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ORIGINAL ARTICLE

Inhalation or ingestion of orthodontic objects in Finland

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Abstract

Objectives. Although inhalation or ingestion of orthodontic appliances can lead to serious medical problems, the real incidence of these complications is anecdotal. This study had two aims: (1) to define the frequency of accidental inhalation/ingestion of orthodontic objects in Finland and (2) to analyze their further management. ***Materials and methods.*** An electronic, semi-structured questionnaire was sent to all members of the Orthodontic Section of Apollonia, the Finnish Dental Society ($n = 251$) and the Finnish Federation of Dental Hygienists ($n = 437$). After one reminder, 55.8% of dentists and 34.8% of dental hygienists responded. ***Results.*** In total, 20.0% of the dentists and 6.9% of the dental hygienists reported having one patient who had ingested or inhaled an orthodontic object. The percentages for two or more cases were 18.6% and 6.9%, respectively. According to dentists' answers, the procedures following these complications were (1) observation for 2–14 days ($n = 27$), (2) radiologic evaluation ($n = 14$), (3) medical emergency ($n = 6$) and (4) dietary instruction ($n = 4$). Dental hygienists reported (1) observation ($n = 9$), (2) dietary instruction ($n = 3$) and (3) medical emergency ($n = 1$). None of the cases had been life-threatening. ***Conclusions.*** Although the risk of inhalation or ingestion of orthodontic objects is small and the consequences rarely serious, it should be taken into consideration. Prospective patients should be informed of this possibility.

Key Words: *accidental, aspiration, dental hygienist, emergency*

Introduction

In Finland, orthodontic services in publicly funded healthcare are free-of-charge for children and adolescents up to the age of 18 years. Approximately 24,000 orthodontic treatments are started every year. Because of the scarcity of specialist orthodontists, treatments are generally managed by specialist orthodontists while almost half of the treatments are implemented by general practitioners trained in orthodontics and supervised by specialists [1]. In addition, routine orthodontic tasks have been delegated to dental hygienists [1]. The average starting age for orthodontic treatment is 9.5 years, although the variation is wide [2]. Early intervention in the age group of 5–8 years or even earlier is common [2].

Given that most orthodontic treatments usually last several years, accidental inhalation and ingestion of orthodontic objects is a potential complication during treatment. Inhalation or ingestion can pose a serious medical concern that requires immediate action and in some cases even hospitalization [3,4]. According to a Japanese study [5], foreign bodies of dental origin constitute 4–28% of all esophageal foreign bodies. There have been reports of, e.g. ingested braces, arch wires [6–9], a rapid palatal expander, a key applied with this kind of appliance [10–12], an orthodontic/pediatric appliance [9], a fractured Twin Block [13] and a removable quad helix [4]. Furthermore, inhalations of a dental retainer [14] and a bracket [15] have been reported in the literature. However, most of these cases did not have serious consequences. In addition to the immediate obstruction of the airway, there are several possible consequences. These include, e.g. bronchial stenosis, bronchiectasis, lung abscess, tissue ulceration or erosion, esophageal perforation with secondary mediastinitis, pneumothorax, intestinal obstruction, perforation with subsequent abscess formation and hemorrhage or fistula [13,16]. In orthodontics, there are no reported deaths as a complication following ingestion or inhalation, but in the field of dentistry, one fatal ingestion of a

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prosthesis has been reported [17]. The frequency of inhalation or ingestion episodes is not well known, although the phenomenon is recognized and familiar to the orthodontic community [18].

Although inhalation or ingestion of orthodontic appliances can lead to serious medical problems, the prevalence of these complications is more or less anecdotal. During the past 20 years, only two cases have been reported to the Finnish Patient Insurance Centre. Because the decision to treat a malocclusion is based on an elective choice, the benefits and disadvantages of orthodontic treatment must be considered carefully. The aims of this study were (1) to define the frequency of accidental inhalation/ingestion of orthodontic objects in Finland and (2) to analyze further management of these cases in order to find out whether the risks or complications may in some cases exceed the expected benefits of orthodontic treatment.

Materials and methods

This study is comprised of two parts. Two semi-structured questionnaires (Appendix) developed by the authors were sent electronically using online survey and analysis software (Webropol, University of Turku). The first questionnaire was sent in May 2011 to all members of the Orthodontic Section of Apollonia, the Finnish Dental Society (n = 251) to which the majority of orthodontic practitioners belong. The second questionnaire, a similar but appropriately modified version, was sent in April 2012 to all members of the Finnish Federation of Dental Hygienists (n = 437). One reminder was mailed to both groups 3 weeks later. A total of 55.8% (n = 140, 111 specialist orthodontists, 14 post-graduate students, 15 general practitioners) of the members of the Orthodontic Section and 34.8% (n = 152) of the dental hygienists responded. Fifty-one of the dental hygienists responded that they were not involved in orthodontics; they were given instructions not to proceed with the inquiry after Question 5.

In addition to background data, the respondents were asked whether their patients had inhaled or ingested any orthodontic object during their career as a practitioner. If the response was positive, the respondent was asked for further information, e.g. whether the appliance or part of it was inhaled or ingested and what procedures according to sequence were used. In the modified questionnaire, dental hygienists were further asked if they had received training for these types of emergency situations.

Statistical analyses

Associations between the number of patients experiencing ingestions or inhalations, graduation year and effect of these incidences on future treatment protocols were evaluated using cross-tabulation and chi-squared tests, separately for dentists and dental hygienists (IBM SPSS Statistics for Windows, Version 20.0, IBM Corp., Armonk, NY); p-values < 0.05 were interpreted as statistically significant.

Results

A total of 20.0% of the dentists and 6.9% of the dental hygienists reported that ingestion or inhalation of an orthodontic object had occurred once. Further, 18.6% of the dentists and 6.9% of the dental hygienists reported it had happened to 2–15 patients. Dentists who had graduated before 1979 reported more cases than dentists in later graduation years (Table I).

The numbers of reported cases were 150 (dentists) and 28 (dental hygienists). In addition, the answers included estimations such as 'many' or 'several cases'. A total of 7.9% of the responding dentists and 5.9% of the dental hygienists could not recall whether or not their patients had ingested or inhaled any orthodontic objects. The distribution of the ages of patients who had experienced these accidents is presented in Figure 1. Only dentists reported accidents that had occurred to patients in the age group of 0–5 years and to patients older than 21 years. Among 6–20-year-olds, the ages of dental hygienists' and dentists' patients were comparable. The majority of patients were between 11–15 years. All cases reported by dental hygienists were ingestions, while 53 dentists reported ingestions and two dentists reported inhalations.

Table I. Number of reported inhalation and ingestion cases according to the respondents' graduation year.

	Accidental inhalation or ingestion of orthodontic objects	
Year of graduation (number of respondents)	One patient (% of the category)	More than one patient (% of the category)
Before 1970 (n = 11)	0 (0)	4 (36)
1970–1979 (n = 41)	15 (37)	8 (20)
1980–1989 (n = 41)	5 (12)	7 (17)
1990–1999 (n = 35)	5 (14)	6 (17)
2000 or later (n = 12)	3 (25)	1 (8)

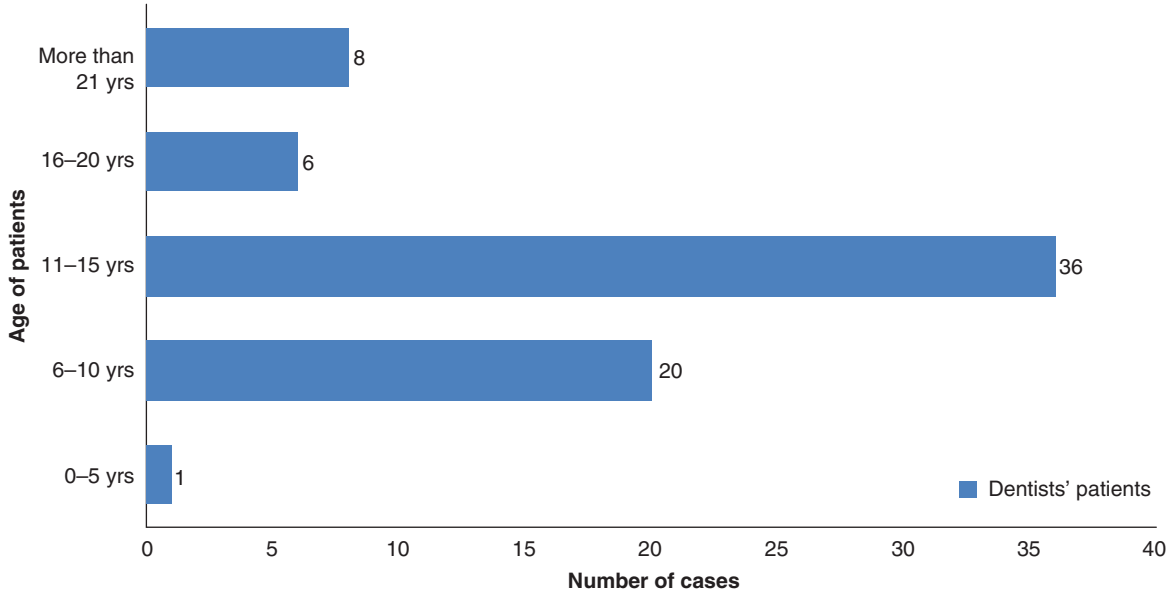

Figure 1. The age of patients inhaling or ingesting orthodontic objects. The figure illustrates accidents reported by dentists; those reported by dental hygienists were distributed equally.

According to dentists, complications had usually occurred outside of the office, while eating or sleeping, whereas, for dental hygienists, the complication usually occurred while in the office. The locations of these events are presented in more detail in Figure 2. Among dentists, the most common reason for ingestion or inhalation was loosening of the appliance (n = 29), whereas for dental hygienists the most common reasons were the object falling into the mouth ($n = 10$) and loosening of the appliance ($n = 6$).

The incident frequencies for the different types of ingested or inhaled orthodontic objects are illustrated in Figure 3. Among removable appliances were reported e.g. silicon trainers. No particular fixative material could be pinpointed as being responsible for the loosening of fixed appliances.

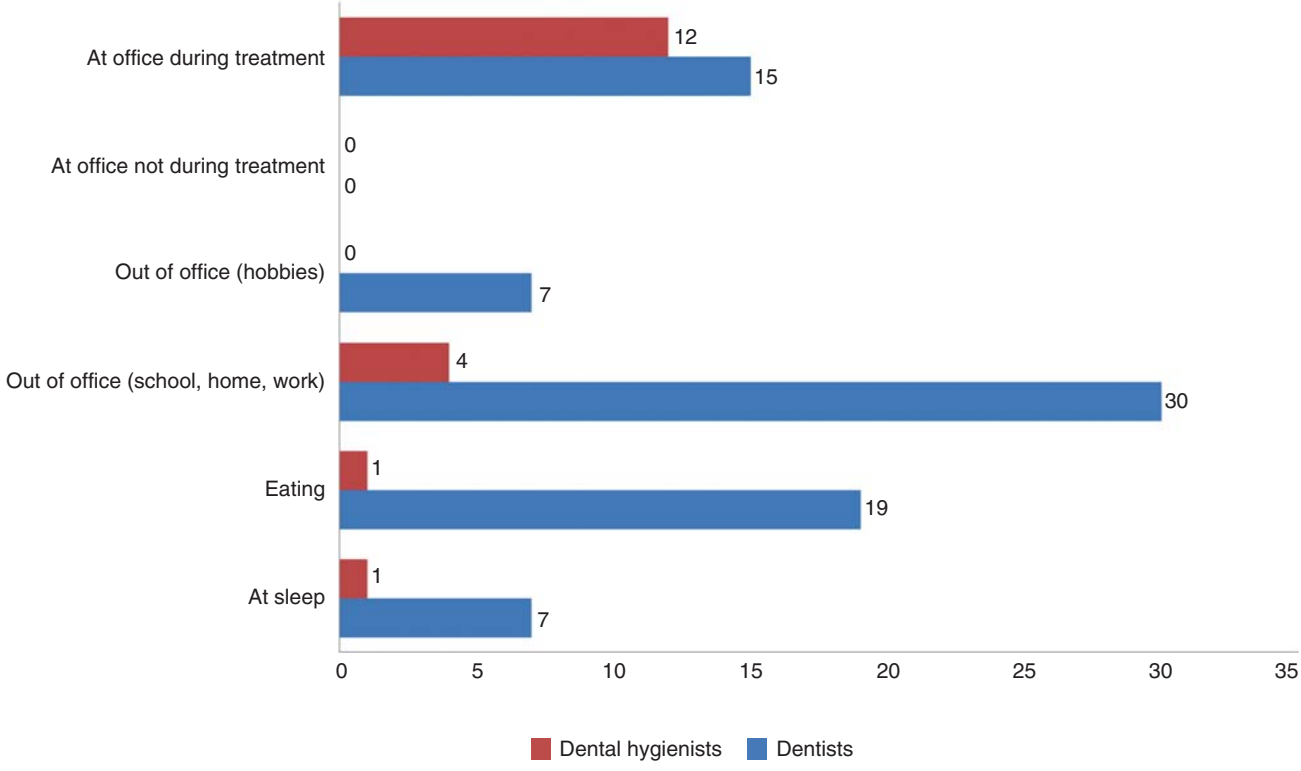

Figure 2. The site of inhalation or ingestion of orthodontic objects reported by dentists and dental hygienists.

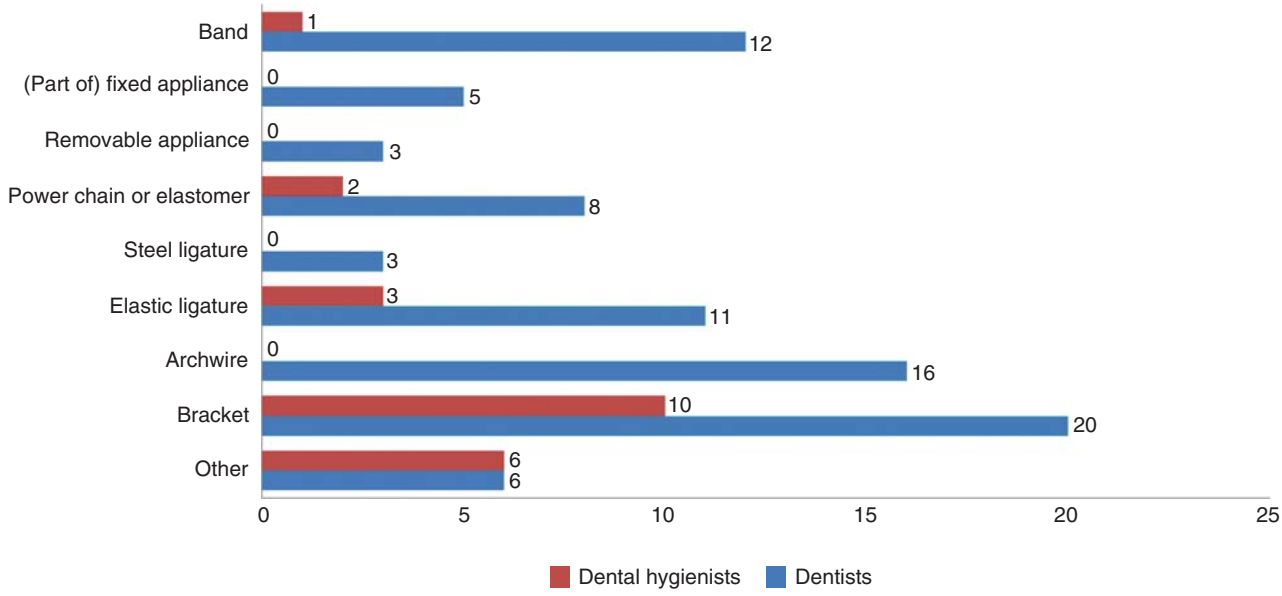

Figure 3. The number of dentists (n = 140) and dental hygienists (n = 101) reporting different types of orthodontic objects being inhaled or ingested.

According to the dentists, the procedures following these complications were (1) observation for 2–14 days (n = 27), (2) radiologic evaluation (n = 14), (3) medical emergency (n = 6) and (4) dietary instruction (n = 4). Surgical removal of the object was necessary in two cases. None of the cases had been life-threatening. Twenty-nine dentists selected the alternative 'something else' for the subsequent procedure, including, e.g. consultation by a medical doctor. Dental hygienists reported observation (n = 9), dietary instruction (n = 3) and taking the patient to the emergency room for a radiologic evaluation (n = 1). Two of the cases had been reported to the Finnish Patient Insurance Centre.

After these incidents, 42.9% of the dentists with one incident and 19.2% of those with more than one incident changed their treatment protocols (Table II). The respective shares for dental hygienists were 57.1% (one incident) and 42.9% (more than one incident) (p = 0.593).

Ten dentists reviewed their treatment protocols, for example by taking impressions in an upright position, using dental floss to tether bands when fitting them and being more careful when handling the appliances in the mouth. Four dentists limited the use of the ingested or inhaled appliances and two dentists started providing more guidance about the use of the appliances at home. All of the dental hygienists who changed their treatment procedures reviewed the treatment protocol. One in three dental hygienists had received training for these types of emergency situations.

Discussion

This study focused on the frequency of inhalation and ingestion episodes involved in orthodontic treatments during the past three decades. According to the answers of dentists and dental hygienists, the estimated number of ingestion or inhalation cases was ~150 patients and 28 patients, respectively. The accurate number of cases could not be calculated because the answers included estimations such as 'many' or 'several'; however, these data give a picture of the extent of these episodes. Not all responding dentists and dental hygienists could recall whether or not their patients had ingested or inhaled orthodontic objects or they were unable to check their files. The imprecision may partly derive from a lack of information, as patients cannot always tell what has happened, i.e. they do not necessarily know if they have ingested a missing part of an orthodontic appliance. This

Table II. Cross-tabulation of reported inhalations and ingestions and their effect on the dentists' treatment protocols (Chi-Square test, p = 0.062).

	Effect on treatment protocol	
Number of patients experiencing inhalation or ingestion	No change (number of dentists)	Changed treatment protocol (number of dentists)
One patient	16	12
More than one patient	21	5

phenomenon has also been recognized in the literature [14,18].

The background data concerning the year of graduation was asked in order to find out whether there was an association between orthodontic experience and complications. The result that dentists who had graduated earlier reported more cases than dentists in later graduation years is logical, since the former have worked longer and presumably treated more patients. The difference might, however, result partly from formerly applied treatment modalities or materials.

Most of the reported cases were ingestions; only two were inhalations. This is rather a low share, as compared to other studies; e.g. Koch [19] estimated that 80% of ingested foreign bodies will enter the gastrointestinal tract, while 20% will go into the tracheobronchial tree. According to Webb et al. [20], only 7.5% of the ingested foreign bodies enter the tracheobronchial tree. In this study, it was unfortunately not possible to define the type of appliances that had been inhaled.

The main reason for ingestion or inhalation was the appliance loosening from the mouth or teeth, which occurs occasionally in orthodontics. The most commonly involved orthodontic objects were braces, which is comparable to the fact that fixed appliances are applied very often [21]. Their loosening percentage during 6 months has been estimated at 7.4–10.6% [22] and during 18 months at up to 15.6–17.6% [23]. In addition to braces, a large variety of other orthodontic appliances had reportedly been ingested. Among them was only one rapid palatal expander key, while parts of quad helix appliances were reported more commonly. These numbers correspond well to prevailing practice; quad helices are used more often than rapid palatal expanders [21]. Ingested removable appliances also included silicon trainers.

Most of the cases reported by dentists happened outside of the office. This is in line with earlier findings indicating that 85% of accidental inhalations and ingestions happen out of office [24]. In contrast, dental hygienists reported cases usually happening in the office. The reason for this difference is unclear. It is possible that dental hygienists do not meet the patients regularly enough to hear about these episodes, because of patients' appointments with a dentist. In these cases, patients may report more recent 'out-of-office' incidents to their dentist. In accordance with the results of Tamura et al. [5], our findings indicate that out-of-office ingestions usually occur while sleeping or eating.

The procedures that were implemented following inhalation and ingestion complications varied widely, indicating that they depend on the situation. It is also possible that dental personnel are not aware of protocols for these adverse incidents. According to the guidelines for dealing with such incidents, after the immediate provision of potentially lifesaving treatment at the chairside, the patient should be referred for clinical and radiologic examination by an appropriate physician [6,25,26]. In our study, almost one-third of responding dentists who had experienced these episodes had referred their patients to a radiologic evaluation, while only one of the dental hygienists' patients had been referred to radiologic evaluation. Nevertheless, it is worth noting that only one-third of dental hygienists had received training for these types of emergency situations. Compared to the emergency protocols recommended in the literature [25,26], the reported number of patients referred to an emergency room in this study was very small. Luckily, none of the cases had been life-threatening.

The response rate among dentists can be considered reliable in terms of providing an estimate of ingestions or inhalations of orthodontic objects in Finland. The share of respondents who had long-term experience in orthodontics gives the results a wide time perspective. However, the lower response rate among dental hygienists may reflect the number of dental hygienists participating in orthodontic treatments. The delegation of orthodontic tasks, including removal of fixed appliances, has only recently become more common [21]. Dental hygienists not involved in orthodontic tasks may have neglected participation in this study.

On the basis of our results, the risk of inhalation and ingestion of orthodontic objects seems small, and the consequences are rarely serious. However, the risk should be taken into consideration. Patient information and a written medical emergency protocol should be included already in the informed consent form at the beginning of the treatment process. Moreover, the dental team should update their first aid skills regularly.

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Supplementary material available online

Appendix