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Accidental Aspiration of Orthodontic Components or Appliances

Siddharth Sonwane

Abstract

Background: Contemporary orthodontic practice consists of innovative appliances for ease, safe, and quick results. However, the associated potential disadvantages are rarely published. **Objective** is to publish the literature on the accidental swallow of foreign objects such as orthodontic appliances or parts of fixed orthodontic appliances in patients. **Method:** An electronic search was performed on PubMed, Medline, Scopus, The Cochrane Library, and EMBASE until March 15th 2019. Methodological quality and synthesis of case series and case report tool (MQCC) was applied to determine the quality of these case reports and series. The outcome variable was to assess its effect on airway and gastrointestinal tract; methods of removal of these foreign bodies. Meta-analysis was not performed as the study included case reports and case series in which no control groups were present. **Results:** Out of 113 case reports and series, twenty-nine articles were included in this systematic review. Only 31% of articles have satisfied the MQCC scale and maintained as high-quality case reports, 43% of articles were medium to high quality and 26% designated as low quality. **Conclusions:** An orthodontic appliance accidentally detaches from its position, and patient can engulf due to patient's negligence, lack of its maintenance education and awareness. Orthodontist should educate, instruct and provide a written format of management, precautions. Accidental ingested foreign body can be managed in two methods, first is noninvasive, check forth airway obstruction, encourage for fiber-rich diet and laxatives. Second method is the use of endoscopically and laparoscopy with use magill's forceps.

Keywords: accidental swallow, orthodontic appliances, arch wire, mini-screw

1. Introduction

Accidental ingestion of a foreign body is more often seen in children. Contemporary studies have reported that 1500 subjects die per year [1]. However, data published on a death rate depends upon the nature of the aspirated object, i.e. size, shape, and finishing [2]. Dhandapani et al. (2009) illustrate that 80% - 90% of the aspirated foreign bodies pass through the gastrointestinal tract routinely, approximately 10–20% need to be removed endoscopically, and 1% requires surgery [3]. Most researchers have described that high intake of fibrous diet; water and

laxatives are the regular methods in the management of ingested blunt objects. But, accidental swallow of sharp objects always associates with a high rate of airway obstruction and gastrointestinal (GI) perforation corresponding to treatment dilemmas [1–4].

To date, various innovative appliances are being used in dentistry and orthodontics but very rare among these material limitations have been published. Through this chapter, I would like to present the associated drawbacks of such appliances to “GI” and airway systems, their clinical presentations, recommendations, and management. For a better understanding of readers, this chapter is divided into introduction, incidences; Types of appliances ingested or aspirated, Pathophysiology and associated symptoms of ingested “FBs”, Management, Retrieval of accidental swallowed “FBs”, Recommendations to prevent accidental swallow, Basic measures to prevent accidental swallow and Conclusion.

2. Incidences of accidental ingestion of different orthodontic appliances reported in the literature

In general, incidence of accidental aspiration of foreign body occurs in children (80%), elderly, mentally impaired, or alcoholic individuals and sometimes it may occur deliberately in prisoners or psychiatric patients. Coins, meat boli, and button batteries; sewing needles, tooth picks, straightened paper clips and razor blades are the most often ingested foreign bodies [5].

In dentistry, accidental aspiration of foreign bodies is recognized as a hurdle in all clinical specialties of dentistry. A wide range of complications succeeding from foreign bodies (“FBs”) has been recognized in clinical practice as a broken denture, single-tooth crowns, inlays, endo files, and broken orthodontic appliance’s reason for the majority of “FBs” ingested by adults in the dental setting [1–6].

Kurkciyan et al. (1996), Pavlidis et al., (2008) and Dhandapani et al., (2009) have reported that the overall incidence of dental “FBs” aspiration is higher in adult than in children, among which 10–20% required endoscopic removal and 1% alarm for surgical removal [1–7].

In orthodontics, Wasundhara A. Bhad (2011), Uday Kumar Wizziyane Ahmad, and Priya Balakrishnan (2012), Appasaheb Naragond et al. (2013), have reported that the most frequently aspirated FBs are brackets, wire fragment, activation key, and fractured twin block, removable retention appliances, and lingual retainers. However, Tamura et al., reported that the incidence of accidental swallowing of orthodontic appliances ranges from 3.6% to 27.7% among them 2% -3.7% require emergency treatment as these foreign bodies obstruct in “GI” or respiratory tract, and the rest of the material pass “GI” without complications [7–11].

3. Types of appliances or components of orthodontic appliance ingested or aspirated

While the existing incidence of this complication in orthodontics is hypothetical, there is significant variation as to the types of appliances involved [8]. The reported “FBs” includes a lower spring retainer; fractured twin block appliance, expansion keys, fragment of a maxillary removable appliance, retainer, trans-palatal arch, and pieces of the arch wire [9]. In orthodontics, Hinkle published the first case of accidental aspiration of removable retainer

		Object	Place	Immediate symptoms	Location	Complications	Basic treatment	Final outcome
Nazif, M.M.; 1983	9 yr./f	Activation of expansion key	Home	Vomiting	Stomach	No signs of bleedings	Fiber rich diet	child's excrement
Hinkle, F.G. 1987	18/f	Retention plate	Home	Vomiting	Esophagus	Nil	Not seen	Laproscopy
Parkh house 1991	15/m	Removable plate	Home	Breathing	Esophagus	Medical emergency	Life support	Surgical removed
Lee BW 1992	15/m	Retention wire	Fast	Stomach pain	Pylorus	Bleeding in excreta	Soft diet	Gastroscope
Absi et al. 1995	25/m	Wire of Trensapatel bar	Home	Pain and vomiting	Upper part of iliac fosse	Pain	methylcellulose, stomach filler	Proctoscopy.
Debis et al. 2000	9 /f	Digit sucking appliance(habit braking appliance)	Home	Pain, palatel laceration,	Esophagus	Due to laceration during removal	Soft diet, antibiotics and analgesics	Without surgical intervention
Milton et al. 2001	14/f	Fixed bracket	Home	Pain, bleeding excreta	Abdominal region	Antibiotics and analgesics	Fiber rich diet	came out in large bowels
Queck et al. 2002	26/m	Coil spring	Dental office	Vomiting	Stomach	pain and blood spot in excreta	Fiber rich diet antibiotics	Gastroscope
Klein et al. 2002	15/m	Retainer	Home	Plural chest pain	Chest left side	Decreased count of WBC, cough	Broad-spectrum antibiotics	rigid bronchoscopy and removed

Table 1.
Summary of all case reports.

Author	Age/ sex	Object	Place	Immediate symptoms	Location	Complications	Basic treatment	Final outcome
Sfondrini, M.F.; 2003	23/f	Broken transpalatal bar	Fast food	Bleed during speech	Upper part of GI tract	Pain,		
Abdel-Kader 2003	26/m	Fixed bracket	Home	Nil	Stomach	Pain initiated after 13 day	Soft diet, antibiotics and analgesics	Gastroscope
Al-Wahadni et al. 2006	15/f	10 mm NITI 17X25 wire	Dental office	NILL	piriform recess	Pain during food intake	Post operative pyrexia	endoscopic retrieval
Allwork et al. 2007	13/m	Quad helix	Dental office	Bleeding, vomiting	lower esophagus.	visceral perforation	Post operative pyrexia	mini-laparotomy
Fiho et al. 2008	17/f	During orthognathic surgery	Operation theater	Nil	piriform recess	Soft diet, antibiotics and analgesics	removed with Magill forceps	MacIntosh laryngoscope
Sheridan 2009	16/f	Bracketa	DENTAL OFFICE	Nil	lower esophagus.	Nil	Soft diet, antibiotics and analgesics	Gastroscope
Nicolas et al. 2009	17/m	17x25 santilone	Dental office	Nasal bleeding	Floor at junction	Nasal spray otravin	antibiotics and analgesics	Nasal endoscopy
Rohida et al. 2011	12/M	Broken twin block	Home at sleep	Pain TMJ	Upper part esophagus.	Nil	Soft diet, antibiotics and analgesics	Endoscopy
Tripathi T et al. 2011	17/m	Hyrax activation key	Home	otorhinolaryngology emergency	hypopharynx	otorhinolaryngology emergency	Magill's forcep	fiber-optic nasopharyngoscope

Table 2.
Summary of all case reports.

		Object	Place	Immediate symptoms	Location	Complications	Basic treatment	Final outcome
Monini Ada et al. 2011	9/M	Expansion key	Home	Nil	Abdominal	Nil	Fiber food and drinks	Excreted after 4 days
Umesan et al. 2012	12/F	Arch wire 17x25NITI	Dental office	Sharp pain in throat region	Laryngeal region	Nil	Fiber food and drinks	Endoscope
Naragon et al. 2013	16/M	Molar band	Home	NILL	Left lower chest	Nil	Laxative, fiber food	Endoscop with grasper
Park et al. 2013	19/m	Arch wire 19x25NITI	Dental office	Momentary pain	piriform recess	Nil	Routine food	MacIntosh laryngoscope
Hoseini 2013	29/m	Premolar bracket	Home	Gastric irritations	lower stomach.	Pancreatitis,	Metronidazole, ceftriaxone, Pantoprazol	under sedation with Midazolam
Tiller et al. 2014	37/f	Khubyoshki wire	Home	Calcification in pancreatic	Head of papillae of pancreas	PANCREATITIS	Metronidazole, ceftriaxone, Pantoprazol	Endoscope
Wilmott et al. 2016	19/F	Bracket	Home	a scratch at side of throat	Lower left posterior teeth	Pain unable to chew food	five day course of Amoxicillin	Oral and maxillofacial surgeon removed
Nikhilesh vaidya et al. 2016	11/M	Mini-screw	Dental office	Nil	Not located	Nil	Observation	Observation
Ravi Kumar Mahto, 2019	15/M	Molar band	Home	Nil	Neck Region of esophagus	Nil	Observation	Endoscopy

Table 3.
Summary of all case reports.

and its retrieval report in 1987 [8–12]. The detail of cases published on accidental ingestion of various components, and their management is illustrated in **Tables 1–3**.

4. Pathophysiology and associated symptoms of ingested “FBs”

The accidental ingestion of “FBs” and appearance of any symptoms or signs is highly inconstant and depends on the age of the subject (child or an adult), movement, or impaction of “FBs”. According to Susini (2007), Yadav Yadav RK (2015), Thakral A, (2015) in 75% of children accidental aspirated “FBs” have impacted at the level of the upper esophageal sphincter, and in adults 70% of the ingested FBs lodge at the level of the lower esophageal sphincter. Thus, it’s crystal clear that accidental ingested “FBs” travel across a long pathway from an oropharynx to a gastrointestinal system with providing the clinical features of each stage [5, 8, 10].

4.1 “FBs” impacted at the oropharyngeal level

60% of the foreign bodies become lodged at this level. Subject presents with clear sensation of impacted “FBs”, discomfort, drooling of saliva, inability to swallow, airway compromise and also infection and perforation can also occur [5–13].

4.2 “FBs” impacted at the esophageal level

If the impacted “FBs” as expansion key, twin block, removable retainer, subject (child) represents with gagging, vomiting, recurrent aspiration pneumonia and due to tracheal impingement may develop stridor or respiratory embarrassment while in adults presents with, dysphagia, and salivary drooling/pooling [5, 7, 8, 11, 14]. Wasundhara bhad and Rohida reported that the use of a broken Twin-block appliance was accidentally ingested in sleep [11, 13, 15, 16]. The patient developed immediate symptoms as breathless with a severe cough. The patient’s father tried Heimlich’s Maneuver method to retrieve it but failed, immediately subject shifted to emergency medical service. Endoscopically removed and confirmed that broken part of twin block located in the esophageal region [15–20].

4.3 “FBs” impacted at a sub-esophageal level

At this level delayed, symptoms develop as recurrent vomiting, passing rectal blood, and melena. Ghori et al. published case report in which removable retainer was accidentally aspirated, passed uneventfully from the elementary canal and caused perforation of the sigmoid colon proving lethal to the patient [16, 18, 20–23].

4.4 “FBs” impacted at gastrointestinal perforation

Delayed symptoms presents as with acute mediastinitis with chest pain with signs of pleural effusion and acute/subacute peritonitis. Uday Kumar Umesan et al. 2012 reported a case of accidental aspiration of arch wire segment during adjustment and were located at the laryngeal region that necessitated endoscopic retrieval in the hospital [24, 25–29].

4.5 “FBs” impacted at body in airway

Patient present with classic triad of wheezing, coughing, and dyspnea immediate after accidental swallow; It later may develop with signs of the respiratory arrest and stridor [5–39].

5. Management

The existing incidence of accidental ingestion of “FBs” complication in orthodontics is hypothetical; there is substantial dissimilarity as to the types of appliances involved [14, 17, 30]. The literature published on accidental swallowing of “FBs” includes a lower spring retainer; broken twin block appliance, expansion keys, quad helix, transpalatal arch, and pieces of arch wire (**Tables 1–3**). Although, there is scanty evidence to pinpoint appliance or procedure has been related with an augmented risk of aspiration; the minute size of orthodontic components and saliva, limited working access, apprehensive subject, chair position, operator knowledge are the contributing factors [2, 4, 5, 7–9, 13, 16–18].

5.1 Case history

If the incident occurs in resident (outside of the clinic), a positive history of accidental swallow could be elicited. Clinician should note that a high degree of disbelief should be maintained especially in children and impaired adult while recording case report with missing orthodontic appliance fragments or components. A wise clinician must have check for clinical signs and symptoms that could appear in subject, which helps for a clinician to advise further radiographic investigation or call medical emergency service [17–21, 31].

5.2 Diagnosis

Based on case history and appearance of clinical symptoms suspicious inspection of the complete oral cavity, pharynx, larynx, and esophagus should be the first step taken. As per the pathophysiology of “FBs”, and clinical signs further investigations as abdominal and chest X-rays, endoscopy, and computed tomography scans of thorax should be advised to confirm the lodgment of “FBs” [2, 3, 6, 11, 13, 14, 16–18, 22, 23, 33].

5.3 Radiographic assessment

Generally, radiographic assessment designated for subject with a positive history of accidental swallow of “FBs” within a period of less than 24 hours and without appearance of any respiratory symptoms. A chest radiograph is mandatory, but the “FB” is acrylic (radiolucent object), becomes difficult in localization of its exact position. In such situation subjects are made to swallow to identify the precise site of impaction, and ask the patient for area of uneasiness [2–26, 30–36].

If both the attempt fail to locate “FBs”, a small amount of barium sulfate suspension is mixed with cotton wool pellets given to subjects to form a radio-opaque bolus around the object; this method significantly allow to track “FBs” radiographically. Also, gastrografin (a contrast agent), “CT” and “CBCT” scans have proved to be highly useful in locating the radioluscent foreign bodies [26, 38, 39].

6. Retrieval of accidental swallowed “FBs”

If accidental swallowing of FB occurred in a dental office, there are two methods to retrieve FB, the first line of action is the use for the Heimlich maneuver technique, abdominal or chest thrusts; secondly, turn the patient head one side and ask to spit; if an object does not spill out check in the oral cavity and oropharynx, supra-tonsillar recess, epiglottic vallecula and the piriform recess under good illumination and if the object is visible, it should be retrieved with forceps or high-volume suction [1, 5, 9, 12].

If the incidence occurs outside the clinic or in resident, based on case history, symptoms, diagnosis, and location of aspirated FBs subjects can be managed as Non-invasive emergency measures, Invasive emergency measures, and Surgical intervention [1, 2, 4, 9, 12, 16, 20, 24].

6.1 Non-invasive emergency measures

Size of the ingested “FBs” (larger than 6 cm in children and longer than 10 cm in adults) cause cyanosis, loss of consciousness, and permanent brain damage occurs within 4 to 6 minutes alarming a medical emergency if the obstruction is not relieved [1, 3, 6, 8, 16, 20, 34]. Therefore, speed and updated cardiopulmonary resuscitation (CPR) skills are vital for the clinician. If the “FBs” is obstructive and the patient is in respiratory distress, dislodgement should initially be attempted with back blows and abdominal thrusts (Heimlich maneuver). If this cannot dislodge the object, positive airway pressure needs to be maintained by artificial respiration until emergency services arrive [4, 5, 7, 11, 14, 21, 32, 35].

6.2 Invasive emergency measures

In this stage, “FBs” has passed the vocal cords uneventfully, but the subject requires medical attention. Few authors have reported that in 1–2% of subjects ingested “FBs” spontaneously expel, still do not wait for this to happen. Consider the entire subject as in an extreme emergency and to be escorted to the hospital for radiographic investigation to locate the position of “FBs”, because 6% mortality has been reported with such subjects [4, 11, 16, 25, 32]. In this phase of emergency if the “FB” lodged in esophageal and tracheal region endoscopy is the best method to retrieve “FBs”. Flexible pan endoscopy under local anesthesia is preferred for “FBs” lodged in intrathoracic areas and is accessible in tertiary medical centers. However, in this situation rigid endoscopy is recommended to reduce complication rates. Most commonly available armamentarium is Foley’s catheter, passed distal to ingested “FB” under fluoroscopic guidance, inflating the balloon object can be retrieved [14, 16, 17, 21, 31, 34, 36].

6.3 Surgical intervention

This method to be opted last measure to retrieve accidental ingested “FBs”. Subject gives all the clinical signs and symptoms of vital organ damage. Few authors have reported that the mortality and morbidity rates are very high in this stage. However, surgery is relatively successful opted during gastrointestinal perforation or lodgment in the airway [23, 26, 33, 36, 38].

7. Recommendations to prevent accidental swallow

During orthodontic treatment, there is always a high risk of accidental swallow or aspiration of appliance components. So the aim of the orthodontist must be to prevent and secure loose orthodontic components during treatment procedures.

Measures to be taken to minimize accidental swallow of orthodontic components include the following recommendations.

7.1 Case selection

The clinician needs to be more alert during the first consult appointment with young children, at this age group subject cannot understand and follow the instructions given by the clinician. The principal responsibility of an orthodontist is to assess the amount of cooperation that can be achieved from the patients and their parents during treatment. So an orthodontist must check complete cooperation and persistent controlling of their children to confirm that professional instructions are respected [10, 16, 23, 24, 26, 27].

The medico-legal point of that an orthodontist must opt to delay treatment until a patient's parent should give consent about their awareness of risks involved during a course of orthodontic treatment to avoid fallouts later [1, 23, 24, 27, 38].

8. Basic measures to prevent accidental swallow

8.1 Removable appliances

Operate with textured latex gloves to have a firm grip on orthodontic components. Routine visits for appliance adjustment should ensure adequate retention and its integrity. The clinician must give patient instruction in both verbal and written forms, also warn or alert them not to self-adjust or repair broken fragments instead should visit the orthodontist to ensure the appliance uprightness [11, 13, 16, 30, 33].

Use of contrast color to gastrointestinal mucosal color, in case of accidental swallows, can be identified easily during its retrieval through endoscopy [16].

During the night, wares of appliance tie a silk thread knot to either clasp assembly or active components [1–27, 30–39].

In-office, on chairside adjustment of an appliance, 7'o'clock should be the operator's position and make the patient comfortable before doing any adjustment [37].

Tie a silk thread knot to the activation key, quad helix at the time of activation, if any accidental aspiration occurs, the appliance can be securely retrieved through tied silk thread [29].

8.2 Fixed appliances

During bonding brackets, the operator should be at 7'o'clock position; use of a high-intensity light cure unit is always recommended and a high-vacuum section should be used.

Molar bands should be preferred over bondable tubes; especially in the second molar figure of ligature (. 009) should be tied to the first molar and second pre-molar [21, 26, 31, 39].

During the cutting of excessive distal end of archwire segment, use the gauze pad as protection distal tissue, adjust the length of wire outside the mouth on study models, or cinch the excess wire.

During debonding should be carried along with its base wire attachments.

9. Conclusion

Accidental swallowing of orthodontic appliances or components of it can occur often. The orthodontist must be skillful, knowledgeable, and cautious during

treatment procedures. To counteract such an emergency, someone must well equip the orthodontic office, well-trained nurse staff; the medical emergency number should be maintained.

At the first consultation, an orthodontist must well educate and must make aware of demerits and accidental situations, management protocol in such as condition. The clinician must follow a protocol of prevention is better than cure.

Abbreviations used

“FB”/“FBs”	foreign bodies
“GI”	gastrointestinal Track
“CT”	cone been technique
“CBCT”	computed cone been technique
“CPR”	cardiopulmonary resuscitation

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