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Ingestion of orthodontic appliances: A literature review

Ioanna I. Karamani¹, Miltiadis A. Makrygiannakis¹, Ilias Bitsanis¹ and Apostolos I. Tsolakis^{1,2}

Abstract

Ingestion is the entry of a substance into the human organism, which occurs by taking it through the mouth into the gastrointestinal tract. One of the adverse events that may happen during the course of an orthodontic treatment is the ingestion of orthodontic appliances. The present review aims to investigate the literature regarding the ingestion of orthodontic appliances. An electronic search was carried out in order to identify case reports of ingestion of foreign objects related to orthodontic treatment in PubMed, Scopus, and Web of Science until July 2019. Nineteen articles were retrieved. In these articles, ingestion had occurred inadvertently, due to patients' or orthodontists' errors. Some of the most commonly ingested appliances were molar bands, segments of wire, and expansion keys. It is likely that patients with a specific medical background are more prone to ingestion of orthodontic appliances. Special precautions need to be taken in order to avoid such incidents. These precautions are analyzed in three categories: general, those related to fixed appliances, and those related to removable appliances.

Keywords:

Aspiration, ingestion, orthodontic appliances, orthodontics, review

Introduction

Ingestion constitutes the entry of a substance into the human organism, which occurs by taking it through the mouth into the gastrointestinal tract.^[1] On the other hand, aspiration is the entry of a substance into the larynx and lower respiratory tract through the oropharynx or gastrointestinal tract.^[2] Regarding dental procedures, the entry of a material occurs only from the oropharynx. No symptoms are usually presented during the ingestion of foreign objects, and its confirmation occurs after recognition in the patient's stool. In case the ingestion is symptomatic, common symptoms are coughing, gagging, dysphagia, cramps, and peritonitis.^[3] On the contrary, aspiration of foreign bodies is symptomatic and accompanied by signs

and symptoms such as coughing, choking, gagging, inspiratory stridor, cyanosis, and decreased oxygen saturation. Atelectasis is apparent in complete airway obstruction, while the retention of a foreign object in the airway for a long time can result in infection, pneumothorax, or death.^[4] Nevertheless, it should be clarified that in many papers, the terms "ingestion" and "aspiration" are perplexing, misinterpreted, and sometimes used interchangeably. Therefore, whenever "ingestion" is mentioned in the present review, it will be defined as above.

The most frequently ingested objects are dietary foreign bodies and toothpicks, with dentures being a common risk factor,^[5] while it has been considered that objects related to dental clinical practice come second in the list of most commonly ingested foreign objects.^[3] The occurrence is more likely to take place among children. Extracted teeth, endodontic instruments, prosthesis, and orthodontic appliance items are possible

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¹Department of Orthodontics, School of Dentistry, National and Kapodistrian University of Athens, Athens, Greece, ²Department of Orthodontics, School of Dental Medicine, Case Western Reserve University, Cleveland, Ohio, USA

Address for correspondence:

Dr. Ioanna I. Karamani, Dentist, Department of Orthodontics, School of Dentistry, National and Kapodistrian University of Athens, Thivon, Athens - 11527, Greece.
E-mail: joanna.karamani@gmail.com

ORCID ID: <https://orcid.org/0000-0003-4815-0967>

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to be aspirated or swallowed.^[6] It could be explained by the fact that unanticipated movement of a patient in combination with a supine positioning proliferates the possibility of ingestion or aspiration during the dental clinical practice.^[3] Bilder *et al.*^[7] mentioned that most cases of ingested dental objects occurred outside the dentist's office and in fact the maxilla was involved. According to Webb *et al.*^[8](1984), chances are better than 12 to one that it will be in the gastrointestinal tract rather than in the airway if an object passes the tongue. The reflective coughing after the entry of a foreign body in the patient's airway could explain the reason why ingestion is more likely.^[7]

The ingestion and aspiration of dental materials, devices, and instruments are mainly described in case reports, in which the possible risks and complications of these situations are also noted. Due to the nature of the adverse event of ingestion of orthodontic appliance, the most convenient way to study it would be in a retrospective manner. However, it seems that there is a lack of relevant retrospective studies regarding orthodontic instruments or materials and the existing literature mainly consists of case reports. Thus, the objective of the present review is to investigate the existing literature about the ingestion of orthodontic appliances and specifically identify relevant case reports, elucidate patients who are prone to ingestion, and make suggestions in order to avoid it.

Materials and Methods

An electronic search was carried out in order to find case reports of ingestion of foreign objects related to orthodontic treatment in the databases PubMed, Scopus, and Web of Science until July 2019. Searches were performed without placing any restrictions on the date and status. Only English language papers were considered. Case reports, in which orthodontic patients of any sex, age, or nationality underwent orthodontic treatment and happened to ingest fixed or removable orthodontic appliances, were taken into consideration. The type of appliance and some details about the patients should be reported. If an ingestion of dental instruments, irrelevant to orthodontics, had been described, then the case report would not be considered for inclusion.

Results

In total, 147 articles were retrieved from the electronic search. After title-reading, 113 articles were rejected, while 15 more did not meet the inclusion criteria after reading the abstract and full text. Finally, 19 papers (case reports or case series) were included in this review [Figure 1]. They are presented in Table 1. Various reasons led to the ingestion of the appliances.

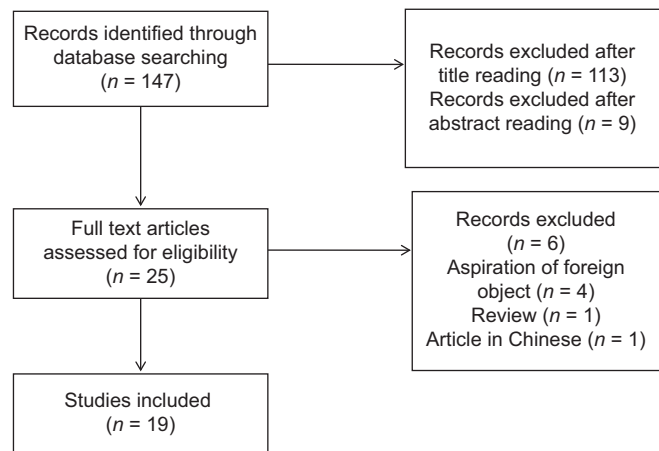


Figure 1: Flowchart of records

In Hinkle (1987), the appliance was ingested during sleep, although it had been manufactured in order to reduce the probability of accidental swallowing.^[9] The exact same occurrence happened in a patient of Dibiase *et al.*^[10] (2000), and the main reason was the lack of retention. Abdel-Kader^[11] (2002) also described a patient who ingested his appliance with food, but apart from that, he was also a poor attender. Regarding Allwork *et al.*'s^[12] case (2007), the patient had Down's syndrome, but the primary reason for his accidental ingestion of the Quadhelix appliance was the fact that the replaceable elastomeric separating rings of the appliance were worn and therefore the removable part of the appliance was displaced from the molar bands. In Rohida and Bhad's article (2011), although the lower portion of the appliance had broken after it was dropped, the patient kept wearing it and subsequently ingested it during his sleep.^[13] Verma *et al.*^[14] (2014) report that a segment of pendulum appliance was fractured and the patient swallowed it during her breakfast. In Puryer *et al.*'s article (2016), the archwire fragment was not retained in the cutting pliers and slipped into the oropharyngeal region.^[15] In Lee's case report and Milton *et al.*'s second patient, a segment of the wire was swallowed while eating food.^[16,17] A segment of wire was also ingested in Obinata *et al.*'s (2011) and Jauhar *et al.*'s (2016) cases, but the condition under which the ingestion occurred is not explained.^[18,19] Hoseini *et al.*^[20] (2013) report that the lack of patient compliance led to the debonding of several teeth brackets of the maxillary arch and the incident of ingesting a piece of wire occurred while the patient was eating. In the case report of Monini *et al.*^[21] (2011), a key was swallowed during the activation of an orthodontic appliance at home. Tripathi *et al.*^[22] (2011) report that while the hyrax screw was being activated, the patient made an unexpected movement, because of a phone ringing, and as a result, the key slipped. Nazif and Ready (1983) refer to two cases in which the patients swallowed the expansion appliance keys, but

Table 1: General characteristics of the included case reports

Authors (year of publication)	Orthodontic appliances	Patient's sex	Patient's age (years)
Nazif <i>et al.</i> (1983) 2 cases ^[23]	Expansion keys	–	–
Hinkle (1987) ^[9]	Modified lower spring retainer	Male	14
Lee <i>et al.</i> (1992) ^[16]	Piece of archwire	Male	15
Milton <i>et al.</i> (2000) 3 cases ^[17]	Bracket on LR6 (46)	Female	14
	Segment of wire	Female	13
	Segment of wire	Male	15
Dibiase <i>et al.</i> (2000) ^[10]	Simple removable appliance	Female	9
Abdel-Kader <i>et al.</i> (2002) ^[11]	Transpalatal arch	Female	12
Al-Wahadni <i>et al.</i> (2006) ^[26]	Molar Band	Female	16
Allwork <i>et al.</i> (2007) ^[12]	Quadhelix	Male	13
Obinata <i>et al.</i> (2011) 2 cases ^[18]	Orthodontic wire	Male	62
	Orthodontic lingual arch ST lock	Female	8
Monini <i>et al.</i> (2011) ^[21]	Expansion key	Male	9
Rohida and Bhad (2011) ^[13]	Twin-block appliance fragment	Male	12
Tripathi <i>et al.</i> (2011) ^[22]	Key	Male	17
Hoseini <i>et al.</i> (2013) ^[20]	Orthodontic wire	Male	29
Naragond <i>et al.</i> (2013) ^[27]	Molar Band	Male	16
Verma <i>et al.</i> (2014) ^[14]	Wire of pendulum appliance	Female	15
Puryer <i>et al.</i> (2016) ^[15]	Archwire fragment	Female	15
Jauhar <i>et al.</i> (2016) ^[19]	Section of orthodontic archwire	Male	15
Pantuzo <i>et al.</i> (2017) ^[24]	RPE activation key	Male	13
Mahto <i>et al.</i> (2019) ^[25]	Molar band (16)	Male	15

Articles appear in chronological order; RPE=Rapid palatal expansion

the circumstances under which the ingestion occurred are not clarified.^[23] According to Pantuzo *et al.*^[24] (2017), the key slipped from the parent's fingers and the patient swallowed it during the activation of the appliance at home. Parents admitted that they felt overconfident and as a result they neglected to use dental floss to tie the rapid palatal expansion (RPE) key, as it was advised. Finally, Mahto *et al.*^[25] (2019) report that the patient swallowed a molar band, when it was recemented, whereas in Al-Wahadni *et al.*'s^[26] (2006) and Naragond *et al.*'s^[27] (2013) cases, the molar bands were swallowed under unknown circumstances.

Discussion

Ingestion or aspiration of foreign bodies is not a common occurrence. Actually, both retrospective and longitudinal studies of ingestion and aspiration have shown that its frequency is around 0.004% and that aspiration is rarer than ingestion.^[24] In most of the cases, natural excretion of the foreign object is observed. In only 1% of the cases complicated problems occur, which may result in death.^[17] At this point, it should be made clear that the aforementioned details refer to ingestion in general and not specifically to orthodontic appliances.

As far as orthodontic appliances are concerned, the small size of their components combined with saliva makes their handling difficult and therefore increases the possibility of ingestion. In addition, the inclination of the patient on the dental chair during the treatment

constitutes another risk factor. More specifically, a patient who is supine or semirecumbent presents a higher probability of swallowing or inhaling an object that has been fallen into the oropharynx.^[7] Furthermore, the risk of the occurrences depends on the size, shape, and flexibility of the object and as a result some cases present minimal danger, while others can be lethal.^[28] Finally, patients may be susceptible to ingestion when fractures or detached components have been observed in the orthodontic appliances.^[16]

This may explain why the majority of the included case reports refer to ingestion of materials related to orthodontic treatment with fixed appliances. As far as size, shape, and flexibility of these objects are concerned, it seems that they are at high risk of being swallowed by the patients. Also, as they are fixed on teeth, the patient is not able to detect potential fractures in order to have them removed before ingestion. Furthermore, although keys are not part of the appliances, they are used to activate them. When an appliance is fixed, its activation needs to be performed intraorally. Its small size, the supine position of the patient, and potential difficulties in placing them inside the screw in order to complete the activation may be the most significant factors related to their ingestion.

On the other hand, regarding removable appliances, fractures of functional appliances are mainly mentioned in the literature. Specifically, a patient kept wearing a Twin Block, despite its breakage.^[22] This resulted in its ingestion.

From our point of view and based on our clinical experience, patients who are more prone to ingestion of orthodontic appliances are people suffering from intellectual disability, epileptic seizures, hyperkinetic disorder, intense vomit reflex, and panic attacks. Thus, it is extremely important to always take a meticulous medical history before the initiation of an orthodontic treatment.

The most significant and difficult task of an orthodontic patient is to complete the orthodontic treatment without orthodontic material fractures and debonding, and this is the reason why the abovementioned categories of patients have an increased tendency for ingestion of the appliances. Utmost care, cooperation, and maintenance are some of the basic requirements.^[27]

The type of appliance ingested depends on the stage of the orthodontic treatment. It includes both removable appliances (or parts of them) and components or accessories of fixed appliances such as expansion keys, some types of retainers, segments of wire, transpalatal arch, a molar band, and even a twin block appliance. However, incidence of broken orthodontic appliances or components constitutes the vast majority.^[27]

Regarding orthodontic wires, which are one of the most common ingested orthodontic components, they may fall into two situations. First, this may occur when the orthodontist places a new archwire and the distal end should be cut in order not to injure the patient's mucosa.^[10] For this reason, distal end cutter orthodontic pliers are on the market. However, the component of the archwire may fall into the patient's oropharynx for any reason such as using inefficient or inappropriate instruments. Another case is that the patient may be discharged, and the wire breaks in everyday life activities. This may happen if a part of the archwire accepts a masticatory force without support or because of inadvertence during mastication or due to application of a very high force that could lead to debonding of some of the brackets.^[16]

Since it is not possible for orthodontists to fully eliminate the possibility of a patient swallowing an appliance, the fabrication and the design of the orthodontic appliances should be performed with special attention. In the majority of cases, it is not the size but the design or structure of the appliance that leads to dangerous and complex problems during ingestion, by harming or irritating the tissue. An additional problem is the irritation and the damage of tissues during the effort required for the object's retrieval.^[12]

Regarding patients who ingested a foreign object, radiography should be performed at regular intervals,

and they should be evaluated for signs and symptoms, such as airway obstruction or intestinal perforation.^[16]

If a material falls into a patient's oropharynx, the reclined position of the patient is required in combination with vigorous coughing. The main concern is to keep the airway open. Otherwise, signs and symptoms of airway obstruction are presented, such as intense coughing and choking. If further intense coughing does not improve the situation, the Heimlich maneuver should be performed.^[29] If the foreign object continues not to be retrievable, emergency help should be called and the patient should be transferred to the nearest hospital.^[30]

In order to prevent or reduce the possibility of such foreign body ingestions, the following precautions must be taken.

General Precautions

1. Patients with special needs and very young children are categories of patients who may not be capable of understanding the directions of the clinician. The orthodontist has to evaluate the cooperation of the patient and the support of parents and protectors in order to ensure that the instructions are followed. Otherwise, the orthodontist should postpone the treatment or not provide treatment at all.
2. Textured latex gloves may help in a better handling of orthodontic instruments and appliances.
3. The orthodontist should check the retention and possible wear of the appliance at each meeting.
4. Both verbal and written advice should be given to patients when a new device is placed. It should be clarified to patients that they should not try to reposition broken or damaged fragments of any appliance. On the contrary, the patients should stop using them immediately until they visit the orthodontist.
5. Cell phones should be turned off when attending the clinical practice in order for both the orthodontist and the patients not to be disrupted.^[22]
6. All orthodontic instruments must be periodically checked for signs of malfunction and should be replaced or repaired when necessary.
7. If a segment of appliance falls into the mouth of the patient, immediate suction is required.
8. The clinician should refresh their knowledge of cardiopulmonary resuscitation, as there are frequently changes and updates.^[9]
9. The presence of an orthodontic assistant is always crucial so that they can help the clinician in such a case.
10. Keys used to turn screws must be tied with floss, which should be tied to the hand of the person feeling the activation.^[9]

Precautions with Fixed Appliances

1. Bands should be tied by dental floss through the molar tubes, especially during banding of the second molars.
2. Making use of bondable tubes and attachments increases the risk of these attachments being inhaled or swallowed if they are displaced, so it is recommended to secure the archwire whenever possible.
3. A gauze pad distal to the device or the archwire is a good practice to protect the mucosa from possible injury and could also work as a trap for any segment of archwire, which cannot be kept in the distal cutter pliers.
4. Cutting tips of instruments should be frequently inspected for any sign of wear and should be swapped in case of damage.
5. Removable transpalatal arches must be secured with the use of dental floss during placement and reinforced at the attachment point with elastomeric ligatures and/or stainless-steel ligatures.
6. During the debonding of brackets, it may be safer if they remain attached to the base archwire.^[31]
7. A visual confirmation of the cutting ends of distal cutters pliers for trapped segments of wire is recommended.^[31]
8. The resistance of the material of the archwire to masticatory force should be considered.^[32]

Precautions with Removable Appliances

1. All retentive components should be examined at every scheduled appointment for any sign of fracture. Re-fabrication of the appliance is advised if this is detected.
2. The acrylic plate(s) should be checked for cracks, particularly on pressure-bearing surfaces, to rule out accidental damage to an appliance during use.
3. The acrylic which will be used to make the appliance should be radiopaque. This way, locating the appliance or part(s) of it would be made easier.^[31]
4. The removable appliances should have smooth edges, and small orthodontic appliances should be secure when they are placed in the patient's mouth.^[13]
5. The orthodontic appliances that are to be used should have an acrylic color other than pink (or clear).^[22]

At this point, we would like to clarify that the aforementioned precautions are based on the existing literature and the authors' clinical experience.

Conclusions

Ingestion is an unwanted incident that may occur during the course of orthodontic treatment. Orthodontic patients

may swallow parts of fixed or removable orthodontic appliances, during clinical practice or on their own. Precautions should always be taken to avoid ingestion, as it can seriously compromise patients' health. Regarding the ingestion of orthodontic appliances, the existing literature mainly consists of case reports and case series. Well-documented retrospective studies need to be conducted in the future in order to further elucidate which patients are more prone to ingestion, which errors from the patients, and orthodontists could lead to ingestion and what other precautions can be taken in order to avoid it.

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Conflicts of interest

There are no conflicts of interest.

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