

PEDIATRIC OTORHINOLARYNGOLOGY

Foreign body injuries in children: a review

Lesioni da corpo estraneo nei bambini: una revisione

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SUMMARY

The aim of this paper was to overview existing knowledge on foreign body (FB) injuries in children, with particular focus on FB types and anatomical locations, clinical presentation and complications. FB injuries represent a severe public health problem in childhood. The fact that the highest prevalence of FB injuries is reported for children between 0 and 3 years of age depends primarily on the fact that they explore objects using their mouth and are also not able to distinguish edible objects from non-edible ones. Types of FB causing injuries depend on the symptoms related to FB ingestion/inhalation/insertion (providing an early diagnosis of FB injuries) and complications related to the FB characteristics (type, shape, dimensions). The analysis of the Susy Safe database showed that in 10,564 cases, in which the object type was available, 74% of objects were inorganic and were mostly represented by pearls and balls, followed by coins. The main concern about FB injuries is the fact that they may be asymptomatic or that symptoms may be non-specific. Consequently, the FB injury can be misinterpreted as a gastrointestinal or respiratory infection. The absence of specific symptoms indicating the occurrence of FB injury can lead to delays in diagnosis, thereby increasing the risk of complications. Symptoms seem to mostly depend on the anatomical location. Many ingested FBs pass naturally through the gastrointestinal tract without complications or damage. However, severe complications can occur depending on the characteristics of the FB, its anatomical location, the child's age and delays in diagnosis.

KEY WORDS: Foreign bodies • Suffocation • Children • Emergency care

RIASSUNTO

Nel presente lavoro gli Autori sintetizzano le testimonianze relative ai danni provocati da corpi estranei in bambini sottolineandone il tipo, la sede la clinica e le complicitanze. I danni provocati da corpi estranei rappresentano un importante e frequente problema di salute pubblica specie nell'infanzia, in quanto i piccoli tra 0 e 3 anni di età hanno l'abitudine di esplorare oggetti sconosciuti portandoli in bocca senza riconoscere se gli stessi sono commestibili o no. L'analisi effettuata nell'ambito del progetto "Susy database" ha permesso di rilevare come nei 10.564 casi esaminati il 74% di oggetti erano inorganici (principalmente perle e palline di ogni genere, seguite da monete). Nella maggior parte dei casi i piccoli non presentavano particolare sintomatologia ovvero sintomi assolutamente non specifici tale da non evidenziarne la causa. L'assenza di specifici sintomi porta generalmente a dilazioni nella diagnosi, aumentando il rischio di complicitanze. I sintomi dipendono in massima parte dall'ubicazione e dalla dimensione dell'oggetto inalato ovvero ingerito che può passare attraverso il tratto di gastrointestinale, senza danni. Comunque, è da sottolineare come le complicazioni più importanti sono relative alle caratteristiche del corpo estraneo alle quali bisogna rivolgere particolare attenzione per la scelta terapeutica.

PAROLE CHIAVE: Database Susy Safe • Corpi estranei • Emergenze in pediatria

Acta Otorhinolaryngol Ital 2015;35:265-271

Introduction

Foreign body (FB) injuries represent a severe public health problem in childhood, especially in infants. The fact that the highest prevalence of FB injuries is reported for children between 0 and 3 years of age depends primarily on the fact that young children explore objects using their mouth, are not able to distinguish edible objects from non-edible ones, their teeth are physiologically lacking (they have incisors to tear food, but not cuspids, with consequently difficulties in reducing food in a smooth bolus) and have poor swallowing coordination (compared to older children and adults). Additionally, FB injuries in

pre-schoolers can be related to distractions (e.g. eating and playing at the same time)¹.

FB injuries are related to increased morbidity (they often have a non-specific clinical presentation, resulting in a delay of recognition of FB injury that can lead to serious complications depending on the type of FB, its anatomical location and the child's characteristics²) as well as mortality (choking is one of the main causes of death in kids aged 0-3 years, but it is common also in older children, especially in those up to 14 years of age)³.

In order to improve clinical management of children in whom FB injuries occurred, reduce the risk of complications and death, and to develop strategies for prevention

of FB injury, it is crucial to understand the types of FB that cause injuries, the symptoms related to FB ingestion/inhalation/insertion (providing an early diagnosis of FB injuries) and complications related to the characteristics (type, shape, dimensions) of the FB. However, despite the severity of this type of injury (and the consequently need for evidence to improve clinical management and develop prevention strategies), the availability of high quality evidence on FB injuries is lacking⁴. This is probably related to a lack of systematic collection of data on FB injuries in children: only a few countries have developed a surveillance tool collecting information on FB injuries, and most of the available data come from publication of single case studies^{5,6}, collection of case studies from a single health care centre⁷ and review of previously published case studies⁸ (consequently, data are collected in a heterogeneous manner resulting in difficulties in pooled analysis). Currently, the main surveillance tool providing epidemiological data on FB injuries, is represented by the Susy Safe registry^{9,10}. It was developed to provide a risk profile of products causing injuries in children, investigate the impact of socio-economic disparities in injuries' likelihood and involve consumer associations to educate consumers on the risks of FB injury. It collects information in both European and non-European countries on characteristics, symptoms and complications of FB injury, and on the procedures performed for diagnosis and removal of the FB. This paper aims to overview existing knowledge on the types of FB injuries in children, clinical presentation and complications related to FB type, and to provide an update of the literature.

Foreign body types and anatomical location

Types of FBs ingested/inhaled/swallowed/inserted by the child are generally classified as food and non-food objects. Regarding anatomical location, it is usually reported (e.g. from the Susy Safe registry) using the International Classification of Disease ICD-9, corresponding to codes from 931 to 935 (which are represented, respectively, by FB in: ears, nose, pharynx and larynx, respiratory tract and digestive tract) in order to provide a standardisation of FB injuries. Generally, FB injuries involving the respiratory tract occur more often in young children (less than 4 years of age), while insertion of FBs in ears or nose is reported more frequently in older children¹¹. The results retrieved from the literature on FB characteristics and anatomical location are shown in Table I.

The analysis of 16,878 FB injuries from the Susy Safe database¹² showed that in 10,564 cases in which the object type was available, 74% of objects were inorganic and were mostly represented by pearls and balls, followed by coins. A review of FB injuries reported in the literature demonstrated that coins were the objects most often in-

gested by kids¹³. This finding is similar to those reported from a retrospective study conducted on 192 FB injuries cases, demonstrating that the most frequently found oesophageal objects were coins¹⁴. Moreover, data on Romanian children showed that, among children who swallowed a FB, the objects most frequently retrieved were coins¹⁵, which is consistent with the analysis of 320 oesophageal FB cases in Argentinean children¹⁶. Toys (particularly parts of broken toys and *Lego*[®] type toys) represent a particular category of inorganic objects: they are often found in the upper aero-digestive tract (especially since children insert them in the nose). However, in recent years, the incidence of this type of injury is decreasing thanks to stricter regulations for toy manufacturers and commercialisation^{17,18}.

Regarding organic objects, the analysis of the Susy Safe database showed that only 26% of cases (among those in which the object type was specified) were related to food items and were most frequently found in ears (ICD931), pharynx and larynx (ICD933), trachea, bronchus and lungs (ICD934)¹⁹. The fact that food is the object that is generally most frequently aspirated by children is confirmed also by a retrospective study of 184 cases of FB aspiration, showing that nuts and seeds (especially sunflower seeds and hazelnuts) were more frequently retrieved in the respiratory tract²⁰, which is consistent with data on FB injuries retrospectively revised in a German hospital, showing that organic objects (particularly seeds, nuts and berries) were those that were most often inhaled by children²¹. Additionally, a systematic review of articles reporting on FB injuries demonstrated that food items (especially nuts) were most frequently found in children's airways⁸. Nuts and seeds are found to be the objects most frequently inhaled by children, particularly those younger than 3 years of age²². The high incidence of nut and seed retrieval in young children's airways is mostly associated with difficulties in chewing this type of fruit due to a physiological lack of teeth. Nuts are more commonly retrieved in children living in Western countries, while watermelon seeds are more common in Asian ones²². Additionally, a study conducted among Turkish children highlighted the fact that inhalation of hazelnuts during the hazelnut harvest season represents a severe public health problem²³. These findings clearly indicate that the type of object causing injuries in children is highly dependent on the social, economic and cultural environment in which the child lives.

Symptoms of foreign body injuries

The main concern about FB injuries is the fact that they can be asymptomatic or that symptoms can be non-specific. As a consequence, FB injury can be misinterpreted with a gastrointestinal or respiratory infection. If the injury is not witnessed, the absence of specific symptoms

Table I. Foreign body (FB) types and anatomical location. For FB type, only the three objects most frequently retrieved are reported.

Source	Year	Study Type	Country	No. of cases/ No. of included studies	FB anatomical location	FB type
Šlapák et al. ¹²	2012	Prospective study (Susy Safe's data analysis)	Both EU and non-EU countries	10,564 cases for which the FB type was specified. Analyses were performed on the 7,820 (74%) injuries due to a non-food item	37% Nose 29% Mouth, Oesophagus, Stomach 24% Ear 6% Pharynx and Larynx 4% Trachea, Bronchi and Lungs	22% Pearl, Ball, Marble 20% Coin 8% Other non-food
Sebastian van As et al. ¹⁹	2012	Prospective study (Susy Safe's data analysis)	Both EU and non-EU countries	10,564 cases for which the FB type was specified. Analyses were performed on the 2744 (26%) injuries due to a food item	50% Trachea, Bronchi and Lungs 19% Nose 16% Pharynx and Larynx 8% Mouth, Oesophagus, Stomach 7% Ear	32% Bone 22% Nut 21% Other food
Chinski et al. ¹⁶	2010	Prospective study	Argentina	320 cases	Oesophagus	268 Coins 15 Bones 15 Plastic pieces
Rybojad et al. ¹⁴	2012	Retrospective study	Poland	192 cases were reviewed, a FB was retrieved in 163 cases	Oesophagus	54% Coins 19% Food fragments 7% Toy parts
Jayachandra et al. ¹³	2013	Systematic review		17 articles, corresponding to 5,559 cases	Digestive tract	2 studies analysed exclusively coins ingestion. Among the other 15 studies, 10 reported coins as the objects most frequently ingested
Sarfoleanu et al. ¹⁵	2012	Retrospective study	Romania	455 cases	44.62% Nose 24.18% Mouth, Oesophagus, Stomach 14.73% Trachea, Bronchi and Lungs 12.75% Ears 3.74% Pharynx and Larynx	23.96% Nuts and Seeds (50.46% were aspirated) 12.75% Marbles 12.53% Coins (96.49% were ingested)
Oncel et al. ²⁰	2012	Retrospective study	Turkey	184 cases	Airways	45% Sunflower seeds 26% Pistachio 11% Hazelnut
Göktas et al. ²¹	2010	Retrospective study	Germany	78 cases	Airways	69.2% Seeds, nuts, berries and grains 15.4% Other types of food
Brkic et al. ⁷	2007	Retrospective study	Bosnia and Herzegovina	662 cases	84% Bronchi 14.3% Trachea and Larynx	87.1% Organic objects
Foltran et al. ⁸	2012	Meta-analysis		174 articles, corresponding to 30,477 cases	Airways	6504 Nut 5553 Organic unspecified 3678 Seeds Toys
Foltran et al. ¹⁸	2012	Prospective study (Susy Safe's data analysis)	Both EU and non-EU countries	10,564 cases for which the FB type was specified. Analyses were performed on the 441 (2.6%) injuries due to toys	75% Nose 13% Mouth, Oesophagus, Stomach 9% Trachea, Bronchi and Lungs 4% Pharynx and Larynx	
Foltran et al. ¹⁷	2011	EFSBI (European Survey on Foreign Bodies Injuries), retrospective study	19 European countries	2,094 cases. Analyses were performed on the 121 (5.8%) injuries due to toys	74% Nose 13% Trachea, Bronchi and Lungs 7% Mouth, Oesophagus, Stomach 6% Pharynx and Larynx	29 (31%) Toy 17 (18%) Part of a toy 16 (17%) <i>Lego</i> [®] type toys

Table II. Symptom of FB injury.

Source	Study type	No. of cases/ No. of included studies	Anatomical location
Jayachandra et al. ¹³	Systematic review	17 articles, corresponding to 5559 cases	Digestive tract
Rybojad et al. ¹⁴	Retrospective study	192 cases were reviewed, a FB was retrieved in 163 cases	First, Second and Third narrowing of oesophagus
Balci et al., 2004 ²⁴	Retrospective study	1116 cases	Oesophagus
Chinski et al., 2010 ¹⁶	Prospective study	320 cases	Oesophagus
Foltran et al., 2012 ⁸	Meta-analysis	174 articles, corresponding to 30,477 cases	Airways
Lea et al., 2005 ²⁵	Prospective study	98 cases with suspected FB, in 56 FB was found	Airways

indicating the occurrence of FB injury can lead to delays in diagnosis, thus increasing the risk of complications. Symptoms seem to depend mostly on anatomical location (Table II).

A review of published cases of FB ingestion¹³ showed that symptoms differ in each of the studies, but include mostly gastrointestinal symptoms (vomiting, dysphagia, drooling, gagging) when the FB is located in the upper-mid-lower oesophagus. In studies in which coins were found to be ingested by children, vomiting and drooling were the most frequently reported symptoms. However, some studies reported that injured children were completely asymptomatic. A study conducted in Polish children on FB ingestion, in which most of FB were found to be coins, that most common symptoms were dysphagia, vomiting and drooling¹⁴. Drooling and dysphagia were also most frequently reported in oesophageal FB in a retrospective study conducted on 1116 cases in a Turkish paediatric population²⁴. Gastrointestinal symptoms were frequently encountered among Argentinean children injured by FB located in the oesophagus, although vomiting and

odynophagia were those most frequently reported, while drooling and dysphagia were less prevalent¹⁶. Despite the fact that FB located in the mouth/oesophagus/stomach are more often related to gastrointestinal symptoms, it is difficult to identify a specific pattern of symptoms considering the FB type, location and child's characteristics, as is demonstrated by the fact that significant heterogeneity in clinical presentation was reported among studies.

Regarding FB in the airways, a meta-analysis of published studies showed that most frequent symptoms are cough and fever, followed by dyspnoea and choking, while the most common sign was abnormal breath sounds at auscultation⁸. Consistent with this meta-analysis, a 2-year prospective study on Israeli children showed that the symptoms most frequently associated to FB aspiration were choking, cough and dyspnoea²⁵. Given the high frequency of symptoms such as cough and fever associated with FB inhalation, the risk of misdiagnosing the FB injury with a respiratory tract infection is high. A retrospective study reviewing medical records of children with a suspect diagnosis of FB aspiration reported that all chil-

Symptoms				
Gastrointestinal	Respiratory	Pain	Others	Asymptomatic
7 studies: Vomiting 6 studies: Dysphagia 4 studies: Drooling 2 studies: Gagging 1 study: Fluid intolerance	2 studies: Choking	1 study: Odynophagia 1 study: Retrosternal pain 2 studies: Pain (not specified)		2 studies
First narrowing: 34 Drooling 34 Vomiting 33 Dysphagia Second narrowing: 12 Drooling 13 Vomiting 24 Dysphagia Third narrowing: 2 Drooling 3 Vomiting 8 Dysphagia		First narrowing: 6 pain cases Second narrowing: 9 pain cases Third narrowing: 12 cases		
512 (45.9%) Drooling 298 (26.7%) Dysphagia 12 (1.1%) Vomiting	89 (8%) Wheezing 45 (4%) Respiratory Infection 19 (1.7%) Hemoptysis 11 (1%) Choking/cyanosis 2 (0.2%) Pneumonia	97 (8.7%) Cervical pain 26 (2.3%) Chest pain	4 (0.3%) Fever 1 (0.08%) Anorexia	
92 (28.7%) Vomiting 38 (11.86%) Sialorrhoea 31 (9.69%) Ptyalism 28 (8.75%) Dysphagia		75 (23.4%) Odynophagia		47 (14.69%)
96 Vomiting	12,605 Cough 5947 Choking 4507 Dyspnoea 73 Voice hoarsens 59 Blood stained mucus	111 Throat pain 43 Thoracic pain	1970 Fever 15 Unconsciousness	109
	76.8% Choking 14.3% Cough 3.6% Dyspnoea 1.8% Pneumonia			

dren presented with cough and abnormal breath sounds, but about 20% of FB injury cases were misdiagnosed with tracheobronchial infections or disease (e.g. pneumonia or asthma). Among these, diagnosis was correctly achieved after 3 days and 2 years. Moreover, FB aspiration symptom patterns are unclear with a consequently high risk to misdiagnose the injury with a respiratory infection if the FB aspiration is not witnessed.

Complications of FB injuries

Many ingested FBs pass naturally through the gastrointestinal tract, without complications or damage. However, severe complications can occur that depend on the characteristics of the FB, its anatomical location, the child's age and delay in diagnosis.

FB characteristics play a key role in determining the risk of complications, particularly considering its consistence and shape: rigid and semi-rigid objects and those with sharp and edges are those most commonly found to cause complications such as laceration and perforations²⁶, while

small, round items (e.g. food items like berries) are found to increase choking risk²⁷. Referring, more specifically, to the categories of hazardous organic and inorganic objects, it has been demonstrated that, among food items, bones (especially fish and chicken bones) and broken nut shells can lead to determine mucosal perforation/laceration, although nuts (the food item most frequently retrieved in children's airways) are those most often related to complications, compared to bones and nut shells, because they can also cause an inflammatory reaction determining sudden tracheobronchial obstruction¹⁹. Among inorganic objects, in addition to those that have a rigid/semi-rigid consistence and sharp/edges, there are also two types of items that deserve particular attention because of the severe complications related to their ingestion/inhalation: magnets and batteries. Regarding magnets, if the ingestion of a single magnet is generally not dangerous because it passes naturally through the gastrointestinal tract, the ingestion of multiple magnets is dramatic as they can attract each other once in the gastrointestinal tract (especially in the bowel)²⁸. The most frequently described com-

plications associated with ingestion of multiple magnets are necrosis, bowel obstructions, perforations, sepsis and even death²⁹, which are mainly attributable to delays in diagnosis¹⁵. Additionally, the incidence of the ingestion of multiple magnets has increased in the last years³⁰, highlighting that, despite the fact that the risk related to magnet ingestion is well documented, preventive strategies are lacking. In addition, batteries represent a hazardous item if ingested/inhaled/aspirated: complications can occur not only to battery rupture and release of its toxic content, but, more often, due to the generation of an electronic current from the battery in contact with tissue fluids³¹. This reaction leads to the production of hydroxide, which is dangerous and can lead to severe complications including necrosis, perforation, fistula, haemorrhage and even death. Despite the fact that batteries may pass through the gastrointestinal tract without complications, as an inert FB, the ingestion of button batteries is particularly dangerous. More specifically, the ingestion of a button battery with a diameter of 20 mm by children younger than four years of age increases the risk that the button battery hangs in the oesophagus determining severe complications within two hours³¹⁻³³. There is thus a crucial need for prompt medical attention after button battery ingestion.

Not only for batteries and magnets, but more generally for all types of FB injuries, it has been widely demonstrated that the prevention of complications requires early diagnosis and prompt clinical reaction. A review of 136 cases of FB aspiration conducted in a Israeli hospital demonstrated that children who referred to the health care centre after 2 days (or more) from the injury had a 2-fold increased risk of complications². Another study, conducted on 263 children in whom a tracheobronchial FB was found, demonstrated that no complications occurred in patients who were referred to the hospital within 24 hours from the injury occurrence, while complications were reported for children who referred later to the health care centre. Clearly, in addition to the FB type and anatomical location, another key factor associated with a risk of complications is the time at which children are referred to the hospital: delays in referral or in diagnosis increase the risk of onset and/or worsening of complications.

Conclusions

The aim of this paper was to summarise the existing knowledge on FB injuries in children, with focus on the FB types and anatomical locations, clinical presentation and complications. Young children are more susceptible to FB injuries. Referring to FB characteristics and sites in which they are found, the data in the literature showed that the majority of FB are inorganic objects, while food items (especially nuts and seeds) are those most often retrieved in children's airways. The risk of complications is highly related to the type of FB: rigid and semi-rigid objects and

those with sharp and edges pose a risk of perforation and laceration, while small round items (food items like berries) increase the likelihood of choking. Early referral of injured children to the hospital is crucial to prevent complications; if the injury is not witnessed, misdiagnosis can occur, leading to delays in clinical intervention because symptoms may be non-specific. At present, we could not identify a specific pattern of symptoms related to FB injuries from the published literature.

Given the risk of misdiagnosis of FB injuries due to non-specific clinical presentation and the severity of complications to which a FB injury may be associated, it is essential crucial to develop primary prevention strategies for FB injuries. In particular, educational programs should be carried out for parents to stress the importance that children eat food and play with toys that are appropriate for their age (e.g. avoiding nuts and seeds and, more generally, small round food items, as berries, in kids younger than 4 years of age, guaranteeing adult supervision when young children are playing or eating). Primary prevention is also represented by the involvement of manufacturers and consumer associations, providing strict regulation on manufacturing, packaging, quality control and commercialisation of hazardous objects (particularly toys, magnets and batteries).

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Received: May 24, 2015 - Accepted: June 18, 2015