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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 concerning 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

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 characteristics 2) 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 lacking. 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, collection of case studies from a single health care centre and review of previously published case studies (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. 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 children. 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 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. A review of FB injuries reported in the literature demonstrated that coins were the objects most often ingested by kids. 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 coins. Moreover, data on Romanian children showed that, among children who swallowed a FB, the objects most frequently retrieved were coins, which is consistent with the analysis of 320 oesophageal FB cases in Argentinean children. 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.

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). 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 tract, 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 children.

Additionally, a systematic review of articles reporting on FB injuries demonstrated that food items (especially nuts) were most frequently found in children’s airways. Nuts and seeds are found to be the objects most frequently inhaled by children, particularly those younger than 3 years of age. 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 ones. Additionally, a study conducted among Turkish children highlighted the fact that inhalation of hazelnuts during the hazelnut harvest season represents a severe public health problem. 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. 14       | 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           | Argentine                                                               | 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 |                                                                       |
| Sarafoleanu 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                                   | 69.2% Seeds, nuts, berries and grains 15.4% Other types of food        |
| Göktaş et al. 21                  | 2010 | Retrospective study         | Germany                                                                 | 78 cases                             | Airways 6504 Nut 5553 Organic unspecified 3678 Seeds                                   |                                                                       |
| 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                                   |                                                                       |
| 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 | 29 (31%) Toy 17 (18%) Part of a toy 16 (17%) Lego® type toys            |
| 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 |                                                                       |
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 ingestion 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 drooling. Drooling and dysphagia were also most frequently reported in oesophageal FB in a retrospective study conducted on 1116 cases in a Turkish paediatric population. 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 prevalent. 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 auscultation. 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 dyspnoea. 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-

| 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                     |
Foreign body injuries in children 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 it 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 perforations 26, while small, round items (e.g. food items like berries) are found to increase choking risk 27. 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 obstruction 19. 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-

### Table II. Symptom of FB injury.

| Source          | Study type         | No. of cases/No. of included studies | Anatomical location | Symptoms                           |
|-----------------|-------------------|-------------------------------------|---------------------|------------------------------------|
| Jayachandra et al. 13 | Systematic review  | 17 articles, corresponding to 5559 cases | Digestive tract     | 7 studies: Vomiting               |
|                 |                   |                                     |                     | 6 studies: Dysphagia                |
|                 |                   |                                     |                     | 4 studies: Drooling                 |
|                 |                   |                                     |                     | 2 studies: Gagging                  |
|                 |                   |                                     |                     | 1 study: Fluid intolerance          |
|                 |                   |                                     |                     |                                    |
| Rybojad et al. 14 | Retrospective study| 192 cases were reviewed, a FB was retrieved in 163 cases | First, Second and Third narrowing of oesophagus | 512 (45.9%) Drooling |
|                 |                   |                                     |                     | 298 (26.7%) Dysphagia               |
|                 |                   |                                     |                     | 12 (1.1%) Vomiting                  |
|                 |                   |                                     |                     |                                    |
| Balci et al., 2004 | Retrospective study| 1116 cases | Oesophagus | 512 (45.9%) Drooling |
|                 |                   |                                     |                     | 298 (26.7%) Dysphagia               |
|                 |                   |                                     |                     | 12 (1.1%) Vomiting                  |
|                 |                   |                                     |                     |                                    |
| Chinski et al., 2010 | Prospective study | 320 cases | Airways | 96 Vomiting | 92 (28.7%) Vomiting |
|                 |                   |                                     |                     |                                    |
| Foltran et al., 2012 | Meta-analysis     | 174 articles, corresponding to 30,477 cases | Airways             | 96 Vomiting | 12,605 Cough |
|                 |                   |                                     |                     |                                    | 5947 Choking |
|                 |                   |                                     |                     |                                    | 4507 Dyspnoea |
|                 |                   |                                     |                     |                                    | 73 Voice hoarsens |
|                 |                   |                                     |                     |                                    | 59 Blood stained mucus |
|                 |                   |                                     |                     |                                    |
| Lea et al., 2005 | Prospective study  | 98 cases with suspected FB, in 56 FB was found | Airways             | 92 (28.7%) Vomiting |
|                 |                   |                                     |                     | 14.3% Cough                         |
|                 |                   |                                     |                     | 3.6% Dyspnoea                       |
|                 |                   |                                     |                     | 1.8% Pneumonia                      |
|                 |                   |                                     |                     |                                    |

| Symptoms         | Pain              | Others                           | Asymptomatic |
|------------------|-------------------|----------------------------------|--------------|
| 2 studies: Choking | 1 study: Odynophagia | 1 study: Retrosternal pain | 2 studies: Pain (not specified) | 2 studies |
Complications associated with ingestion of multiple magnets are necrosis, bowel obstructions, perforations, sepsis and even death, which are mainly attributable to delays in diagnosis. Additionally, the incidence of the ingestion of multiple magnets has increased in the last years, highlighting that, despite the fact that the risk related to magnet ingestion is well documented, preventive strategies are lacking. In addition, batteries represent an 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 fluids. 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 hours. 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 complications. 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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