscopic removal of an esophageal foreign body is a safe and effective treatment. There are various types of foreign bodies, and this study suggests accessory devices that can be preferentially used for each type of foreign body. Transparent cap or overtube was used relatively frequently, and there was a difference in preference between endoscopists. The choice of an appropriate endoscopic accessory device according to the type and shape of the foreign body is essential for shorter procedure times, improved safety, and reduced use of unnecessary accessory devices.

### Declarations

**Conflicts of interest:** All authors have no conflicts of interest or financial ties to disclose.

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**Author contributions:** Conceptualization: HHJ, BKP; Data curation: BKP; Formal analysis: YKL, JHS; Funding acquisition: BKP; Investigation: JWC, SYW, YSC; Methodology: HHJ, BKP; Project administration: BKP; Supervision: SYW, YSC, JHS; Writing-original draft: HHJ; Writing-review & editing: all authors.

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