

Epidemiology of Pediatric Foreign Body Ingestions Amidst the Coronavirus 2019 Pandemic at a Tertiary Care Children's Hospital

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ABSTRACT

Objectives: The coronavirus disease (COVID) 2019 pandemic and resultant stay-at-home orders altered caregivers' responsibilities and children's daily environments. We aimed to compare the epidemiology and morbidity of foreign body ingestions (FBIs) during the COVID pandemic and the prior year.

Methods: We performed a retrospective review of children cared for at our tertiary care children's hospital for FBI from March to July 2019 (pre-COVID) and March to July 2020 (COVID). Cases were identified via a search of all diagnoses of foreign bodies (FBs) in the alimentary tract. Charts were reviewed to determine the types of FBs ingested and the patients' clinical courses.

Results: A total of 71 encounters were identified. Thirty ingestions occurred in the pre-COVID cohort and 42 in the COVID cohort. One patient ingested 2 different FBs. There was a significantly higher rate of FBIs per day in May 2020 (COVID) compared with May 2019 (pre-COVID; 0.387 versus 0.161; $P = 0.046$). The median age at presentation was not significantly different between the two groups (pre-COVID, 63.8 months; COVID, 62.5 months; $P = 0.78$). FBs were located in the esophagus less frequently in the COVID cohort than in the pre-COVID cohort ($P < 0.01$). Endoscopies were less frequently performed in the COVID cohort (52.4% versus 70.0%; odds ratio, 0.47; 95% CI, 0.15–1.40).

Conclusions: The frequency of FBIs trended higher in the COVID cohort, with significantly more FBIs in May 2020 when compared with May 2019. Patients in the COVID cohort more frequently had FBs located beyond the esophagus, indicating later presentation and a lesser need for urgent endoscopic removal.

Key Words: foreign bodies, pediatric endoscopy, children, COVID

INTRODUCTION

Foreign body ingestion (FBI) by children is a serious public health problem. In 2018, the American Association of Poison Control Centers reported 77977 calls related to FBIs in children (1). Young

What Is Known

- Foreign body ingestion (FBI) by children is common, with a risk of subsequent morbidity and mortality.
- The coronavirus disease (COVID) 2019 pandemic caused changes in caregivers' responsibilities and children's environments.

What Is New

- The overall frequency of FBIs trended higher during the early months of the COVID pandemic, with a significantly higher rate of FBIs during May 2020 of the pandemic.
- Endoscopies were less frequently performed for FBIs during the early months of the COVID pandemic.

children are especially at risk, due to their developmental stage and proclivity for exploring their surroundings orally (2). Twenty percent of children between the ages of one and three have ingested a foreign body (FB) (3). FBIs are not a new occurrence in children, but the FBI rate in children less than six years of age increased by 91.5% between 2005 and 2015 (2). Children less than six years of age most frequently ingest coins (61.7%), toys (10.3%), jewelry (7.0%), and batteries (6.8%) (2). Most FBs pass through the digestive system spontaneously and without causing harm. However, in recent years, studies have demonstrated increased morbidity and mortality among children ingesting FBs (4,5).

Certain FBs like button batteries and small rare-earth magnets (SREMs) can cause injury to the gastrointestinal tract, including enteroenteric fistulas, bowel necrosis, perforation, and strictures (4,6–8). External factors, like alterations in the manufacturing and availability of lithium button batteries and SREMs, have altered the epidemiology, morbidity, and mortality of FBIs (9).

The coronavirus disease (COVID) 2019 pandemic may have also altered the landscape of pediatric FBIs. Early evidence suggests that children experienced changes to home injury patterns during the COVID pandemic (10–15). Caregivers needed to balance personal life responsibilities, work, and raising children. Additionally, some caregivers undertook a primary role in education (16–18). These major changes in caregivers' responsibilities and children's daily environments may have served as a risk factor for increased FBI by children. Few studies have focused on FBI during the COVID pandemic (15,19), and there are no available studies on FBI in similar public health emergencies and postdisaster periods. We, therefore, aimed to characterize the epidemiology and morbidity of FBIs during the COVID pandemic compared with the prior year at our children's hospital, a tertiary referral center.

METHODS

Patient Selection

We performed a retrospective review of all emergency department (ED) visits, inpatient admissions, and outpatient endoscopies

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at our institution between March 5, 2019, and July 31, 2019, and between March 5, 2020, and July 31, 2020, for the diagnosis of FBI. The *International Classification of Diseases, Tenth Revision*, codes corresponding to FBs in the alimentary tract (T18.x), except for FBs in the anus and rectum, were utilized for case inclusion. The majority of FBs in the anus and rectum are introduced from the anus and not from oral ingestion (and thus not within the scope of this study).

The Monroe Carrell Jr. Children's Hospital at Vanderbilt in Nashville, Tennessee, is a tertiary care center, serving as a referral center for all pediatric subspecialties and a local hospital for children residing in the surrounding neighborhoods. All patients younger than 18 years of age were included in the query.

We defined March 5, 2020, through July 31, 2020, as the COVID cohort, as March 5, 2020, was the date of Tennessee's first confirmed COVID case (20). We compared ingestions in the COVID cohort to those within the same date range in 2019. We also reported the frequency of FBIs during the months preceding the COVID era. The pre-COVID cohort was defined as March 5, 2019, through July 31, 2019, for more direct comparisons with data from the following year.

Patient Variables and Outcomes

Patient charts were reviewed to identify patients who met the criteria of suspected or confirmed FBI based on parental report, diagnostic imaging, or endoscopy report. For ambiguous cases, where ingestion was not observed and not identified on imaging, a senior author reviewed the case to determine if the clinical history was consistent with FBI. If a child ingested multiple FBs on the same day, this was coded as a single ingestion. FBIs were coded as unique ingestions if a child presented having ingested multiple types of objects on different days per clinical history or presented on different dates with confirmed unique ingestions.

Data were collected on patient demographic characteristics, type and number of FBs ingested, FB location based on imaging, patient disposition, procedures or operations required, and complications. Patients with an admission order for the sole reason of endoscopic removal were not classified as admitted. Inpatient encounters included patients with new FBIs during admission or previously unrecognized FBIs. Patients who had a confirmed outpatient FBI that required removal were recorded as endoscopy suite encounters. These patients did not go through the ED.

FB object type was classified as (1) coins, (2) sharp objects, (3) multiple magnets, (4) button batteries, (5) screws, and (6) other. Categories were determined based on a combination of frequency and clinical relevance. Location of FB in the gastrointestinal tract was categorized as (1) esophagus, (2) stomach, (3) post-pyloric, or (4) not identified by radiographic imaging. The category of post-pyloric included FBs that were located distal to the stomach. An independent review of images was completed in cases of uncertainty from the clinical record.

Statistical Analysis

Statistical analyses were performed using STATA, version 16.1 (StataCorp LLC, College Station, TX). A P value <0.05 was considered statistically significant. The Vanderbilt University Medical Center Institutional Review Board approved the study.

Continuous variables were reported as medians and 25th to 75th quartiles. Categorical variables were reported as frequencies and percentages. Age was examined as both a continuous and categorical variable and was divided into age groups consistent with those reported by the American Association of Poison Control Centers (<1 , 1–5, 6–12, and 13–17 years). The Kruskal-Wallis test was used to compare continuous variables between the groups of patients. Between-group comparisons of patient characteristics were

performed using the chi-square or Fisher's exact test if values were equal to or less than 5. The two-sample test of proportions was used for within-group comparisons. The level of statistical significance was set at 0.05, and all P values were two sided.

Ingestion frequency was reported as both a crude number and per month days to allow for adequate comparison between the COVID and pre-COVID cohorts. These proportions were compared using the two-sample test of proportions.

RESULTS

Patient Demographics and Clinical Characteristics

A total of 71 encounters for FBIs were examined. Thirty FBIs occurred in the pre-COVID cohort and 42 in the COVID cohort (Table 1). One patient in the COVID cohort ingested two types of FBs. As the patient had ingested these FBs at different times, these were counted as two separate ingestions. In the five months before the COVID-19 pandemic (October 2019 to February 2020), there were 43 FBIs (See Supplemental Digital Content Table 1, <http://links.lww.com/PG9/A67>)—a total consistent with the number of FBIs during the COVID cohort. The remaining discussion herein centers on the results from the pre-COVID and COVID cohorts to allow for month-to-month comparisons.

Demographic data and baseline characteristics of patients in both cohorts (pre-COVID and COVID) did not differ significantly (Table 1). The median age at presentation was not significantly different between the two groups, with patients 1–5 years of age in each cohort most often having ingested FBs (pre-COVID, 53.3% versus COVID, 54.8%; $P = 0.90$). Males more frequently ingested FBs ($P = 0.03$). There was no difference in rates of ingestion by males between the two time periods (pre-COVID, 63.3%; COVID, 61.9%; $P = 0.90$). Multiple magnet ingestions occurred only in males during COVID ($n = 4$); in the pre-COVID cohort, there was one occurrence of single magnet ingestion by a female.

Ingestion Trends

Coins accounted for the most frequently ingested FBs in both cohorts: 53.3% and 40.5% of the pre-COVID and COVID cohorts, respectively. There was no statistical difference in coin ingestion frequency between the groups ($P = 0.28$). The FBs classified as other in the pre-COVID cohort included a rock, cylindrical battery, metal band, pipe-cleaner with beads, and washer. In the COVID cohort, the other FBs included sensory tubular objects, a rock, AAA battery, cat toy, bouncy ball piece, plastic brick, metal wire, ring, unspecified round object, soda can tab, strand of beads, water bottle cap, and twist tie. While there was a trend toward an increase in the frequency of other objects ingested in the COVID cohort (33.3% versus 16.7%), this did not meet statistical significance ($P = 0.12$).

Twelve ingestions occurred in May 2020 (COVID) compared with five ingestions in May 2019 (pre-COVID; Fig. 1). There was a significantly higher FBI rate per day in May 2020 compared with May 2019 (0.387 versus 0.161; $P = 0.046$; Fig. 1). The rate of ingestions per day in the COVID cohort trended higher in April and June when compared with the same months in 2019 but did not reach statistical significance.

Most patients in both groups (pre-COVID, 93.3%; COVID, 85.7%) presented to the ED for FBIs. The FB location on radiographic imaging differed significantly between the two time periods. In the pre-COVID cohort, most FBs were identified in the esophagus (pre-COVID, 56.7% versus COVID, 21.4%; $P < 0.01$). FBs were more commonly identified in the stomach during COVID, though this did not meet statistical significance. There was no difference between the two cohorts' post-pyloric FBs. During COVID, three FBs could

TABLE 1. Demographics and characteristics of foreign body ingestion during the pre-COVID and COVID cohorts

Variable	Pre-COVID* (n = 30)	COVID* (n = 42)	P value
Male	19 (63.3)	26 (61.9)	0.90
Age, months	63.8 (28.6–128.5)	62.5 (46.2–96.2)	0.78
Age by category			0.48
<1 year	3 (10.0)	1 (2.4)	0.17
1–5.99 years	16 (53.3)	23 (54.8)	0.90
6–12.99 years	5 (16.7)	11 (26.2)	0.34
13–17.99 years	6 (20.0)	7 (16.7)	0.72
Encounter location			0.63
ED	28 (93.3)	36 (85.7)	0.31
Inpatient	1 (3.3)	2 (4.8)	0.75
Endoscopy suite	1 (3.3)	4 (9.5)	0.31
Type of foreign body			0.31
Coin	16 (53.3)	17 (40.5)	0.28
Sharp object	3 (10.0)	1 (2.4)	0.17
Multiple magnets	1 (3.3)	4 (9.5)	0.31
Button battery	3 (10.0)	5 (11.9)	0.80
Screw	2 (6.7)	1 (2.4)	0.37
Other	5 (16.7)	14 (33.3)	0.12
Location in GI tract on XR			0.02†
Esophagus	17 (56.7)	9 (21.4)	<0.01†
Stomach	7 (23.3)	19 (45.2)	0.06
Post-pyloric	6 (20.0)	12 (28.6)	0.41
Not identified	0 (0.00)	2 (4.8)	0.22
Admitted	7 (23.3)	12 (28.6)	0.61
Discharged home without intervention	9 (30.0)	18 (42.9)	0.27
Required endoscopy	21 (70.0)	22 (52.4)	0.13
Required surgery	0 (0.0)	1 (2.4)	1.0
Complication‡§	3 (10.0)	5 (11.9)	1.0
Perforation	0 (0.0)	0 (0.0)	-
Bleeding	1 (3.3)	0 (0.0)	0.41
Mucosal injury	0 (0.0)	4 (9.5)	0.14
Fistula	0 (0.0)	1 (2.4)	1.0
Stricture	0 (0.0)	0 (0.0)	-
Obstruction	0 (0.0)	0 (0.0)	-
Tissue necrosis	2 (6.7)	0 (0.0)	0.17
Bowel resection	0 (0.0)	1 (2.4)	1.0
Objects not found on endoscopy	1 (3.3)	3 (7.1)	0.64

Categorical variables are expressed in frequency (percentage) and continuous variable as median (25th to 75th percentiles). COVID = coronavirus disease; ED = emergency department; GI = gastrointestinal; XR = radiographic imaging.

*Pre-COVID (March to July 2019); COVID (March to July 2020) The first date examined in both cohorts was March 5, as this was the date of the first COVID case in Tennessee.

†Denotes a *P* value of <0.05.

‡Calculated as a binary variable. Reported as those that experienced complication.

§Patients may have had more than 1 complication. Percentages may not add up to 100.

not be retrieved endoscopically, as they had advanced beyond the reach of regular endoscopes. In the pre-COVID cohort, one FB was unable to be removed endoscopically. Coin ingestions were more likely to be in the esophagus pre-COVID versus COVID (75.0% versus 35.3%; *P* = 0.02). Coins were less frequently found in the stomach in the pre-COVID cohort than in the COVID cohort (12.5% versus 58.8%; *P* < 0.01; Table 2).

Clinical Course and Complications

Endoscopy was less likely to be performed during the COVID cohort (52.4%) than during the pre-COVID cohort (70.0%; odds ratio, 0.47; 95% CI, 0.15–1.40; *P* = 0.13). The decreased odds of endoscopy performance during COVID was most apparent in patients between one and five years of age compared with other age groups (odds ratio, 0.25; 95% CI, 0.04–1.32; *P* = 0.06).

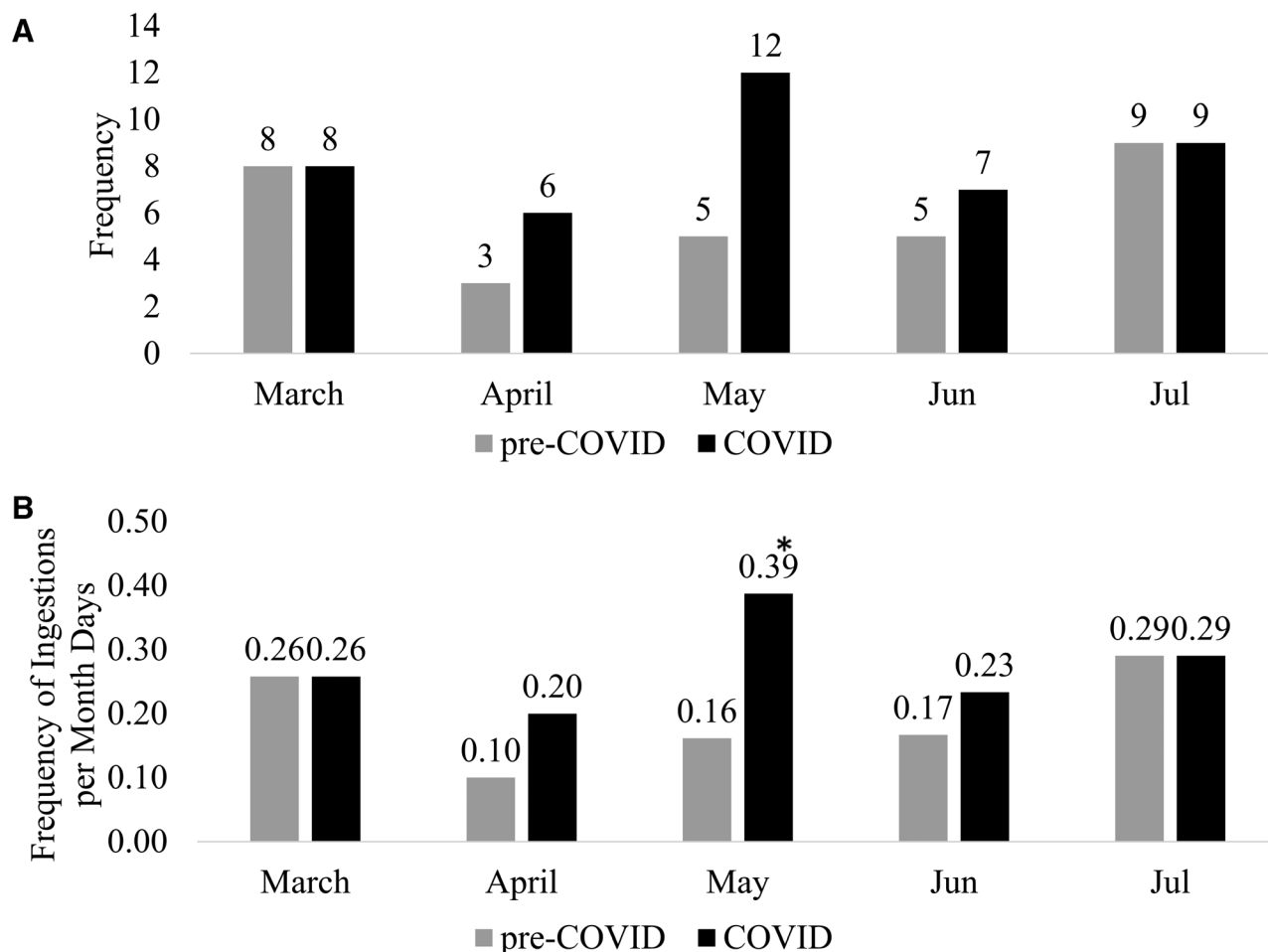


FIGURE 1. Bar charts comparing the frequency of foreign body ingestions (FBI) during the coronavirus 2019 (COVID) pandemic versus the prior year. (A) was the frequency of FBI per month and (B) was the frequency of FBI per month days. **P* value of <0.05 when the frequency of ingestion per month days was directly compared. Pre-COVID represents March to July 2019, and COVID represents March to July 2020. The first date examined in both cohorts was March 5, as this was the date of the first COVID case in Tennessee.

Complication frequency did not differ significantly between the two groups ($P = 1.00$). During COVID, one patient ingested multiple SREMs and developed a fistula, ultimately requiring small bowel resection. Other complications in the COVID cohort included mucosal injury from a button battery ($n = 1$) and FBs classified as other ($n = 3$). The complications in the pre-COVID cohort were bleeding from coin ingestion ($n = 1$) and tissue necrosis from button batteries ($n = 2$).

Admission frequency did not differ significantly between the pre-COVID and COVID cohorts (23.3% versus 28.6%; $P = 0.61$). Pre-COVID admissions were for the following types of FBs: coins ($n = 1$), sharp objects ($n = 1$), multiple magnets ($n = 1$), button batteries ($n = 3$), and screws ($n = 1$). Admissions were required for the following types of ingestions during COVID: coins ($n = 1$), sharp objects ($n = 1$), multiple magnets ($n = 3$), button batteries ($n = 1$), screws ($n = 1$), and other ($n = 5$).

DISCUSSION

The frequency of FBIs trended higher in the COVID cohort when compared with the pre-COVID cohort, with the most significant

difference observed in May 2020 compared with May 2019. Across both cohorts, coins were the most frequently ingested objects, consistent with findings of other studies (2). Types of FBs ingested were similar between the two cohorts, as were admission and complication trends. However, endoscopies were less likely to be performed in the COVID cohort than in the pre-COVID cohort.

The higher rate of ingestions per day in May 2020 versus May 2019 (and the overall trend toward increased frequency in the COVID cohort versus the pre-COVID cohort) may reflect changes in children's home environments due to school closures and Tennessee's "safer at home" order. In addition, due to the evolving pandemic, responsibilities for caregivers increased (16–18). That there was not a significant increase in FBIs during March 2020 (when compared with March 2019) may be reflective of fewer perturbations to daily life during these months, as the local "safer at home" did not go into effect until March 23, 2020 (21). The stability of ingestion frequency between June and July 2019 and June and July 2020 may similarly reflect a lack of notable change in the home environment during the summer months. Although Pizzol et al recently reported an increase in battery ingestions during the peak of the COVID pandemic, we did not identify such an increase (15). This discrepancy may represent a

TABLE 2. Comparison of coin locations on radiographic imaging between pre-COVID and COVID cohorts

Location in GI Tract	Pre-COVID*	COVID*	P value
Esophagus	12 (75.0)	6 (35.3)	0.02†
Stomach	2 (12.5)	10 (58.8)	<0.01†
Post-pyloric	2 (12.5)	0 (0.0)	0.13
Not identified	0 (0.0)	1 (5.9)	0.32

COVID = coronavirus disease; GI = gastrointestinal.

*Pre-COVID (March to July 2019); COVID (March to July 2020). The first date examined in both cohorts was March 5, as this was the date of the first COVID case in Tennessee.

†Denotes a P value <0.05.

difference in referral practices between Italy and the United States, especially since the button batteries' location was not published in their study. They also found a relative decrease in coin ingestions, which, as they pointed out, may have been due to a change in financial transactions away from bills and coins. These changes may not have been as prominent in the United States, where the amount of currency in circulation increased dramatically in 2020 (22,23) and where credit card transactions occur commonly (24).

In this study, FBs were more frequently identified in the esophagus in the pre-COVID cohort than in the COVID cohort. In the COVID cohort, FBs were more frequently located in the stomach compared with the pre-COVID cohort. Similar location patterns were identified when analyzing coin ingestions. That fewer FBs were identified in the esophagus during COVID may represent a delay in patients seeking medical care during the early months of the COVID pandemic. Multiple studies have shown a notable decrease in pediatric ED visits during pandemic lockdowns (25,26). In a similar vein, studies have demonstrated delayed presentation of pediatric appendicitis during the COVID pandemic (27,28). The percentage of patients with FBs distal to the esophagus was higher in the COVID era than in the pre-COVID era. This difference may align with families' decreased likelihood of seeking medical care for perceived nonurgent issues during the early months of the pandemic. Health care providers may have also advised waiting. Current endoscopic guidelines require emergent or urgent endoscopic removal of all esophageal FBs, and the ingestion of multiple magnets in the stomach necessitates emergent removal (29). FBs more distal, such as those in the colon, are managed conservatively (3,30,31). However, delayed or absent medical care is a significant concern for pediatric FBs, given the inherent risks of complications with ingestions of button batteries, multiple magnets, and sharp objects. Despite a potential delay in presentation to medical care, there was not an increased complication rate during COVID at our institution.

Endoscopies were less frequently performed in the COVID cohort, particularly in patients between 1 and 5 years of age. In a descriptive study in Spain, a similar trend was characterized with a 58% decrease in upper endoscopies for FBs during the pandemic (32). Conservative management may have been preferred relative to endoscopic removal during the early months of the COVID pandemic, when operating room capacity and other resources were severely strained (33). In addition, updated guidelines from the North American Society for Pediatric Gastroenterology, Hepatology, and Nutrition recommended considering the risks and benefits of FB removals previously classified as urgent (34).

Preprocedural COVID testing and operating room availability may have also led to delayed endoscopic intervention. Delayed endoscopy may have affected the potential for FB retrieval, as well as complication rates. Reassuringly, we did not find increased

FB-related complications during the COVID pandemic. However, three endoscopies during the initial COVID months were ultimately unsuccessful, as those FBs were too distal for endoscopic retrieval. There were no unsuccessful endoscopies in the pre-COVID cohort. Preprocedural testing and resource availability represent challenges of a pandemic, and, therefore, consideration of these factors is necessary when analyzing FBs before and during the COVID pandemic.

The major strength of this study is the timely manner of analysis of FBI during the COVID pandemic. As the pandemic continues to bring significant changes to the home and school environments, FBs remain a significant threat to children's health. In addition, this study highlights endoscopic interventions and complications, which are often lacking in database studies (2,4,35,36).

Limitations of our study include those inherent to a retrospective review performed at a single center. Documentation of time of ingestion was not consistent and, therefore, precluded retrospective analysis of time to care. Therefore, the location of the object in the gastrointestinal tract was the only available proxy to elucidate delays in care. The study did not collect information on where the FB was ingested (eg, home, school, or daycare). The location of ingestion should be included in future studies on the impact of pandemics or disasters on the epidemiology of pediatric FBs. In addition, our sample size was too small to determine if socioeconomic factors impacted trends in FBI. Although pediatric airway FBs are associated with an urban setting and lack of private insurance (37), there is minimal literature on socioeconomic factors related to gastrointestinal FBI. As socioeconomic factors are known to play a role in presentation to medical care, they should be examined in future studies of gastrointestinal FBs (38).

CONCLUSIONS

At our tertiary referral center, the overall frequency of FBI trended higher during the COVID pandemic, with a significant increase in the rate of ingestions in May of the COVID pandemic compared with the same month in 2019. Similar types of FBs were ingested in each cohort. That fewer endoscopies were performed during COVID may be due to the advantages of conservative management relative to endoscopic removal during the pandemic. Patients in the COVID cohort more frequently had FBs located beyond the esophagus, indicating later presentation and a lesser need for urgent endoscopic removal. The overall number of FBs in our study may be underrepresented during the COVID era due to a national trend of less frequent health care visits during those months (20). However, the at least stable, and in certain months increased, frequency of ingestions noted in this study underscores the need for more research to determine how best to prevent these injuries.

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