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Original article

Airway foreign bodies in infants younger than 6 months: a referral center experience

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Abstract

Background: Although the most common age for foreign body (FB) aspiration (FBA) is considered from 1 to 4 years old, it can even happen earlier.

Aim: The purpose of this study is to evaluate the occurrence of FBA in 6-month infants and younger.

Material and methods: This study is a retrospective analysis of all the cases of FBA in infants under 6 months admitted to Namazi Hospital in Shiraz, Iran, and who underwent flexible fiberoptic bronchoscopy from September 2017 to March 2019.

Results: Medical records of 38 infants under 6 months of age who underwent flexible fiberoptic bronchoscopy with a diagnosis of FBA were reviewed retrospectively. 71.1% of the infants were male. History regarding prematurity was positive in 63.2% of the neonates. 55.3% had different degrees of tooth eruption. Sudden-onset cough (97.4%), noisy breathing (92.1%), and cyanotic spells (52.6%) were the 3 most common reported symptoms before hospitalization. Most (73.7%) aspirations occurred in the presence of parents or caregivers. 7.9% of the infants had normal radiographic results. Only 21.1% of the patients were diagnosed and managed within 24 hours after the aspiration. The most common aspirated FBs were organic objects.

Conclusion: Although FBA is more common in older children, it can also occur in infants younger than 6 months. Families, and especially physicians, should be fully informed of the possibility of aspiration at an early age, which can reduce the occurrence of FBA and its irreversible effects.

Keywords

Airway, foreign body, aspiration, infants, bronchoscopy, younger than 6 months.

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Introduction

Foreign body (FB) aspiration (FBA) is a significant cause of morbidity and mortality in children leading to a significant public health concern worldwide. Larger cohorts and nationwide analysis estimate the incidence of FBA to be 0.66 per every 100,000 children [1]. In the United States, FBA corresponded to approximately 5% of all unintentional accident-related mortality in 2013, with 1 death per 100,000 children younger than 4 years [2, 3]. It is also considered the most important cause of accidental death in infants [4]. The outpatient mortality rate after FBA is more than the inpatient one (about 36.4% vs. 0.26-13.6%, respectively) [3, 5, 6]. Age is considered to be the main predisposing factor for children with FBA [7, 8]. Many studies highlight that children younger than 4 years are more vulnerable to FBA, with a peak incidence during the second year of life [9-11]. Most children in this age group can feed independently and like to move and play while eating or swallowing. Younger infants can explore their surroundings through their mouths when the coordination between sucking and swallowing is yet poor in most cases. Other important reasons for aspiration can include lack of teeth, especially molars needed for grinding food, cognitive inability to distinguish between hazardous, hard objects and safe foods, and eventually playing with or being cared for by older children [5]. The severity of clinical manifestations mainly depends on the partial or total occlusion of the respiratory tract, which is related to many variables like age of the patient, location of lodging, type (organic or inorganic materials), and exact diameter of the FBs. Immediately or within a few minutes after FBA, children may be presenting with choking, refractory cough, cyanosis, gagging, vomiting, and noisy breathing [12]. Due to the variety and severity of clinical symptoms that may happen at the onset, parents can easily overlook aspiration. On the other hand, the busy life of parents can reduce the time they spend directly supervising their children. As a result, many aspirations may occur without witnesses, which can increase complications, cause misdiagnosis, and delay the appropriate management by physicians. Therefore, the correct and timely diagnosis of aspirated foreign objects should be based on strong clinical suspicion. Relying solely on medical history, clinical examination, or even chest imaging, can mislead the proper diagnosis, which will cause more complicated situations, especially at a younger age. Since there is a paucity of published data regarding FBA in young infants, the main purpose of this study is to raise awareness against the possibility, demographic features, cultural beliefs, causes, diagnosis, and the proper management of FBA in the first 6 months of life.

Material and methods

Study design and patient data

In this retrospective single-center study, the medical records of 38 infants younger than 6 months who underwent flexible fiberoptic bronchoscopy (FFB) with diagnosed FBA in Namazi Hospital, Shiraz, Iran, from January 2016 to August 2018 were reviewed. Infants who presented with one of the cardinal manifestations of FBA and who aspirated under the direct vision of their parents or caregivers, or those with sudden refractory symptoms while playing with older siblings whose symptoms did not respond to prescribed medications and who presented a high level of suspicion for aspiration, were considered. Analysis was performed by focusing on the infant's age and sex, type of feeding, previous history of prematurity and neonatal admission to the Neonatal Intensive Care Unit, and time lags from aspiration's symptoms and diagnosis. FB characteristics, location, management modalities, chest imaging findings, and clinical outcomes were studied accordingly.

Ethical consideration

This study was performed following the Declaration of Helsinki and was approved by the Ethics Committee of the Namazi Hospital of Shiraz University of Medical Sciences (number: 1398.279). The clinical and demographic information of each patient was recorded anonymously, and the Ethics Committee waived the requirement for informed consent because of the anonymized and retrospective nature of the data and the scientific purpose of the present study.

Anesthesia and bronchoscopic techniques

Fasting time was considered at least 4 and 6 hours before starting the FFB for breastfed and formula-

fed infants, respectively. During the procedure, all patients underwent complete cardiopulmonary and pulse oximetry monitoring. A complete set of rigid bronchoscopes (RB) and a Pediatric Intensive Care Unit were reserved as a backup. All infants underwent deep sedation anesthesia using propofol to maintain spontaneous respiration. Although RB is the traditional and preferred method in the diagnosis and management of FBA in children, we used FFBs as the first modality based on our experiences, the appropriate size, more maneuverable capacity relative to a smaller diameter of airways in younger infants, and finally, the availability of the various types of instruments including FB retrieval forceps, Dormia baskets, suction catheters, and Fogarty balloons. According to the infants' age, 2 different sizes of FFBs (EVIS EXERA III Olympus bronchoscope, Olympus industry, Japan) with an outer diameter (OD) of 2.8 mm and 4.2 mm and working channel (WC) of 1 mm and 1.9 mm, respectively, were used. All bronchoscopies were performed trans-orally directly or via laryngeal mask airway (LMA) and were conducted after a well preoxygenation with anesthesia bag-mask ventilation. Nasopharyngeal prongs were placed just above the vocal cords to maintain oxygenation. Two percent lidocaine solution was applied as local anesthesia with the spry-and-go method. The bronchoscopy was stopped and resumed after adequate oxygenation when the patient's SpO_2 fell below 80%. The FFB was guided to reach the target bronchus and was placed just above the FBs where the suction was applied, and then the FBs were removed using the mentioned retrieval tools. After the procedure, chest radiographs were taken to evaluate the cases, as well as any complications.

Results

The patient group included 38 infants under 6 months of age diagnosed and managed as FBA as indicated from the retrieved records. The mean ± standard deviation of the patient's age was 19 ± 2.9 weeks (ranging from 6 days to 24 weeks) (**Fig. 1**) and comprised 27 males (71.1%) and 11 females (28.9%). The male-to-female ratio was 2.45:1. FBAs were more common in age ranged from 21 to 24 weeks (34.2%). Twenty-four (63.2%) patients had a positive history of prematurity, and 18 (47.4%) had a history of intubation and ventilatory supports at birth time. On stratifying level of parental education into 3 levels (under-educated, less-educated, and well-educated), 97.3% of the FBAs occurred in infants whose parents were less-educated or under-educated. Only 2.7% of aspirations happened in well-educated families. Twenty-eight (73.7%) infants had aspiration in the presence of a witness or under direct supervision. In terms of the

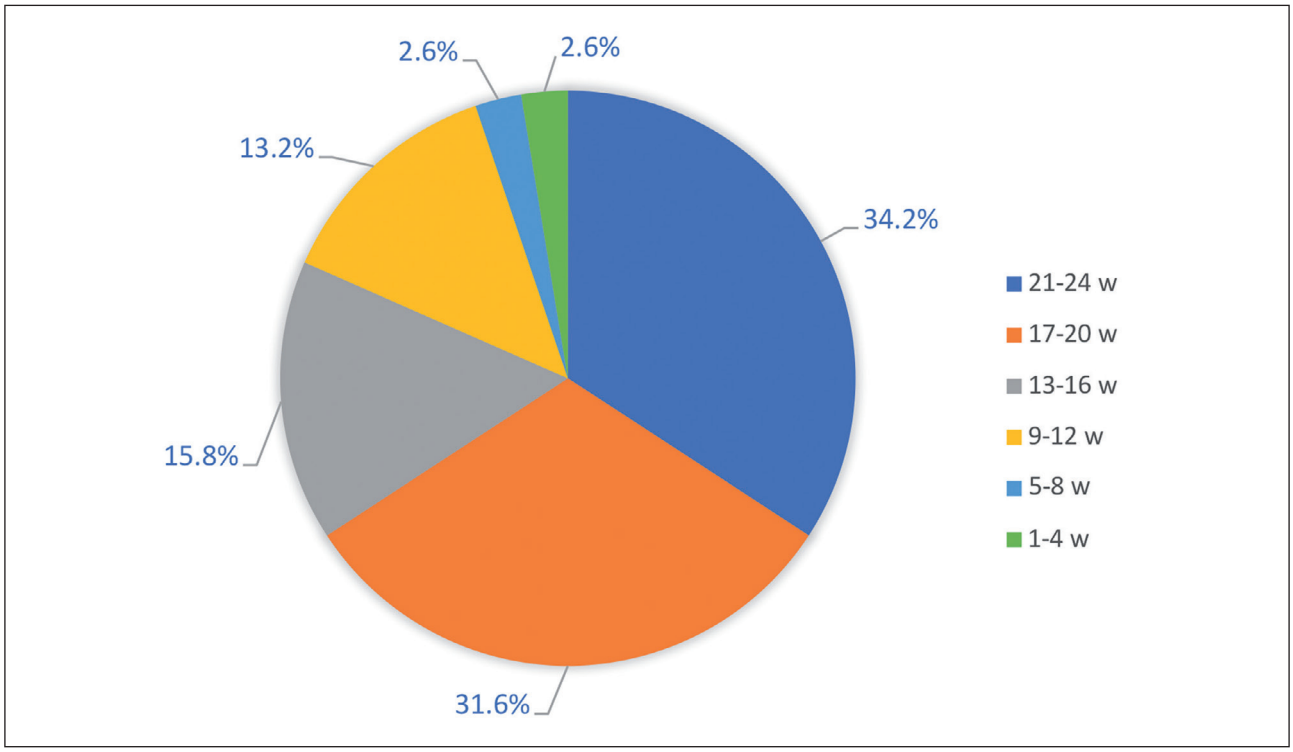

Figure 1. Age distribution of the infants.
W: weeks.

type of feeding, 63.2% FBAs occurred in formula-fed infants. Formula was fed by the caregivers rather than parents in 60.5% of the infants. In the present study, feeding was the most common activity during FBA, in 26 (68.4%) infants. In contrast, supervision by the older siblings (who placed food or objects into the mouths of infants) was the most common risk factor for FBAs, in 10 (26.3%) of the cases. Most patients (44.7%) had no deciduous (primary) teeth. Only 5 infants (13.2%) had both upper and lower incisors. The lag time between aspiration and clinical diagnosis was more than 1 week, 2-6 days, and 1 day in 19 (50%), 11 (28.9%), and 8 (21.1%) of the infants, respectively. Sudden-onset coughing was the most common early symptom when aspiration occurred, in 37 (97.4%) infants. Other common symptoms were noisy breathing and cyanotic spells, in 35 (92.1%) and 20 (52.6%) cases, respectively (**Fig. 2**). Among the findings from the chest auscultation, unilateral decreased breathing sounds were the most common physical sign, detected in 12 (31.6%) of the patients (**Fig. 3**). Organic materials were the most aspirated

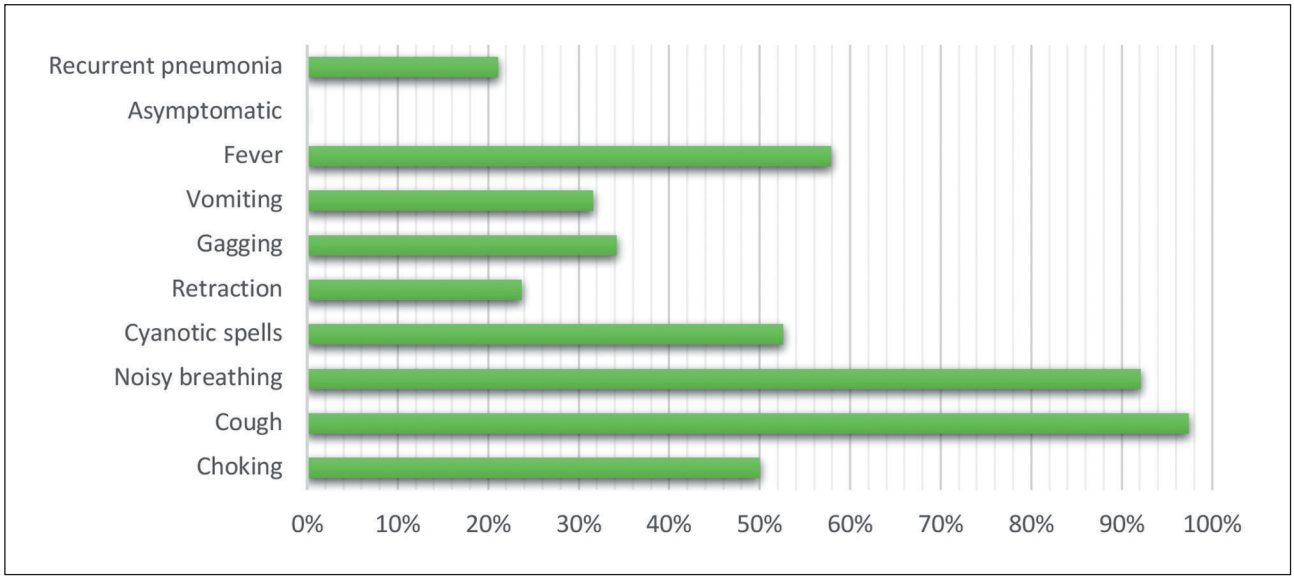

Figure 2. Initial symptoms.

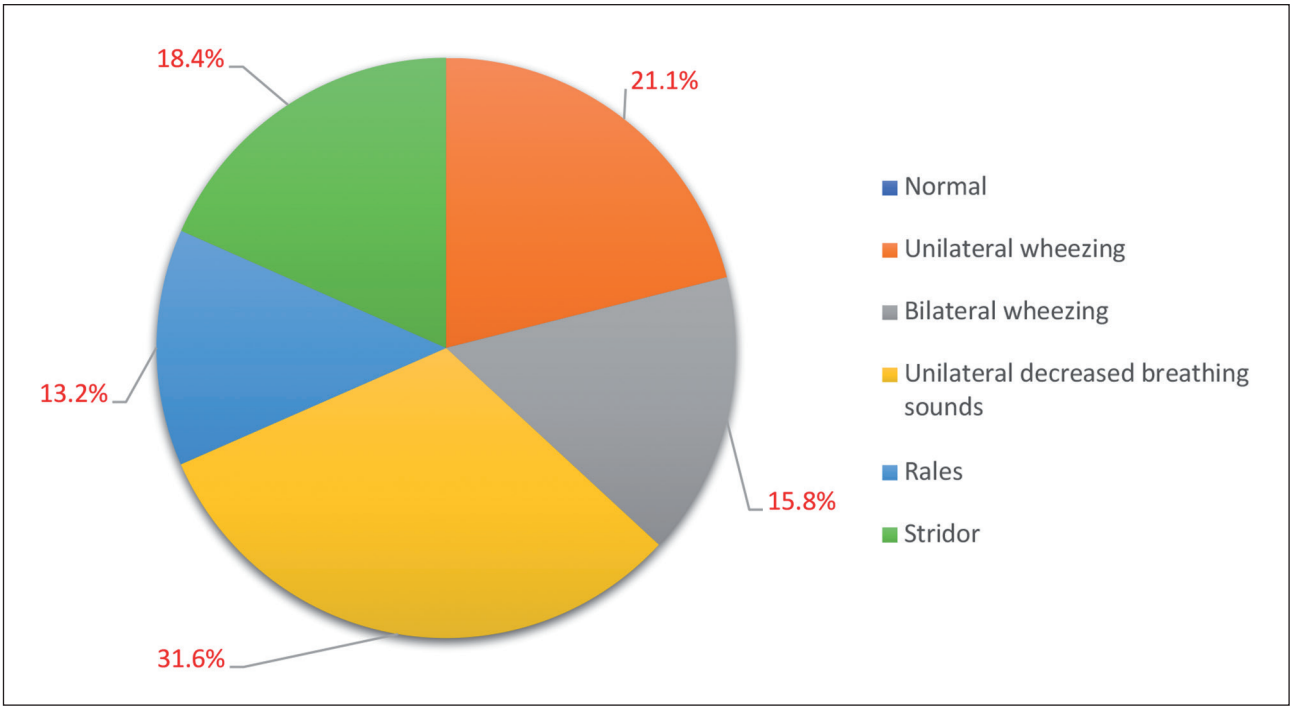

Figure 3. Chest auscultation sounds.

FBs (94.8%). According to bronchoscopic findings, row vegetables were the most common foreign bodies (28.9%) (**Fig. 4**). The left main bronchus was the most common site where the FBs were lodged, in 13 infants (34.2%). Unilateral hyperaeration was the most common chest X-rays (CXR) finding, in 11 (28.9%) patients, but normal CXR was found in only 3 (7.9%) infants. Other common findings in chest imaging consisted of consolidation and infiltration (**Fig. 5**). There were neither mortality nor significant

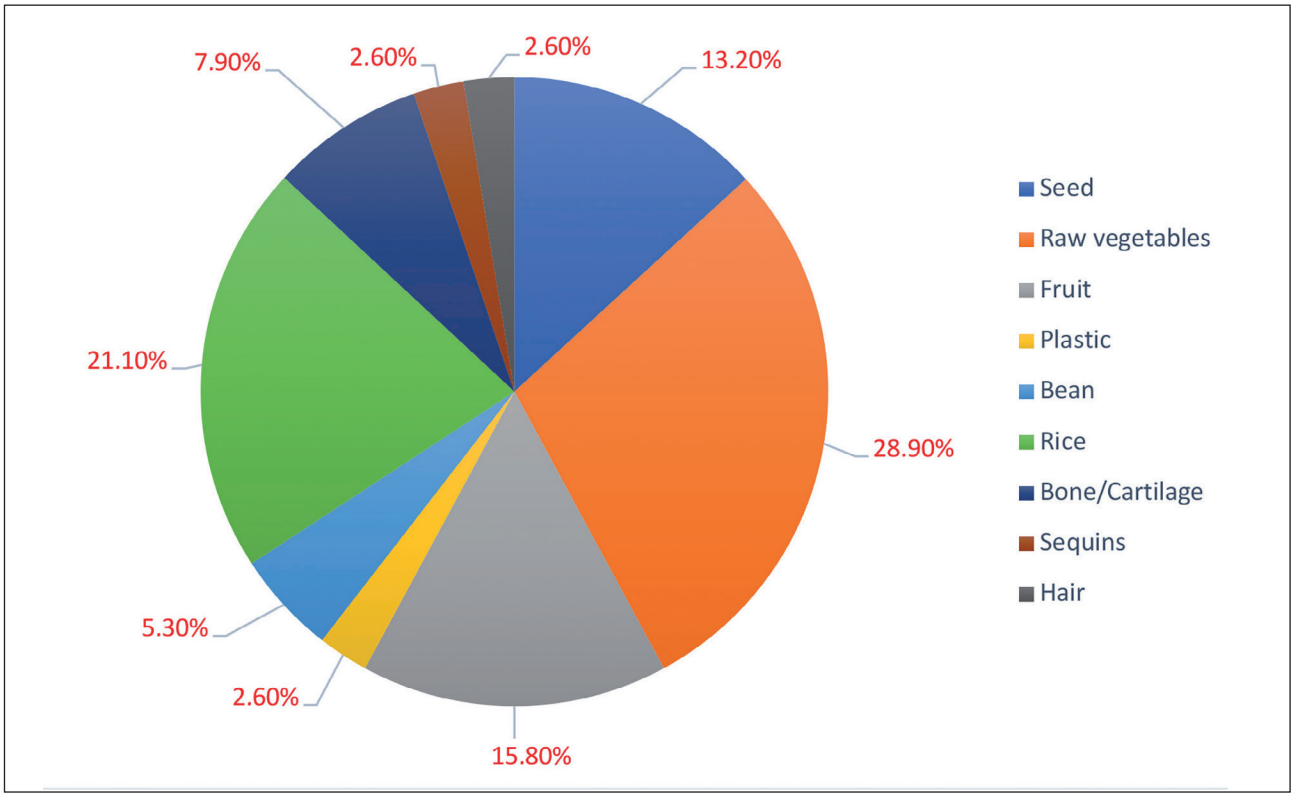

Figure 4. Type of the foreign bodies.

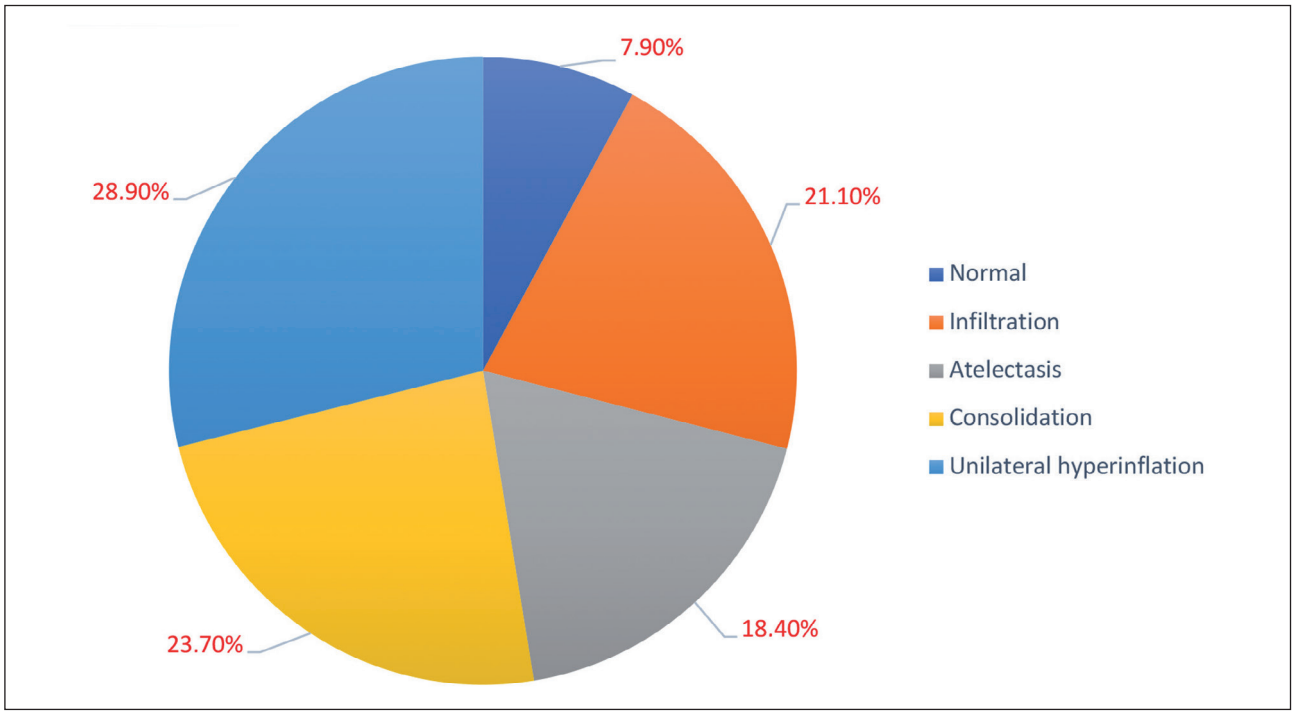

Figure 5. Location of the foreign bodies.

complications related to FBA and the bronchoscopy procedure.

Discussion

FBA is one of the pediatric medical problems and has caused many casualties worldwide so far. Although medicine has made significant advances in diagnostic and therapeutic methods regarding FBAs, there has been no significant success in eliminating the overall risk of aspirations in children, especially in smaller ones. FBA has been more reported in children aged 1 to 3 years, but this study focused on infants under 6 months. In this regard, the medical records of 38 infants under 6 months old who were referred to the hospital and underwent bronchoscopy with the final diagnosis of FBA were retrospectively studied.

This study demonstrates that the peak incidence of the FBA was in infants aged 21 to 24 weeks (34.2%) when infants tend to place all objects in their mouth or the parents and caregivers let them eat by themselves. It is known as the baby-led weaning (BLW) method. BLW is an alternative way to introduce complementary foods in infancy. In this method, most young infants are fed with family table food by themselves instead of purée texture foods using a spoon. Although BLW increases the risk of choking and healthcare providers have serious concerns about its safety, this method is gaining popularity in many cultures worldwide because it is believed that the BLW method can promote eating capability and weight gain by improving feeding skills in infants [13]. This study showed that the lowest aspiration rate (2.6%) was in newborns between 1 and 4 weeks of age. The youngest case was a 6-day-old neonate who had aspirated the mother's long hair strand, which has been found in his left main bronchus. Like many other studies conducted in higher ages, male infants aspirated FBs more than females [14]. In this study, the male-to-female ratio was a bit higher than in older children. Moreover, the analysis also showed a significant difference between the mean age of the patients concerning gender ratio ($p < 0.05$). According to previous studies, the gender of male fetuses is considered a related risk factor for spontaneous preterm birth, which may also be a reason for the gender distribution of the incidence of aspiration [15]. As this study showed, a positive history of prematurity (63.2%), especially in those with a positive history of intubation in the early stages of life, can be an important risk factor for the occurrence of FBA in children younger than 6 months. Prematurity and low birth weight could be considered as 2 known factors affecting neuromuscular coordination. In infants with a history of prematurity, this may be due to the immature coordination of chewing and swallowing mechanisms [16]. It has been shown that up to 80% of these premature infants may have different levels of difficulties in oral feeding, increasing the chance of FBA [17]. Current research shows that the process of tooth eruption in infants under 6 months of age can be accompanied by symptoms such as itchy gums and the desire to chew and squeeze objects between the gums, which may also be accounted as other risk factors for FBA. On the other hand, according to the culture of some counties like ours, families believe that putting chopped or row vegetables such as carrots, cucumbers, or apples in the mouth can improve the symptoms of itchy gums. They conceive that pressure or rubbing the gums using such fruits can be effective for the rapid eruption of the teeth. However, they are not aware that the inability to chew food adequately will facilitate aspiration in them. The present study revealed a significant difference between the mother's education level and FBAs, as 97.3% of the FBAs have occurred in infants whose parents were less-educated or under-educated ($p < 0.05$). Since most cases of aspiration have occurred in formula-fed infants (63.2%) and whose formula was fed by the caregivers (60.5%) rather than their mothers, the type of feeding, especially when done by caregivers, becomes an interesting topic about the possibility of FBA occurring in young infants. It has been noted that feeding infants by bottle may interfere with sucking, swallowing, breathing (SSwB) dynamics, causing swallowing to occur more randomly between breaths. Therefore, unsynchronized SSwB can increase the risk of aspiration even in later years of life when the infant starts to be fed with solid foods [18, 19]. However, more research is needed in this field. The data showed that 18.4% of caregivers and 10.5% of mothers refused to report the FBA correctly for fear of being accused, significantly related to delayed diagnosis ($p < 0.05$). Fear of being blamed by the mother is a factor that makes it difficult to provide correct information to the doctors, and this problem is more noticeable in young infants. Sudden-onset cough (97.4%), noisy breathing (92.1%), and cyanotic spells (52.6%) were 3 common symptoms, and unilateral chest findings such as decreased breathing sounds and wheezing were the most common signs on the clinical examination in the 31.6% and 21.1% of the cases, respectively. Although studies have shown

that up to 50% of patients with FBA are completely asymptomatic [20], in this study, all patients had at least 1 definite clinical finding at the time of admission to the Emergency Room (**Fig. 2**). This research also showed that although almost three-fourths (73.7%) of aspiration cases occurred in the presence of an eyewitness, the primary diagnosis took more than 7 days in half (50%) of the cases, and this may indicate that doctors were not familiar with the possibility of aspiration in this age group to give a timely and correct diagnosis. Therefore, if a previously healthy infant suddenly develops respiratory symptoms, the possibility of FBA should be considered to avoid any delay in referral to a tertiary pulmonary service for expert evaluation. The study also emphasizes that a detailed medical history is mandatory as the most crucial diagnostic tool. In the present study, feeding was the most common activity during FBA (in 68.4% of the infants). In contrast, supervision by the older siblings (who placed food or objects into the mouths of infants) was the most common risk factor for FBAs (in 26.3% of the cases). Accordingly, parents and caregivers should be aware of the dangers of leaving their infants alone with older children and exercise adequate control over their playing with each other. Unilateral hyperinflation, consolidation, and infiltration were the 3 most common radiological findings in the patients' CXR. However, only consolidation and atelectasis had a direct relationship with the delayed diagnosis ($p < 0.05$). An important reason may be that many clinical manifestations and even imaging characteristics of FBA can overlap with common respiratory infections, interfering with proper diagnosis and treatment. Thus, it is important to elicit any pre-existing respiratory infections before interpreting imaging and the clinical findings. The present study revealed that only 7.9% of the infants had normal chest imaging, which was less frequent than other studies [21]. The higher incidence of abnormal CXR can be explained by the fact that the lungs of young infants tend to be more collapsed as their airways are smaller and softer, making them more obstructed. Similar to the results of other studies, organic FBs were the most commonly aspirated subjects among younger infants [22-24]. Regarding the FBs types, row vegetables (28.9%) and rice (21.1%) were the 2 most common aspirated objects. This study also showed that younger infants are more likely to aspirate food material when compared with older children, who are more at risk of aspirating non-food objects like nuts and seeds. The difference may reflect the feeding habits based on social and cultural influences, such as the early onset of complementary feeding in infants. In our community, complementary feeding is usually started with pureed ingredients such as almond porridge and softened rice around 6 months. However, some families are more inclined to start complementary feeding early, not prepare food well, or use chopped vegetables to stimulate tooth growth. Also, some parents and caregivers have traditional beliefs that starting complementary feeding in children younger than 6 months can greatly impact the infants' further physical development. However, based on the published studies, there was no difference in growth parameters of the infants who started complementary food earlier, even those at higher risk of hospitalization [25].

Conclusion

Although less common, FBA can occur in infants, even in those younger than 6 months of age. The cultural beliefs in different societies regarding the early starting of complementary feeding and permission for self-feeding to boost oral motor function lead to FBA in young infants. Clinical suspicion is the most influential factor for early and effective diagnosis management. Physicians should consider FBA in the airway in the differential diagnosis of an infant with sudden-onset respiratory complaints. Prevention is the mainstay of decreasing the incidence of any FBA accidents, even in young infants. In this regard, improving the knowledge of doctors, parents, and caregivers can play a fundamental role.

Declaration of interest

The Author declares that there is no conflict of interest and that he does not have any financial or personal relationships with others that could have inappropriately influenced this work. Funding source: there is no financial support.

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