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Original Article

ORIGINAL ARTICLE

Evaluation of the risk factors for severe complications and surgery of intestinal foreign bodies in adults: a single-center experience with 180 cases

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Abstract

Background Foreign bodies (FBs) lodged in the intestine or causing intestinal complications are uncommon in clinical practice but may pose diagnostic difficulties and prove life-threatening. This study aimed to evaluate the risk factors for severe complications and surgery to aid clinicians in the diagnosis and management of intestinal FBs.

Methods We performed a retrospective analysis of patients in whom FBs were lodged in the intestine or caused complications from 2010 to 2020 in the First Affiliated Hospital of Wenzhou Medical University (Zhejiang, China). The characteristics of the patients and FBs, symptoms, imaging findings, diagnostics, treatment strategies, and clinical outcomes were analysed. Furthermore, the risk factors for complications and surgery were investigated.

Results In total, 180 patients were included in our study. Most patients (76.1%) were unable to provide a history of ingestion. Bezoars were the most common FBs (35.6%). The FBs were mainly located in the duodenum (32.8%) and the ileum (27.8%). Surgical removal of FBs was successful in 89 (49.4%) patients and endoscopic removal in 54 (30.0%) patients. Eleven with

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perforations were treated conservatively. FBs located in the jejunum or ileum were more likely to cause severe complications than those located in the duodenum. FBs located in the jejunum, ileum, or sigmoid colon were more likely to undergo surgery, and severe complications were an independent risk factor for surgery.

Conclusion Intestinal FBs, often localized in angulation, are likely to be misdiagnosed because most patients do not provide a history of FB ingestion. Surgery and endoscopic therapy are the most commonly used treatment modalities. Surgery is not mandatory in clinically stable patients with small and contained perforations. FBs located in the jejunum or ileum are risk factors for both complications and surgery.

Key words: complication; foreign body; intestine; risk factor; surgery

Introduction

Foreign bodies (FBs) in the whole gastrointestinal (GI) tract, including the stomach, are encountered commonly in clinical practice worldwide [1, 2]. In addition to rare instances, such as per-anal introduction, FBs are mainly ingested. Most cases of FB ingestion occur in the pediatric population [3]. True FB ingestion in adults occurs more commonly in the elderly population, patients with psychiatric and/or cognitive disorders or abuse of alcohol and drugs [4], and prisoners seeking to evade legal sanction [1].

Most ingested FBs (80%–90%) pass through the digestive tract spontaneously. However, ~10%–20% of cases require endoscopic intervention, while <1% of cases require surgery for FB extraction or treatment of complications [3, 5, 6]. Although the mortality rates caused by FBs have been extremely low [3], FBs present in the GI tract can cause life-threatening complications, such as perforation, GI bleeding and/or fistula formation [7–10]. The accurate diagnosis and timely management of these patients remain challenging because the symptoms caused by FBs are variable [11] and most patients are unable to remember ingesting FBs. In addition, FBs are often misdiagnosed by imaging techniques [2, 7]. The esophagus is a common site of the impaction of FBs [12] and most FBs that enter the stomach can pass through the entire GI tract uneventfully [13]. Therefore, although FBs throughout the GI tract are common, FBs in the intestine are quite rare [13, 14] and there are few reports of such cases. To better understand the natural history of intestinal FBs in adults, evaluate the risk factors for severe complications and surgery, and, thus, potentially improve diagnosis and treatment, we retrospectively summarized the clinical characteristics and treatment of intestinal FBs in 180 patients over the last 10 years.

Methods

Patients

We retrospectively evaluated 180 patients diagnosed with intestinal FBs who visited the First Affiliated Hospital of Wenzhou Medical University (Zhejiang, China) between 24 July 2010 and 15 May 2020. The inclusion criteria were as follows: (i) patients with intestinal FBs diagnosed by radiology, endoscopy, or surgery; (ii) FBs lodged in the intestine or causing intestinal complications; (iii) FBs that migrated to the intestine from adjacent non-digestive tracts, such as the uterus; and (iv) an age ≥18 years. The exclusion criteria were as follows: (i) patients with intestinal obstruction caused by stool or diseases, such as tumors; (ii) FBs that passed through the GI tract uneventfully without any intervention; (iii) FBs that were inserted through the anus; and (iv) FBs that were inserted through the abdominal wall directly.

Data collection

The data were retrospectively extracted and analysed through the electronic medical records database of our hospital. The epidemiological and clinical characteristics were collected. In addition, the diagnostic modality, therapeutic interventions, and outcome were recorded. The patients were followed up for 1 year or until 31 October 2020 (if the follow-up was <1 year). The follow-up information was obtained by telephone. The computed tomography (CT) images of all patients who underwent CT scans were evaluated by two abdominal imaging experts.

The time to presentation was defined as the time between ingestion (or implantation) of FBs and admission to our hospital. The diagnostic modality was defined as the first examination that indicated FBs. The length of the FBs was the maximum diameter. If the patient had multiple FBs, it was the maximum diameter of the FB that was impacted or caused complications. The location of FBs was defined as the position where FBs impacted or the position of the complication if the FB passed through the GI tract. Severe complications included intestinal obstruction, intestinal perforation, ulceration, abscess, and hemorrhage, while mucosal injury was not included. Conservative treatment has been defined as close observation with medical treatment but without endoscopic intervention or surgery [4]. The surgical indications for the patients in this study included intestinal obstruction, perforation, abscess, sharp FBs located in an area that an endoscope could not reach, or blunt FBs with retention for more than 1 week outside the reach of an endoscope.

This study conformed to the standards of the Declaration of Helsinki and current ethical guidelines. The study was approved by the ethics committee of the First Affiliated Hospital of Wenzhou Medical University (approval number R059). Written informed consent for participation in this study was not obtained from the patients because this study was not a clinical trial and the data were retrospectively analysed.

Statistical analysis

The statistical analysis was performed using IBM SPSS statistical software (version 19.0). The data are presented as the mean ± standard deviation (SD) or median and range values for numerical variables with parametric and nonparametric distributions, respectively, and as numbers (percentage) for categorical variables. The χ^2 test was performed to identify the factors that affected the occurrence of complications or surgery. A multivariate analysis was performed using a logistic regression model. A two-sided P-value of <0.05 was considered statistically significant.

Results

Basic characteristics

In total, 195 consecutive patients with intestinal FBs were admitted to our hospital between 24 July 2010 and 15 May 2020. Among them, 180 patients with a total of 181 times of admission (one patient had two times of hospitalization) were enrolled in the study (Figure 1). Most patients (137 of 180, 76.1%) were unable to provide the FB ingestion or implantation history before the examination (Table 1). Of these, four patients could recall ingestion after the diagnosis. Therefore, in total, 47 patients could provide the interval between ingestion/implantation and the presentation for treatment. The causes for FBs entering the intestine were as follows: 76 patients (42.2%) swallowed the FBs accidentally; bezoar formation was the second cause (64 of 180, 35.6%), followed by conscious swallowing (such as cores or bones); and the other causes included iatrogenic factors, such as the migration of intrauterine contraceptive devices (IUDs) and drug addiction (Figure 2A). Regarding the comorbidities, 14 patients (7.8%) had GI disease, such as Crohn's disease. The detailed data are shown in Table 1.

Characteristics of FBs

The most common type of FB was bezoars (64 of 180, 35.6%), followed by jujube pits (32 of 180, 17.8%) and animal bones (28 of 180, 15.6%) (Figure 2B). The other characteristics of the FBs are shown in Table 1. The duodenum was the most common location of FBs, followed by the ileum. The detailed localization data are shown in Figure 2C.

Clinical manifestations

The clinical manifestations of FBs vary according to their length, shape, location, and complications caused by the FBs. The common symptoms included abdominal pain, vomiting, nausea, abdominal distension, and evacuation difficulty. Seventy (38.9%) patients showed abdominal tenderness and 35 (19.4%) patients showed tenderness with rebound tenderness during the physical examination. Intestinal obstruction and perforation were the most common complications. The detailed information is shown in Table 1.

Diagnostic modality

In total, 102 (56.7%) patients were primarily diagnosed with intestinal FBs by a CT scan, 48 (26.7%) patients were diagnosed by endoscopy, 3 (1.7%) patients were diagnosed by X-ray, and 1 (0.6%) patient was diagnosed by ultrasound. The remaining 26 patients (14.4%) were not diagnosed with FBs until surgery. Of the 139 patients who underwent abdominal CT scans, only 102 patients had a diagnosis of FBs. In fact, 25 cases were found to be missed in a second detailed review. Among these 25 patients, 20 (80%) had bezoars. The other imaging tests included X-ray and ultrasound. The diagnostic sensitivity of these tests is shown in Table 2. Representative images of FBs are shown in Figure 3.

Treatment

The removal of intestinal FBs was achieved by surgery in 89 (49.4%) cases and endoscopy in 54 (30.0%) cases. In addition, the FBs were pushed forward by gastroscopy and then excreted out of the body in five (2.8%) cases. Thirty-two (17.8%) patients received conservative therapy. Of the 89 patients who underwent surgery, 79 cases underwent laparotomy (41 enterotomy, 10 enterectomy, 9 perforation repair, and 13 enterostomy; the remaining patients underwent surgery as follows: the FB in 1 patient was pushed from the duodenum to the stomach and then gastrotomy was performed; the FBs of 3 patients were crushed, pushed forward, and then extracted; 2 patients with FBs located at the duodenal bulb underwent distal subtotal

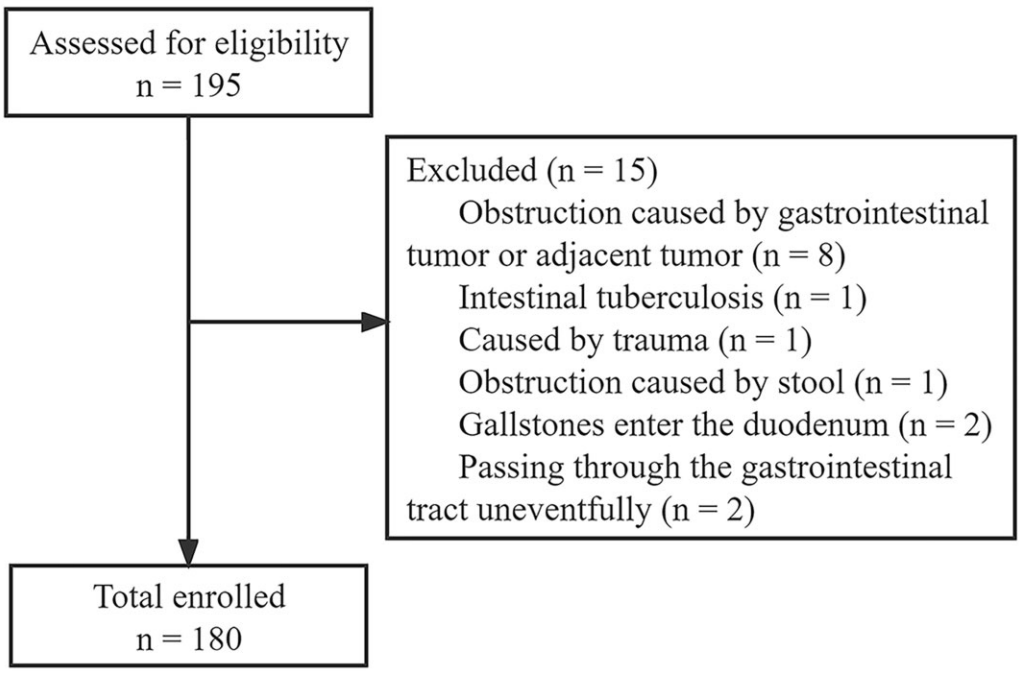

Figure 1. The flow diagram of the study.

Table 1. Characteristics of the patients and foreign bodies

Characteristic	Value
Age, years, mean ± SD	58.1 ± 18.3
Male, *n* (%)	104 (57.8)
FB recall before examination, *n* (%)	43 (23.9)
Time to presentation, days, median (range)	2.0 (0.1–730)
Type of patients, *n* (%)	
Inpatient	132 (73.3)
Outpatient	48 (26.7)
Co-morbidities, *n* (%)	
Hypertension	33 (18.3)
Diabetes	15 (8.3)
GI disease	14 (7.8)
Mental disorder	4 (2.2)
Abdominal surgery history, *n* (%)	33 (18.3)
Length of FBs, cm, mean ± SD	3.5 ± 2.5
Numbers of FBs in GI tract, *n* (%)	
Single	149 (82.8)
Multiple	31 (17.2)
Sharp FBs, *n* (%)	99 (55.0)
Therapy, *n* (%)	
Surgery	89 (49.4)
Endoscopy	54 (30.0)
Conservative therapy	32 (17.8)
Entering large intestine during endoscopy	5 (2.8)
LOS, days, mean ± SD	15.3 ± 10.7
Symptoms, *n* (%)	
Abdominal pain	124 (68.9)
Vomiting	66 (36.7)
Nausea	62 (34.4)
Abdominal distension	51 (28.3)
Reduce or stop defecation	43 (23.9)
Fever	13 (7.2)
Abdominal discomfort	12 (6.7)
Hemorrhage	11 (6.1)
Diarrhea	8 (4.4)
No symptom	30 (16.7)
Physical examination, *n* (%)	
Tenderness	70 (38.9)
Tenderness and rebound tenderness	35 (19.4)
No positive sign	75 (41.7)
Severe complications, *n* (%)	
Obstruction	69 (38.3)
Perforation	56 (31.1)
Ulcer	12 (6.7)
Abscess	7 (3.9)
Hemorrhage	4 (2.2)
Granuloma	3 (1.7)
Intussusceptions	1 (0.6)
Perianal infection	1 (0.6)

FB, foreign body; GI, gastrointestinal; LOS, length of stay; SD, standard deviation.

gastrectomy); and laparoscopy was successful in 9 patients (4 enterotomy, 2 enterectomy, 2 perforation repair, and 1 enterostomy). Moreover, one patient underwent hysteroscopy to remove a migrated IUD. Among the 54 patients with intestinal FBs extracted by endoscopy, foreign body forceps and biopsy forceps were the most commonly used instruments, followed by other instruments, including a basket and snare. Thirty-two patients received conservative therapy because of relatively mild symptoms and physical signs or refusal to undergo surgery. Among them, 11 patients presented with intestinal perforation, 7 patients presented with obstruction, 3 patients presented with peptic ulcers, and 2 patients presented with intestinal bleeding. Short-term fasting and intravenous nutrition were applied. The selection of treatment for different sites is shown in Figure 4.

Clinical outcome and follow-up

The intestinal FBs were successfully removed in all patients who underwent surgery. Of the 66 patients who underwent attempted removal of FBs by endoscopy, 12 failed; of these patients, 5 subsequently received surgery and 7 received conservative therapy. Among the 32 patients who received conservative therapy, the FBs of 18 patients were excreted within 1 year; the bezoar in 1 patient was dissolved and disappeared by traditional Chinese medicine; the FB in 1 patient still existed at 1 year but without any discomfort; and the remaining 12 patients were lost to follow-up. The clinical symptoms disappeared in all patients when they left the hospital, except for two patients with failed attempts to remove the FBs by endoscopy who refused further treatment and were subsequently lost to follow-up. No patients died.

Risk factors for severe complications and surgery

As shown in Table 3, the χ^2 test demonstrated that age, sharpness, and location of FBs were associated with complications (factors with $P < 0.05$ were incorporated in the logistic regression analysis). Then, the logistic regression model further identified that FBs located in the jejunum or ileum were more prone to complications than those in the duodenum. In addition, age, length, numbers, and location of FBs, hypertension, and complications were associated with the need for surgery in the χ^2 test. Then, the logistic regression analysis further identified that patients with FBs located in the jejunum, ileum, or sigmoid colon were more prone to surgery than those with FBs in the duodenum, and complications were another independent risk factor for surgery (Table 4).

Discussion

FBs in the whole GI tract are common, but FBs lodged in the intestine appear to be an uncommon event; the published articles concerning this topic have mostly been case reports [14–20]. We conducted this study to provide a systematic analysis of the etiology, characteristics, clinical manifestation, diagnosis, and clinical management of intestinal FBs. Furthermore, we aimed to explore the risk factors for severe complications and surgery.

In our study, half (50.5%) of the patients were aged ≥60 years. The entry of FBs into the intestines was usually unintentional and, therefore, neglected by the patients. Jujube pits and animal bones were the most common FBs if bezoars were excluded. These results are similar to those of previous studies [2, 5]. Wang *et al.* [21] reported that the terminal ileum and duodenum were typical sites where toothpicks became lodged. Anderson *et al.* [13] reported that the most common impaction point of intestinal FBs was the ileocecal valve. These conclusions are partly consistent with our study, which showed that FBs were usually located in angled regions, such as the duodenum, ileum, and sigmoid colon.

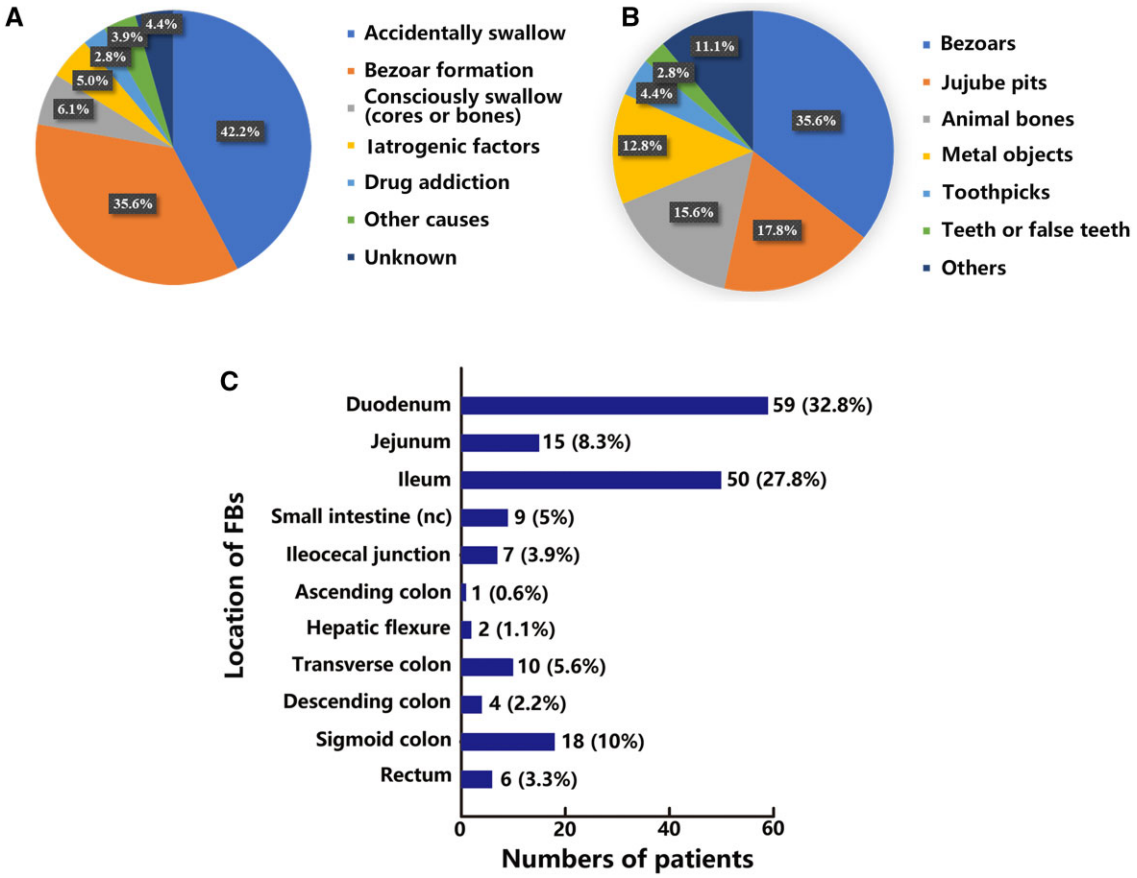

Figure 2. Characteristics of intestinal foreign bodies (FBs). (A) Causes of FBs entering the intestine; (B) types of FBs; (C) locations of FBs. nc, not clear.

Table 2. Sensitivity of imaging techniques in detecting intestinal foreign bodies

Imaging techniques	Number of examinations	Correct diagnosis	Sensitivity
Computed tomography	139	102	73.4%
Ultrasound	25	4	16.0%
X-ray	43	12	27.9%

In our study, more than half of the patients were primarily diagnosed with intestinal FBs by CT. It has been reported in numerous reports that CT is the most reliable modality for detecting FBs [1, 22–24]. CT imaging can not only localize FBs in the whole GI tract but also diagnose complications [24–27]. As shown in Table 2, the diagnostic sensitivity of X-ray or ultrasound was much lower than that of CT. Therefore, we suggest that abdominal and pelvic CT be performed first, unless the patients have contraindications. However, the sensitivity of CT scans in detecting intestinal FBs was only 73.4% (102 of 139) in our study, which was much lower than previous data. The low sensitivity was due to many FBs, especially bezoars, being misdiagnosed in our study.

If a CT scan detects FBs lodged in the proximal duodenum (from the duodenal bulb to the descending duodenum) or the large intestine, endoscopy should be the next diagnostic step. Endoscopy appears to be an effective technique to identify and remove FBs located in the proximal or distal GI tract [24]. As endoscopy allows the removal of FBs immediately after detection, a report of the ingestion of toothpicks suggested that early gastroscopy should be the first diagnostic step to avoid perforation or migration [24]. In our opinion, we recommend CT as the first choice regardless of the FB because CT can describe the size, shape, number, and location of FBs in the whole GI tract in a short time, which could help us make a better decision for the next step. Meanwhile, we should shorten the interval between the CT examination and the next treatment to avoid delayed therapy.

In our study, bezoars accounted for 35.6% (64 of 180) of the patients. Among the 48 patients who underwent abdominal and pelvic CT, only 50.0% were diagnosed with bezoars. Of special interest, when reviewing the CT scans of these 48 patients, FBs could be detected in 91.7% (44 of 48). Bezoars are conglomerates of indigested foreign material that accumulate in the GI tract [28]. Bezoars are commonly found in the stomach, but sometimes they move into the small intestine or can be primarily formed in the small intestine [17, 23]. The most common type of bezoar is the phytobezoar, which consists of indigestible food residue [17]. On CT scans, they vary in density and the mottled gas density can be observed [29–31]. Therefore, many cases of bezoars were misdiagnosed in our study possibly because of the radiologists' insufficient knowledge of bezoars, and sometimes it was difficult to distinguish bezoars from feces [32].

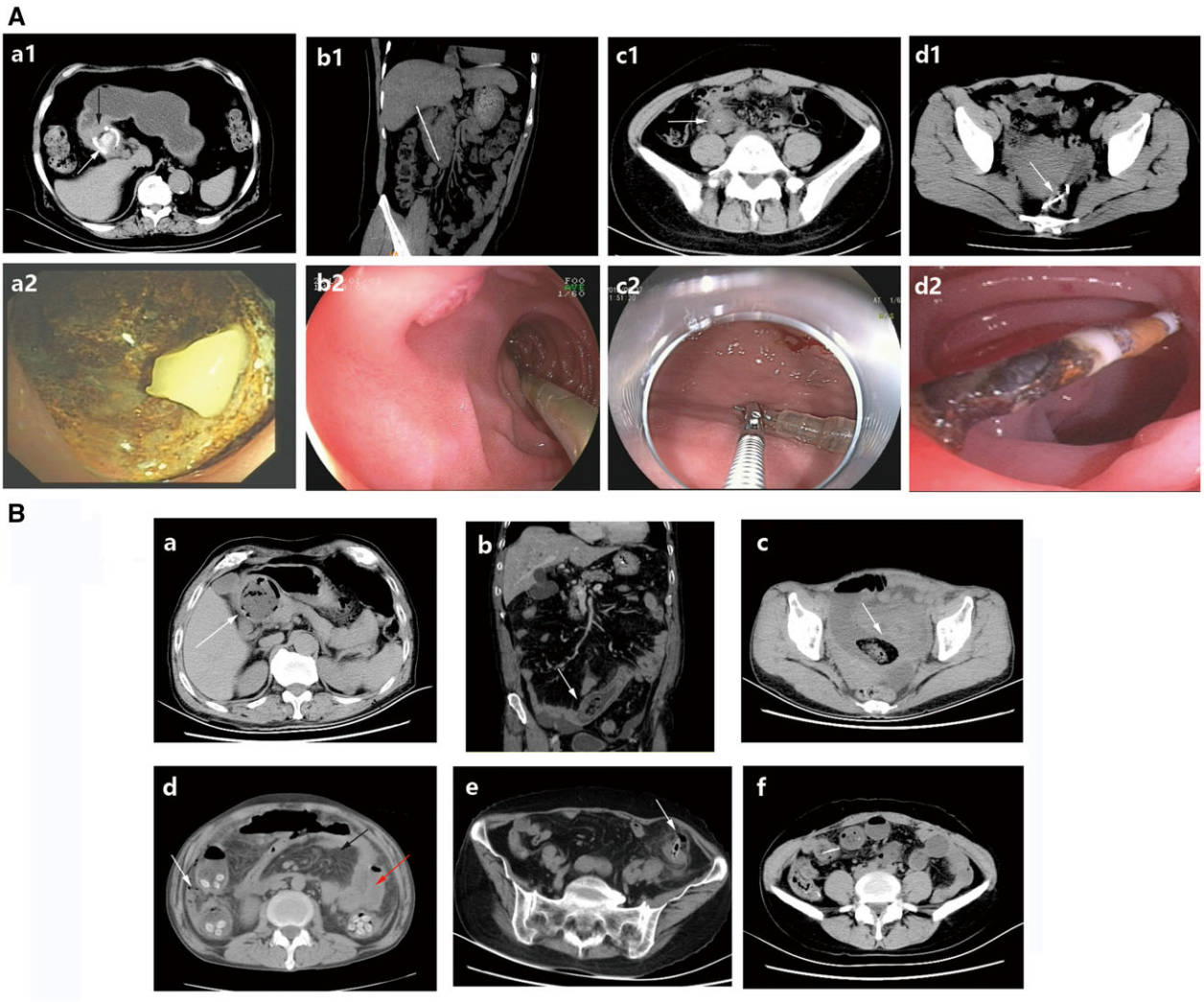

Figure 3. Representative images of intestinal foreign bodies. (Aa1) Representative CT image of an 81-year-old female (Patient 9) with a bezoar (white arrow) located in the duodenum that was initially misdiagnosed as gastric cancer because of gastric wall thickening (black arrow). (Aa2) Endoscopic image of Patient 9. (Ab1) Representative coronal CT image of a 35-year-old male (Patient 4) with a cartridge penetrating the duodenum and causing liver abscess. (Ab2) Endoscopic image of Patient 4. (Ac1) Representative CT image of a 32-year-old female (Patient 151) with a cartridge (white arrow) lodged in the duodenum causing duodenal prolapse. (Ac2) The cartridge was removed from Patient 151 by foreign body forceps. (Ad1) Representative CT image of a 46-year-old female (Patient 134) with an intrauterine contraceptive device (white arrow) migrated to the rectum. (Ad2) Endoscopic image of Patient 134. (Ba–c) Intraluminal round or irregularly shaped bezoars and mottled gas patterns are detected in the small intestine. Wall thickening due to inflammation is observed at the obstruction site. (Bd) Perforation and obstruction of the descending colon caused by swallowing large amounts of waxberry cores. Free gas (white arrow), peritoneal inflammation (black arrow), and wall thickening (red arrow) are observed. (Be) Perforation of the sigmoid colon caused by jujube pit; free gas can be observed (white arrow). (Bf) Perforation caused by duck bone.

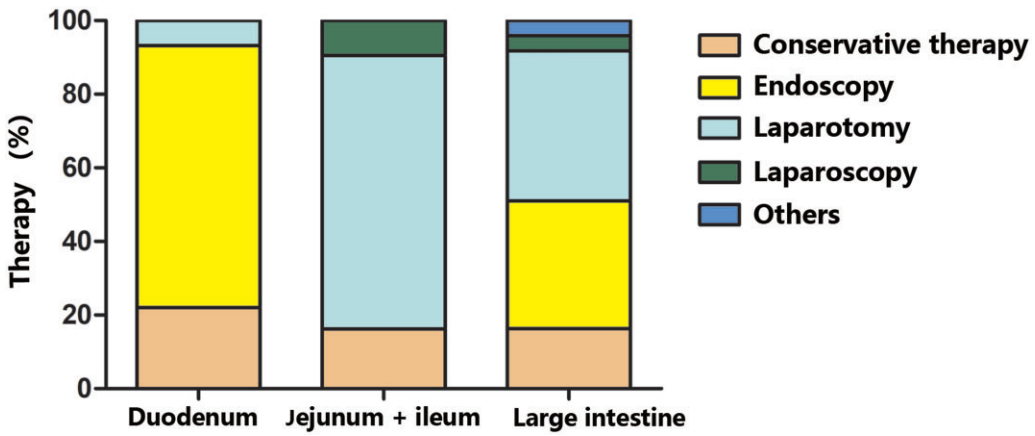

Figure 4. Treatment options based on the localization of foreign bodies.

Table 3. Correlation between the occurrence of complications and clinical characteristics

Characteristic	No. of patients	Complication	*P*	Logistic regression model	
				Odds ratio (95% CI)	*P*
Gender			0.927		
Male	104	76			
Female	76	56			
Age, years			0.005		
<60	89	57		Reference	
≥60	91	75		1.013 (0.991–1.036)	0.248
Length of FBs, cm			0.271		
<3	89	62			
≥3	91	70			
Sharp or not			0.010		
No	81	67		Reference	
Yes	99	65		0.516 (0.216–1.231)	0.136
Numbers of FBs			0.145		
Single	149	106			
Multiple	31	26			
Location of FBs			<0.001		
Duodenum	59	36		Reference	
Jejunum	15	14		8.711 (1.027–73.883)	0.047
Ileum	50	48		13.258 (2.858–61.499)	0.001
Sigmoid colon	18	15		3.580 (0.816–15.705)	0.091
Others	38	19		0.949 (0.390–2.310)	0.909
Hypertension			0.433		
No	147	106			
Yes	33	26			
Diabetes			0.360		
No	165	119			
Yes	15	13			
Abdominal surgery or GI disease			0.143		
No	136	96			
Yes	44	36			

CI, confidence interval; FB, foreign body; GI, gastrointestinal.

Asymptomatic patients with small and blunt FBs can be observed and followed up with serial radiographs [33, 34]. Objects larger than 2–2.5 cm in diameter might not pass through the ileocecal valve and objects longer than 5–6 cm might have difficulty passing through the tight curve of the duodenum [3, 5, 13, 35–37]. In addition, sharp FBs have a higher risk of perforation and migration to adjacent organs. For patients with such FBs, endoscopy should be performed as soon as possible to avoid serious complications [13, 38]. Various instruments can be selected according to the size and shape of the FBs. Based on our study, foreign body forceps were the most commonly used. Even patients with perforation or migration to adjacent organs could be treated by the endoscopic removal of FBs and then managed by conservative treatment [18, 39–41]. In our study, five patients with perforation received the above treatment and recovered. If sharp FBs without complications are out of reach of endoscopy, conservative treatment can be successful, but abdominal radiography should be taken at a 6- to 8-h interval and vital signs should be monitored [42, 43]. Whether or not surgery is necessary when FBs cause perforation is still controversial. In our study, 11 patients with perforation were cured by conservative therapy. However, we still suggest that surgery be considered early to prevent secondary injury caused by FBs.

As reported in previous articles, an indication for surgery exists in cases of perforation or complications that cannot be resolved endoscopically [5, 6]. Surgery should also be considered for objects located distal to the duodenum but in the same place for >1 week. For sharp-pointed objects, the recommended observation time is 3 days [3]. In our study, 40 patients with simple intestinal obstruction underwent surgery. Among them, only four underwent laparoscopic surgery. In addition, 40 patients with perforation underwent surgery; of these, 5 patients underwent laparoscopic surgery. Numerous articles have reported that laparoscopy is useful for abdominal exploration [24, 38, 44, 45]. Furthermore, Laforgia *et al.* [46] showed that the complication rates of laparoscopy and open surgery were similar, but the former showed a shorter post-operative hospital stay, decreased post-operative pain, and better integrity of the abdominal wall. Unfortunately, the proportion of patients undergoing laparoscopy was quite low in our study (9 of 89, 10.1%), which should be improved. As mentioned in the results section, FBs located in the jejunum or ileum were more prone to causing complications and patients with FBs located in the jejunum, ileum, or sigmoid colon were at a higher risk of surgery (these conclusions were all based on using the duodenum as a reference). This may be because they are angled regions and FBs located in these sites are less likely to move forward and more likely to cause complications. Therefore, these patients deserve special attention.

Table 4. Correlation between the surgery and clinical characteristics

Characteristic	No. of patients	Surgery	P	Logistic regression model	
				Odds ratio (95% CI)	P
Gender			0.668		
Male	104	50			
Female	76	39			
Age, years			0.001		
<60	89	33		Reference	
≥60	91	56		1.018 (0.990–1.047)	0.218
FB recall before examination			0.429		
No	137	70			
Yes	43	19			
Length of FBs, cm			0.003		
<3	89	34		Reference	
≥3	91	55		1.882 (0.706–5.016)	0.206
Numbers of FBs			0.008		
Single	149	67		Reference	
Multiple	31	22		2.188 (0.567–8.444)	0.256
Sharp or not			0.075		
No	81	46			
Yes	99	43			
Location of FBs			<0.001		
Duodenum	59	4		Reference	
Jejunum	15	14		145.487 (13.394–1,580.297)	<0.001
Ileum	50	46		159.911 (28.955–883.156)	<0.001
Sigmoid colon	18	12		30.636 (5.865–160.039)	<0.001
Others	38	13		12.843 (3.099–53.228)	<0.001
Hypertension			0.010		
No	147	66		Reference	
Yes	33	23		1.037 (0.254–4.235)	0.960
Diabetes			0.053		
No	165	78			
Yes	15	11			
Abdominal surgery or GI disease			0.666		
No	136	66			
Yes	44	23			
Complications			<0.001		
No	34	7		Reference	
Yes	146	82		4.539 (1.450–14.206)	0.009
Diagnose before endoscopy/surgery			0.164		
No	74	32			
Yes	106	57			

CI, confidence interval; FB, foreign body; GI, gastrointestinal.

Some experts have claimed that surgical removal might be inevitable for intestinal obstruction caused by bezoars [17, 47, 48]. In fact, several reports have described the effectiveness of administering Coca-Cola or traditional Chinese medicine to dissolve phytobezoars [49–52]. Chemical dissolution alone or in conjunction with endoscopy may be successful in the treatment of bezoars. Even if bezoars cause an obstruction, surgery is not invariably necessary. In our study, one patient with intestinal obstruction caused by bezoar was treated by fasting, gastrointestinal decompression, and traditional Chinese medicine administered through a stomach tube. Gastroscopy confirmed that the bezoar decreased and disappeared altogether after 3 weeks. Based on the analysis above, a simple algorithm for the management of intestinal FBs was developed (Figure 5).

There are several limitations of this study. First, as this was a retrospective study, selection and/or recall bias may exist. Second, during the 10-year time span of this study, the diagnostic and therapeutic modalities dramatically changed. Third, some information was incomplete. For example, some patients could not recall the FB ingestion or implantation history such that the data of the interval between ingestion/implantation and the presentation for treatment were incomplete; some patients were lost to follow-up and whether the FBs were discharged from the body is unknown. Finally, the present results may not be generalizable to patients in other countries.

In conclusion, abdominal and pelvic CT should be the first choice for diagnosis. Endoscopy is the most appropriate first-line management for removing FBs if they are located at the proximal or distal GI tract. When complications caused by FBs occur, surgery might not be mandatory in clinically stable patients. In addition, patients with FBs located in angled regions need more attention.

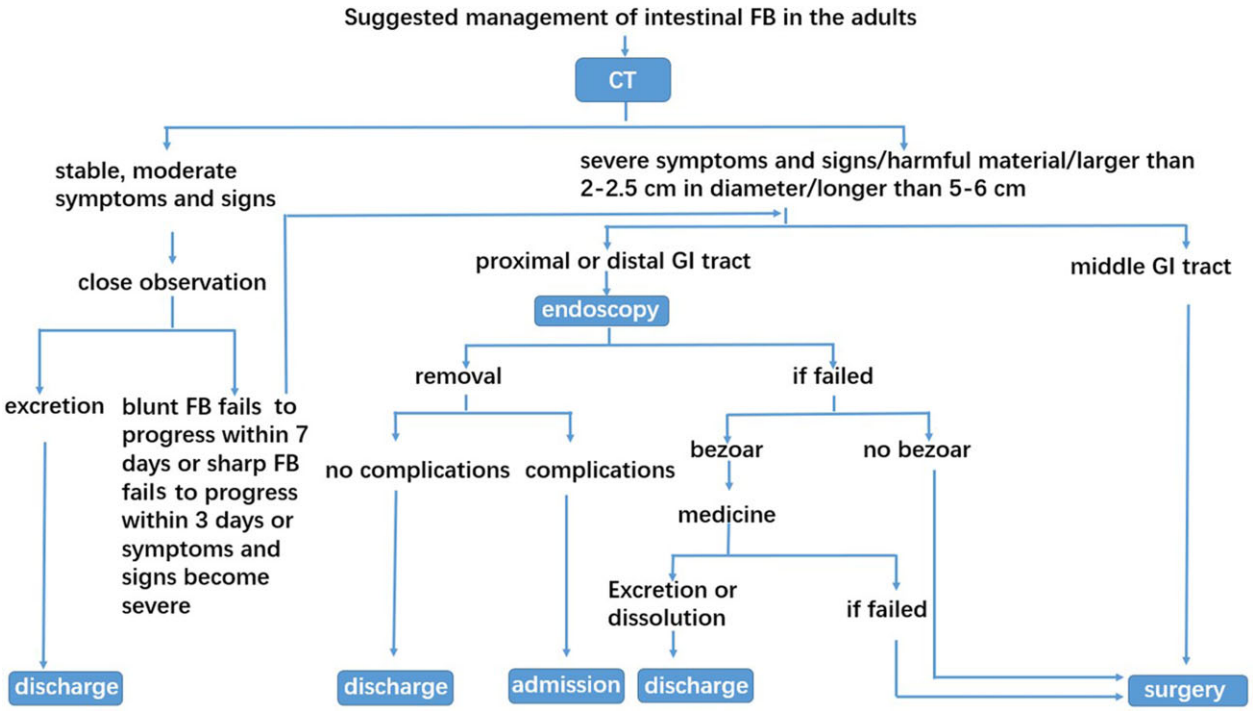

Figure 5. Diagnostic and therapeutic algorithm. FB, foreign body; GI, gastrointestinal.

Authors' Contributions

T.H., J.Z., Y.L., and W.H. contributed to the conception and design; T.H., L.C., and C.W. contributed to the data acquisition and curation; T.H., W.W., Q.H., and X.S. contributed to the data analysis. J.Z., S.S., M.Z., and V.Z. contributed to the methodology. T.H. and Y.L. contributed to the draft-writing preparation. S.S., M.Z., V.Z., Z.B., and W.H. contributed to the writing-review and editing. All authors read and approved the final version of the manuscript.

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Conflict of Interest

None declared.

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