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Comparison of Endoscopy Alone with Surgery Converted from Endoscopy for the Removal of Esophageal Foreign Bodies in Adults: A Retrospective Study from a Single Center

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Data Interpretation D

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Background: The impaction of an esophageal foreign body is an urgent situation requiring emergency intervention. This retrospective study from a single center in China aimed to compare endoscopy alone with surgery converted from endoscopy for the removal of esophageal foreign bodies in adults.

Material/Methods: A total of 252 patients with esophageal foreign bodies were divided into 3 groups based on the treatment received: endoscopy, surgery converted from endoscopy, or surgery only. Patients' clinical and demographic data were retrospectively reviewed and analyzed.

Results: The diameter of the foreign bodies in patients treated by surgery converted from endoscopy was larger than that of those treated by simple endoscopy (5.2 cm vs 2.7 cm, $P=0.0003$). The cervical or upper thoracic esophagus was the most common site of foreign body impaction treated by surgery converted from endoscopy, while the foreign bodies removed by simple endoscopy were frequently lodged at the middle thoracic esophagus ($P=0.021$). Bone-related foreign bodies and dentures were most likely impacted in patients treated with surgery converted from endoscopy. The factors influencing the choice of treatment included foreign body maximal diameter and location.

Conclusions: Larger foreign bodies that were found in the cervical or upper thoracic esophagus were associated with failed endoscopic removal and required surgical removal. Irregularly shaped or sharp foreign bodies, including dentures and fishbones, required surgical removal. These findings may guide future decisions of first-line approaches for the removal of esophageal foreign bodies.

Keywords: **Emergencies • Endoscopy, Digestive System • Esophageal Diseases • Prognosis • Thoracic Surgery**

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Background

Treatment of an esophageal foreign body (FB) impaction is an urgent situation requiring interdisciplinary cooperation. Approximately 80% to 90% of esophageal FBs spontaneously pass and do not need treatment, while an estimated 10% to 20% are removed endoscopically and less than 1% require surgery [1]. An impacted esophageal FB can cause severe complications if not removed in a timely manner [2]. FB removal by surgery and endoscopy are standard. The choice of an optimal treatment should avoid overtreatment (surgical removal when endoscopy is considered to be effective) and undertreatment (enforced endoscopic removal when surgery is a better choice). The optimal treatment should benefit the patients without adding financial burden. The factors reported to be associated with the choice of treatment include the location of the esophageal FB, interval between ingestion and treatment, and complications [3]. This study from a single medical center aims to further identify the factors influencing the choice of optimal treatment for an esophageal FB.

Material and Methods

Patients

This study was approved by the Ethics Committee of our institution (approval No. 99400112) and was conducted in accordance with the principles of the Declaration of Helsinki. Patients gave written informed consent after receiving a detailed explanation of the procedures by researchers. The cohort of this retrospective case-control study included 252 adult patients with esophageal FBs who were treated in our single medical center from January 2008 to January 2018 and who met the following inclusive criteria: (1) age ≥ 18 years; (2) admitted as an inpatient; (3) radiological examination confirming esophageal FB; and (4) a history of accidental FB ingestion. Flexible endoscopy was used at first to remove the esophageal FBs because it was the least invasive procedure. If the

endoscopic removal failed, surgery was performed. In certain circumstances, surgery was prioritized: (1) abscess formation in neck or mediastinum causing severely systemic infection and requiring emergency drainage and (2) occurrence of an esophago-tracheal fistula (ETF) or esophago-aortic fistula (EAF). Of the 252 patients, 63 (25%) underwent surgery, while 189 (75%) were treated endoscopically. Of the 63 patients treated by surgery, 29 were treated with surgery directly and 34 patients were treated by surgery as a conversion from a failed endoscopic removal.

Therapeutic Efficacy and Prognosis

The treatment strategies of esophageal FBs are listed in **Table 1**. Therapeutic outcome was categorized into curation and death. Patients who met the following 3 criteria were considered as curation: (1) normal vital signs; (2) normal oral feeding; and (3) no contrast medium outflow of the esophagus found by esophagography after treatment. Of the 252 patients in this study, 246 patients (97.6%) achieved curation, while all 6 patients (2.4%) treated by surgery died during the perioperative period because of severe infection or hemorrhage.

Statistical Analysis

All statistical analyses were conducted using IBM SPSS for Windows, version 19.0 (IBM Corporation, Armonk, NY, USA). The Wilcoxon nonparametric rank-sum test and quartile statistics were used to compare the differences in age, length of hospital stay, interval between ingestion and treatment, maximal FB diameter, and cost of the patients treated by endoscopy and surgery converted from endoscopy. Analysis of variance was used to compare differences in the sex ratio, FB location, and prognosis. Univariate and multivariate regression analysis were used to identify the factors influencing the choice of treatment. Normally distributed data were presented as the mean \pm standard deviation and non-normally distributed data were presented as the median. A *P* value of <0.05 was considered statistically significant.

Table 1. The treatment strategies for patients with esophageal foreign bodies.

Endoscopy (n=189)	Surgery converted from endoscopy (n=34)	Surgery (n=29)
Retrieval forceps (n=153)	Cervical FBs removal (n=7)	Cervical FBs removal plus abscess drainage (n=7)
Stone retrieval basket (n=9)	Thoracic FBs removal (n=27)	Thoracic FBs removal plus abscess drainage (n=19)
Biopsy forceps (n=9)		Thoracic FBs removal (n=1)
Retrieval forceps plus stone retrieval basket (n=3)		Thoracic FBs removal plus ETF repairing (n=1)
Others (n=15)		Thoracic FBs removal plus EAF repairing (n=1)

FBs – foreign bodies; ETF – esophago-tracheal fistula; EAF – esophago-aortic fistula.

Table 2. Comparison of demographic and clinical data of patients with esophageal foreign bodies treated by endoscopy and surgery converted from endoscopy.

	Endoscopy (n=189)		Surgery converted from endoscopy (n=34)		Z/ χ^2	p
Interval between ingestion and treatment (h)	24	(20, 96)	28	(17, 72)	-0.142 (Z)	0.943
Age (years)	58	(43, 76)	65	(34, 73)	-0.233 (Z)	0.772
Maximal diameter (cm)	2.7	(2, 3)	5.2	(4.2, 7.3)	-4.332 (Z)	0.0003
Hospital stay after treatment (days)	3	(2,6)	8.2	(7, 12)	-3.429 (Z)	0.0017
Cost (1,000 USD)	1.31	(0.80, 3.28)	6.42	(5.02, 12.3)	-5.392 (Z)	0.000
Sex						
Male	102		17		2.289 (χ^2)	0.067
Female	87		17			
FB location						
Cervical	42		14		9.234 (χ^2)	0.021
Upper thorax	45		14			
Middle thorax	75		6			
Lower thorax	27		0			
Complications						
Yes	84		16		2.113 (χ^2)	0.087
No	105		18			
Therapeutic efficacy						
Cured	189		34		–	–
Death	0		0			

FBs – foreign bodies.

Results

Demographic and Clinical Data of Patients with Esophageal FBs

Of the 252 patients included for analysis, 153 were men and 99 were women. The average patient age was 59.1 ± 18.0 years (range, 19-94 years). The average maximal diameter of the FBs was 3.0 ± 1.6 cm (range, 1-11 cm). The average interval between ingestion and treatment was 80.7 ± 99.2 h (range, 3-720 h). The average length of hospital stay after treatment was 6.4 ± 5.6 days (range, 1-14 days). The average cost of treatment was 5003.72 ± 5839.87 USD (range, 90.85-24107.77 USD).

Of the 252 patients, 63 had impacted FBs in the cervical esophagus, 65 in the upper thoracic esophagus, 95 in the middle thoracic esophagus, and 29 in the lower thoracic esophagus. The symptoms caused by FB impaction included dysphagia in

114 patients, chest pain in 102 patients, sore throat in 77 patients, abdominal pain in 15 patients, cough in 18 patients, fever in 12 patients, hematemesis in 3 patients, and hemoptysis in 3 patients. The types of FBs were bone-related FBs in 180 patients, date stones in 33 patients, food bolus in 15 patients, dentures in 9 patients, a stick in 6 patients, a blade in 3 patients, a ring in 3 patients, and a coin in 3 patients.

The complications caused by FBs were EMF in 84 patients, ECF in 27 patients, pulmonary infection in 6 patients, emphysema in 5 patients, pulmonary laceration in 2 patients, ETF in 1 patient, aortic hematoma in 1 patient, respiratory failure in 1 patient, laryngeal edema in 1 patient, and EAF in 1 patient. Of the 84 patients with an EMF, 19 (22.6%) developed an abscess. Seven (21.2%) of 33 patients with an ECF developed an abscess. The patients with an abscess or aortic hematoma formation and with ETF or EAF were treated by emergency surgery.

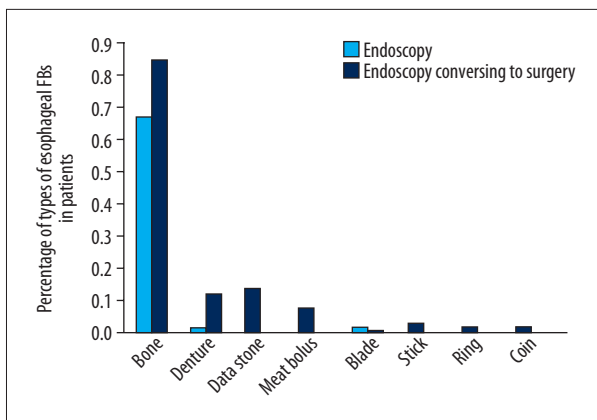


Figure 1. Comparison of esophageal foreign body types in patients treated by endoscopy and surgery converted from endoscopy.

Comparison of Demographic and Clinical Data of Patients Treated by Endoscopy vs Surgery Converted from Endoscopy

The demographic and clinical data of the patients treated by endoscopy or surgery converted from endoscopy are shown in **Table 2**. The median maximal diameter of FBs in patients treated by surgery converted from endoscopy was larger than that of those treated by simple endoscopy (5.2 cm vs 2.7 cm, $P=0.0003$). The location of cervical or upper thoracic esophagus was the most common site of FB impaction treated by surgery converted from endoscopy, while the FBs removed by simple endoscopy were frequently impacted at the middle thoracic esophagus; the difference in treatment by location was statistically significant ($P=0.021$). There was no difference in the interval between ingestion and treatment between the patients treated by simple endoscopy and surgery converted from endoscopy ($P=0.943$).

Comparison of FB Types, Symptoms, and Complications of Patients Treated by Endoscopy and Surgery Converted from Endoscopy

Bone-related FBs were the most likely type of impaction in patients treated with endoscopy or surgery converted from endoscopy, and impacted dentures were common in patients treated by surgery converted from endoscopy (**Figure 1**). In this cohort, the partial dentures removed by surgery converted from endoscopy usually had a sharp edge or barb, which would cause an iatrogenic injury with enforced endoscopic manipulation. The bone-related FBs removed by surgery converted from endoscopy also had a close association with the aorta, which was more likely to cause EAF or aortic hematoma with enforced endoscopic manipulation.

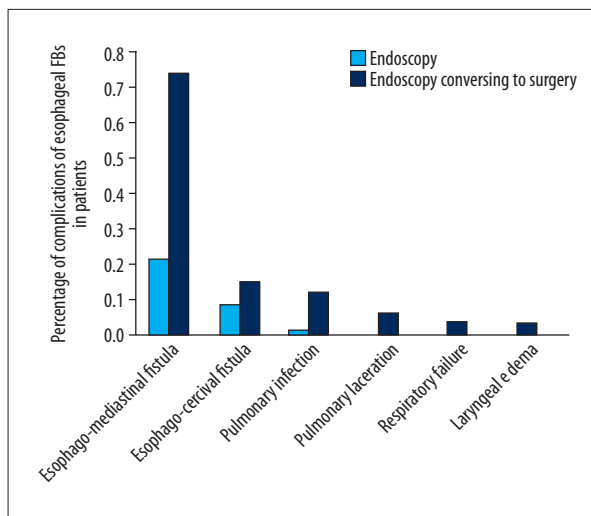


Figure 2. Comparison of esophageal foreign body-related symptoms in patients treated by endoscopy and surgery converted from endoscopy.

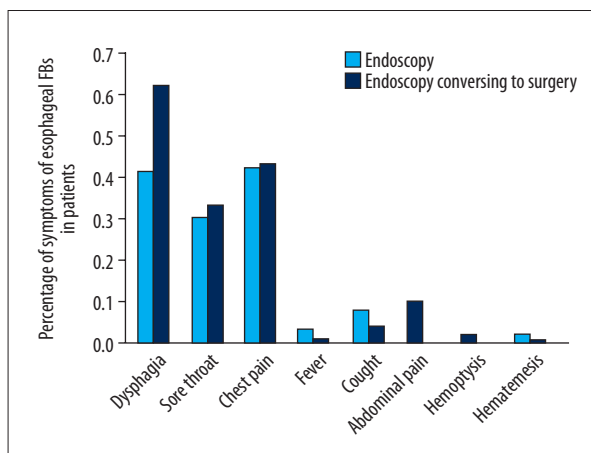


Figure 3. Comparison of esophageal foreign body-related complications in patients treated by endoscopy and surgery converted from endoscopy.

There was a higher incidence of EMF/ECF in patients treated by surgery converted from endoscopy than in those treated by simple endoscopy. In addition, FB-related symptoms, such as pulmonary infection, pulmonary laceration, laryngeal edema, and respiratory failure, were more common in patients treated by surgery converted from endoscopy (**Figure 2**). Symptoms of dysphagia, sore throat, and chest pain were the most frequent symptoms of the patients treated by endoscopy or surgery converted from endoscopy (**Figure 3**). However, the symptoms were nonspecific.

Factors Influencing the Choice of Treatment for Esophageal FBs

According to the results of univariate analysis, the factors influencing the choice of treatment between simple endoscopy

Table 3. Factors influencing the choice of treatments for patients with esophageal foreign bodies, based on univariate analysis.

	Endoscopy (n=189)		Surgery converted from endoscopy (n=34)		Z/ χ^2	p
Age (years)	58	(43, 76)	56	(34, 73)	-0.233 (Z)	0.772
Maximal diameter (cm)	2.7	(2,3)	5.2	(4.2,7.3)	-4.332 (Z)	0.0003
Hospital stay after treatment (days)						
Sex	102		17		2.289 (χ^2)	0.067
Male	87		17			
Female						
FB location	42		14		9.234 (χ^2)	0.021
Cervical	45		14			
Upper thorax	75		6			
Middle thorax	27		0			
Lower thorax						
Complications	84		16		2.113 (χ^2)	0.087
Yes	105		18			
No						

FBs – foreign bodies.

and surgery converted from endoscopy included the FB's maximal diameter and location. The larger FBs, especially with a diameter >5 cm, impacting at the cervical or upper thoracic esophagus were most likely to have been removed by surgery. The FBs with sharp edges or barbs and those lodged adjacent to the aorta were most likely to have been treated by surgery once the endoscopic removal failed (Table 3). However, none of these factors were significant, according to the results of multivariate analysis. Also, the interval between ingestion and treatment was not an independent factor determining treatment.

Discussion

In this cohort, the maximal diameter and location of the FBs were closely associated with the choice of treatment. The results of this study demonstrated a larger (diameter >5 cm) FB lodged in the cervical or upper thoracic esophagus was associated with a greater likelihood of surgery after failed endoscopic treatment. In addition, FBs with sharp edges, barbs, or pleomorphism, such as fishbones or partial dentures, or those that were adjacent to the aorta were inappropriate to remove by endoscopy and required surgery. Also, patients with a cervical or mediastinal abscess or ETF/EAF required emergency surgery. The impaction of an esophageal FB is considered an emergency situation. In some circumstances, surgical removal of a FB is necessary owing to the failure of endoscopic

removal. Enforced endoscopic manipulation can aggravate iatrogenic injury and increase medical consumption. Thus, it is recommended that the optimal choice of treatment for esophageal FBs is made to achieve the best possible prognosis at the lowest patient expenditure.

The esophagus has 3 physiological constrictions, namely at the levels of the cricopharyngeal muscle/upper esophageal sphincter, lower esophageal sphincter, and aortic arch/left main bronchus [4]. Esophageal FB impaction usually occurs at the level of hypopharynx or upper thoracic esophagus because of anatomical (cricopharyngeus muscle or aortic arch) and physiological reasons (low pressure zone at the transition point between striated and smooth muscles fibers) [5,6]. In the present cohort, the larger FBs were most likely to become impacted at the cervical or upper thoracic esophagus, which necessitated surgery after failed endoscopic removal. Previous studies also demonstrated that the cervical or upper thoracic esophagus was most prone to impaction by FBs. Ruan and Lu found that nearly half of the FBs that induced suspected esophago-aortic injury were lodged in the upper thoracic esophagus, which were subsequently treated by surgery [7]. FBs from dentures and fishbones with sharp edges and pleomorphisms are easily impacted at the cervical or upper thoracic esophagus. Interestingly, some of these FBs were removed by surgery because of their proximity to major vasculatures or because of the formation of esophageal diverticulum [8-11].

The esophagus adjacent to major vasculatures, including the aortic arch, is another common site of FB impaction [12], which might cause esophago-vessel injury, namely EAF or aortic hematoma. Surgery is considered in such circumstances because of the greater risk for iatrogenic injury that occurs by enforced endoscopic treatment. Ebrahim et al reported a metallic brush bristle that was lodged at the esophagus adjacent to the aortic arch and had to be removed by surgery [13]. Lee et al reported a man with direct injury to the azygos vein and a subclavian artery pseudoaneurysm due to a fishbone penetration at the upper esophagus that required treatment by surgical manipulation [14].

In the present study, the types and shapes of FBs were also closely associated with the choice of treatment. Bone-related FBs and dentures were most likely to be removed by surgery directly or by surgery following failed endoscopic treatment. The food bolus is reportedly the most common type of FB in Western countries [15], while there is a higher risk of bone-related FB impaction in Asian countries [16]. Bone-related FBs, especially fishbones, are prone to be lodged at the esophagus adjacent to major vasculatures. Lee et al reported an impacted fishbone at the upper esophagus that caused a direct injury of a patient's lung and vessels, which required treatment by minimally invasive surgery [14]. Schneider et al also reported a fishbone stuck tightly at the cervical esophagus that required removed by transcervical surgery, as it was proximal to the major vasculatures of the patient's head and neck [11]. In addition, partial dentures with sharp points or barbs are also likely to cause complications, such as EMF or esophageal diverticulum, requiring surgical treatment [8]. The shape of FBs also contributes to the choice of treatment. It has been suggested that FBs with 2 or 3 pressure points are easily impacted in the esophagus. Researchers reported that spindle-shaped FBs with 2 pressure points are closely correlated with a significantly higher risk of EMF and severe complications requiring surgery [10,17].

Some severe complications, such as ETF or EAF, caused by esophageal FB impaction are rare but life-threatening. In such urgent circumstances, emergency surgery is required within a short period [18-20]. Yanagihara et al reported treating a case of ETF from an impacted FB by a primary repair of the bronchial and esophageal walls, which achieved a good prognosis [21]. Wei et al reported that 3 of 6 patients with EAF who underwent open surgery died of severe hemorrhage within 24 h after surgery [22]. Zeng et al reported that thoracic endovascular aortic repair led to the survival of patients with EAF, with a good prognosis [23]. Wei et al found that endovascular stent implantation is an effective, safe, and minimally invasive treatment for FB-induced vascularis injury [22].

As a retrospective and single-center research, this study had several limitations: (1) the sample size was small; (2) the data were reviewed retrospectively; and (3) the included patients in this cohort were from a single medical center, which is not representative of patients throughout the region. Considering the above limitations, a prospective study with multicenter participation and a larger patient sample is needed in the future.

Conclusions

This retrospective study from a single center in China showed that larger FBs that were found in the cervical or upper thoracic esophagus were associated with failed endoscopic removal and required surgical removal. Irregularly shaped and sharp FBs, including dentures and fishbones, required surgical removal. These findings can be used to guide clinicians in determining the best first-line approaches for the removal of esophageal FBs.

Acknowledgments

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Conflict of Interest

None.

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