

CASE REPORT

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Accidental ingestion of a fractured piece of orthodontic aligner: a case report

Jialiang Huang¹, Yuanhong Xie² and Yichen Pan^{3*}

Abstract

Background Ingestion and aspiration of orthodontic devices are rare occurrences, typically associated with components such as expansion keys, archwire segments, dislodged fixed appliances (including brackets, buccal tubes, and bands), as well as fractured metal or plastic appliances. This article describes the clinical diagnosis and treatment process of a case of accidental ingestion of a fractured piece of orthodontic aligner.

Case presentation A 31-year-old female under orthodontic treatment by aligners accidentally ingested a fractured piece of the aligner. The special difficulty of this case is that the transparent orthodontic aligner has a low radiopacity. At the beginning, no foreign body was found in the commonly used soft tissue window, causing difficulty in its location until greyscale was adjusted to lung window. The 2-centimeter fractured piece was taken out under anesthesia and endoscopic surgery.

Conclusion Materials with low radiopacity should be read with a lower grayscale range. Fractured orthodontic appliances with low retention force should not continue to be worn until consultation with attending doctor.

Keywords Ingestion, Swallow, Aligner, Fracture

Background

Ingestion occurs when a substance enters the body through the mouth and into the gastrointestinal tract while aspiration occurs when a substance enters the throat and lower respiratory tract through the oropharynx or gastrointestinal tract [1]. Instrument aspiration

and ingestion are adverse events in the dentistry, which often occur both during the treatment process and back home. Dental instruments that are often involved includes root canal treatment instruments, tooth drills, extracted teeth, tooth fragments, removable dentures, loosen fixed dentures, removable orthodontic appliances, etc. Once they occur, it not only breaks the trust between doctors and patients, but may also cause psychological problems for patients. Therefore, active measures must be taken to prevent the occurrence of such events and effective treatment protocols must be mastered to minimize harm to patients. Ingestion and aspiration of orthodontic origin usually occur in cases of expansion keys [2, 3], archwire segments [4–6], dropped fixed appliance [6–8], and fractured removable appliances [9, 10]. To date, there has not been any public report of invisible aligners swallowed. This article describes the clinical diagnosis and treatment process of an accidentally ingested piece

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of orthodontic aligner after fracture, as well as clinical implications for similar cases in the future.

Case report

The patient is a 31-year-old female who started orthodontic treatment at the Orthodontic Department of Shanghai Stomatological Hospital on March 2024 complaining about poor occlusion of the anterior teeth. For the past five years, the patient has been feeling uncomfortable in the occlusion of her anterior teeth and difficult to cut off food smoothly but has not yet sought medical help.

The patient has a straight and symmetric facial profile, with no clicking or pain in the temporomandibular joints. Intraoral examination revealed ① a tendency towards Angle's Class III molar relationship, ② mild crowding in upper and lower dentitions, ③ wide lower dental arch, ④ shallow anterior overjet, ⑤ a dental open bite between bilateral first premolars, and ⑥ early

contact of the posterior teeth in front and lateral occlusion (Fig. 1A–E). Lateral cephalometric analysis indicated ① a skeletal Class II sagittal relationship ($ANB=4.2^\circ$, Wits appraisal= -1.2 mm), ② high angle vertical discrepancy ($FMA=35.4^\circ$), and ③ upright anterior teeth ($U1/NA=0.7^\circ$, $L1/MP=82.7^\circ$) (Fig. 2).

We designed intrusion of maxillary first and second molars by mini-screws, together with slight maxillary expansion by aligners to correct the open bite and crowding. A total of four mini-screws were placed on buccal and lingual sides between first and second molars on each side. Clear aligners (Scheu-Dental GmbH, Iserlohn, Deutschland; PET-G thermoplastic; 0.76 mm) were used to assist in maintaining the width of the upper molars. After three months of treatment, the patient's open bite was significantly corrected (Fig. 1F–J).

On June 3, 2024, the aligner was fractured between upper right second premolar and first molar. The patient continued to wear the two parts of the aligner without

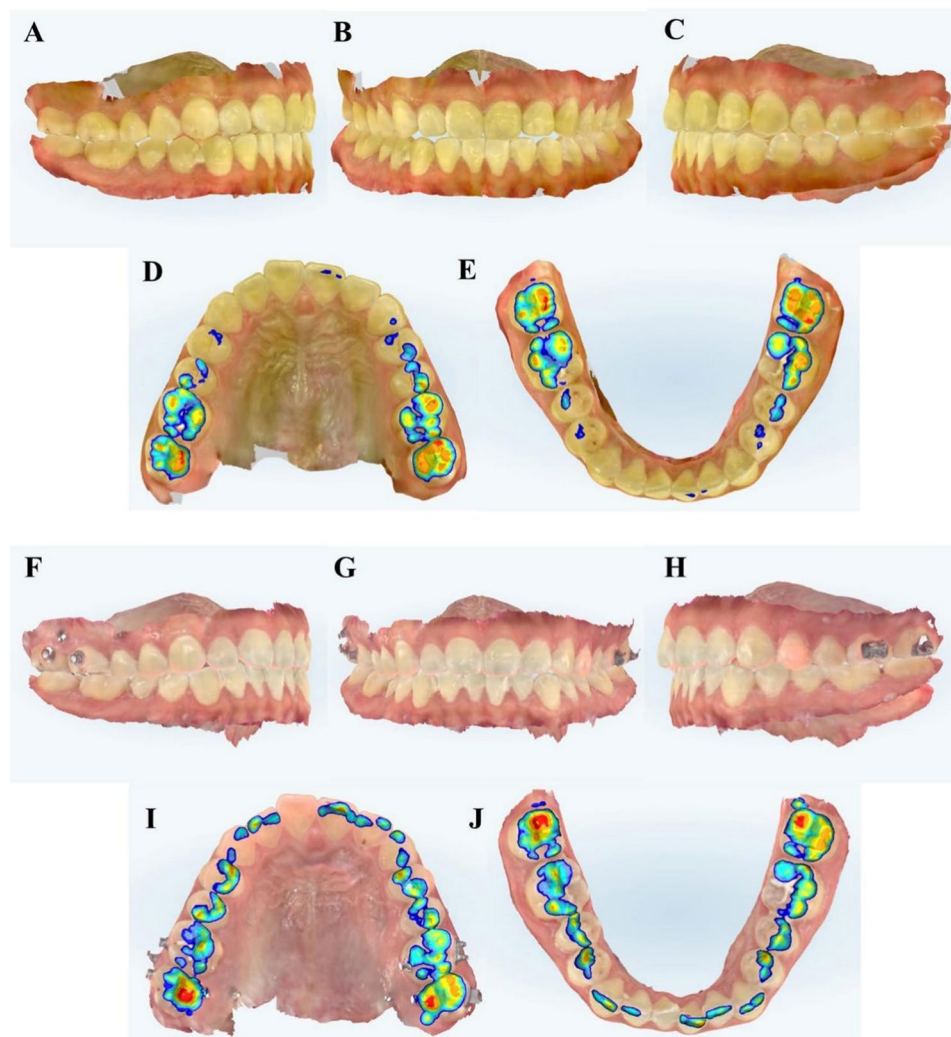


Fig. 1 A–E. Pre-treatment intra-oral scans; F–J. Intra-oral scans at 3 months



Fig. 2 The pre-treatment cephalometric radiograph

notifying the attending doctor. When drinking water before going to bed, the fractured part was loosened and swallowed by accident. Feeling pain when swallowing, she went to the emergency department of the East Hospital of Renji Hospital Affiliated to Shanghai Jiao Tong University in the early morning of June 4, 2024. Clinical examination by the otolaryngology department of Renji ER showed that the patient's blood pressure and heart rate were normal, and the patient was conscious, able to move freely, and had acute pain when swallowing without dyspnea. No foreign body was found after laryngoscopy examination. Since the aligners are made of plastic rather than metal, it may be difficult to see clearly on X-rays, so a CT scan was prescribed (Fig. 3A). After careful check, no obvious foreign body were found on the images, so the emergency internal medicine and radiology departments were consulted. After adjusting the grayscale range to the lung window (Fig. 3B), a strip-shaped foreign body in the esophagus at the level of thoracic vertebrae

T1-T2 was seen (Fig. 3C). The patient was diagnosed as "esophageal foreign body". Since the patient had no history of digestive tract disease and it has been 6 h since her last meal, the emergency internal medicine department recommended endoscopic surgery to remove the foreign body from the esophagus. After fully informed of the treatment options and risks, the patient agreed the treatment plan.

After the patient was given superficial anesthesia with Lidocaine Hydrochloride Mucilage, a transparent sheet-like foreign body was seen embedded in the upper esophagus through the microscope. It was fixed with a foreign body forceps and then removed as a whole. The local mucosa was slightly congested, and no obvious damage or active bleeding was seen (Fig. 4). The operation time was 15 min. Careful inspection showed that the swallowed object was a 2-centimeter transparent aligner broken between the right upper second premolar and first molar (Fig. 5).

The patient still has slight pain in swallowing after surgery. Considering that it is caused by esophageal mucosal damage, it is recommended to have a liquid diet for 2 days and take oral gastric mucosal protective agent for 3 days. If there is significant fever, chest pain and other discomfort, it is recommended to seek medical attention immediately.

Three days after the successful endoscopic extraction, the patient's swallowing pain basically disappeared. After one month of follow-up, the patient did not show any adverse symptoms. Written informed consent has been obtained from the patient for publication.

Discussion

Causes

Foreign body aspiration and ingestion are rare complications of oral medicine. Various oral treatments can lead to aspiration and ingestion, including root canal treatment, implant surgery, tooth extraction, denture restoration, orthodontic treatment, etc. Foreign bodies include

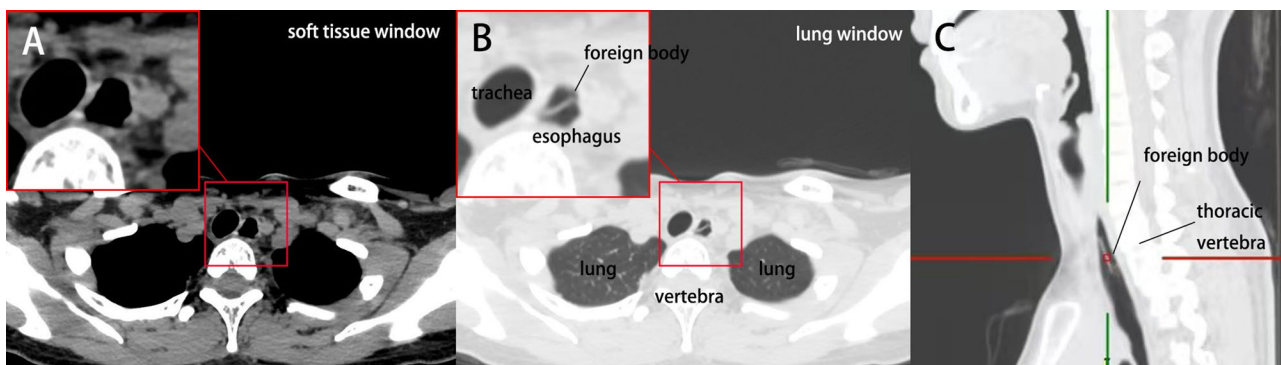


Fig. 3 CT images of esophageal foreign body. (A) Transverse section on T2 level in soft tissue window; (B) Transverse section on T2 level in lung window; (C) Sagittal section of esophagus and foreign body in lung window

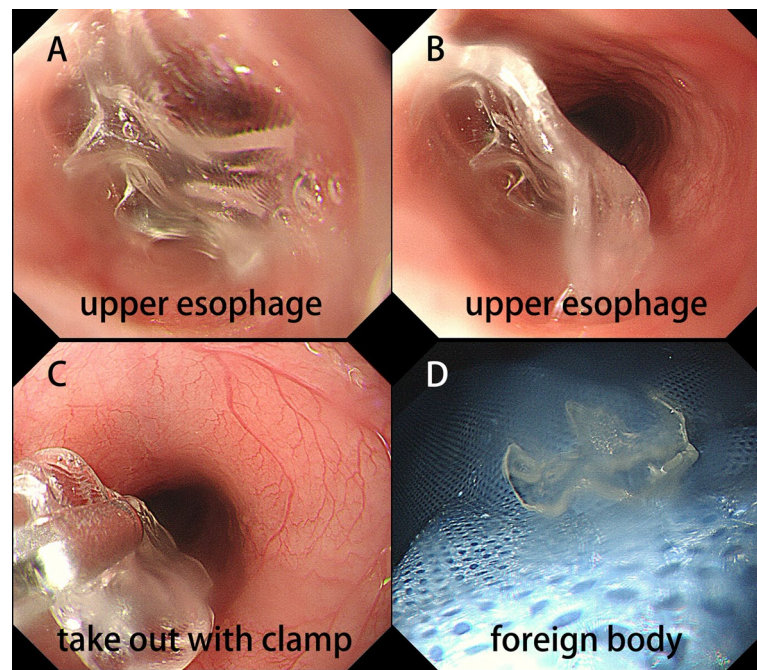


Fig. 4 Endoscopic images. **A, B** Image of the foreign body in upper esophagus; **C** Foreign body taken out with a clamp; **D** The foreign body in vitro



Fig. 5 Fractured pieces of the orthodontic invisible aligner. **(A)** 2-centimetre swallowed piece of the aligner; **(B)** Fractured pieces of the whole aligner on the 3D-printed model; **(C)** Fractured pieces of the whole aligner

root canal treatment instruments, implant parts, implant screwdrivers, dental drills, crown and bridge restorations, orthodontic devices, rubber dams, and even dental mirrors and needles [11–16]. They usually occur in children [17] and the elderly [8, 11].

Reports of accidental inhalation or swallowing of orthodontic appliances are rarely seen, mainly because most orthodontic appliances are bonded to teeth. Even if they fall off, brackets with small size and smooth surface can mostly be discharged smoothly from the digestive tract with food. Also, orthodontic removable appliances, large in size and elastically retained by clasps or other structures, are usually hard to swallow. The most common cases were caused by expansion keys [2, 3] and archwire segments [4–6]. Some other orthodontic appliances often swallowed are children's space retainers, brackets [7], buccal tubes [6] and bands [8] when they are not firmly clamped during bonding or loosened during usage.

Devices vulnerable to fracture are also easily ingested such as welding parts of metal appliances [9], or weak structures of the plastic appliances [10]. In addition, accidental aspiration may also occur when making orthodontic alginate impressions. If inhaled when the impression material has not yet solidified, it may enter deeper structures like bronchi and alveoli, leading to pulmonary dysfunction and necessity for lobectomy [18].

For aligners, apart from the inherent properties of the material itself, external forces and wear are the main causes of aligner fracture [19, 20]. In this case, at the beginning, the occlusal contact were concentrated in bilateral molar areas (Fig. 1D, E), increasing the possibility of abrasion of the aligner in molar segment. In addition, the buccal and lingual border of the fractured aligner piece was cut out for the space of buttons bonded on buccal and lingual surfaces of molars for intrusion purpose (Fig. 5B), leading to a decrease in retention force

and ended up falling off when drinking. On top of that, prolonged wear of a single set of aligner, excessive force applied by the patient when putting on and removing the aligner, wearing the aligner while eating and use of hot water or chemical cleansers may also reduce the life span of aligners [19, 20].

Outcomes

Reports show that about 87% of instruments are swallowed into the digestive tract, and 13% are inhaled into the respiratory tract [21]. Inhalation into the respiratory tract is usually more dangerous and more difficult to treat [21], and there is almost no possibility of natural expulsion [2]. Common aspiration symptoms mainly include inability to talk, cough, wheeze, dyspnea and loss of consciousness and other severe respiratory obstruction manifestations [22]. Some small objects entering the respiratory tract may be asymptomatic for a long time, but may have serious consequences in the long run [23]. The success rate of bronchoscopic removal of foreign bodies in the respiratory tract is 99%, but there are still 2.4–5% rate of complications [24]. 90% of swallowed foreign bodies can pass through the digestive tract successfully, but about 10% of cases require endoscopic removal of foreign bodies, and 1% require surgical removal [25–28]. If it enters the digestive tract, the sharp edges of the metal and plastic fractures can scratch the esophagus and adjacent tissues, which both are dangerous and should be treated in time.

Diagnosis and treatment

When a foreign body enters the mouth by mistake, the doctor should immediately keep the patient calm and remove the foreign body as soon as possible. Orthodontists and general dentists must be vigilant in recognizing signs and symptoms of airway obstruction such as inability to talk, cough, wheeze, dyspnea and loss of consciousness in case that any dental object is lost into oropharynx [10]. If it is no longer visible in the mouth, imaging examinations should be conducted to carefully evaluate the location of the foreign body to determine whether it has entered the digestive tract or respiratory tract and the subsequent treatment plan [12, 29].

If dental instruments and devices enter the airway with no dyspnea, it is not recommended to inducing coughing, performing Heimlich maneuver, patting the back or using any external forces [10]. Instead, the patients should be kept still and delivered to a general hospital immediately. If breathing difficulty occurs, an ambulance should be called immediately, and cricothyroidotomy or tracheotomy should be performed in severe cases. If it enters the esophagus, excessive swallowing should be avoided to mitigate pain and further lesions to esophagus.

To determine the treatment plan, imaging is very necessary to confirm the location, size and adjacent relationship of the foreign body [30, 31]. If the foreign body enters the respiratory tract or is obstructed in the esophagus, it needs to be removed in time, because it is almost impossible to expel it by itself [2] and the esophagus is adjacent to important anatomical structures such as the aorta. The special feature of this case is that commonly swallowed dental instruments often contain high-density components such as metal and ceramic, while orthodontic invisible aligners are made of transparent plastic, which has low density and low X-ray opacity. Therefore, the emergency department lacks experience in reading radiological images of this case and at first, no foreign body was found in the commonly used soft tissue window. The location of the foreign body was determined only after adjusting the gray value range to lung window, which promoted the positive determination of the treatment plan. Therefore, for invisible braces, impression materials, resins and other materials with low X-ray opacity, CT should be taken and the lung window should be selected for image reading.

If a foreign body enters the digestive tract, generally speaking, most can be discharged asymptotically. But for a sharp device, the longer it stays in the body, the more likely it is to cause local tissue perforation and thus cause serious complications. Therefore, early location of the position and in-time removal of the foreign body are suggested [5, 9, 32]. It has been reported that to remove a foreign body by endoscopy, the best time window is within 2 h and no later than 6 h [33]. If delayed, the foreign body may pass through the pyloric sphincter and enter the duodenum [33]. If it enters the stomach, it is usually necessary to observe the patient for clinical discomfort and other symptoms for at least 1 week, and perform a series of imaging and fecal examinations. If the foreign body enters the intestine, it needs to be closely observed until the foreign body is expelled [34]. During the observation period, the patient can have high-fiber foods and closely inspect the clinical symptoms to avoid intestinal perforation, in which case, surgical intervention is required. In a word, the patient needs to be actively followed up.

Prevention

To reduce the incidence of foreign body ingestion and aspiration during treatment, prevention should be the priority. What follows are clinical recommendations for doctors.

- After installing the dental drills, doctors should turn it on for 20 to 30 s away from the patient to test if it is working properly. If the drill swings, rotates abnormally, or falls off, it needs to be adjusted or changed in time.



Fig. 6 Traditional dental forceps and orthodontic reversed forceps. (A) Traditional dental forceps; (B) Orthodontic reversed forceps; (C) A reversed forcep holding a buccal tube

- Orthodontists should use needle holders to clamp the archwires, and use reversed forceps (Fig. 6) to clamp the brackets and buccal tubes rather than traditional forceps to prevent them from falling off [35].

- For handheld micro-instruments that patients need to use at home, such as the expansion key, patients should be instructed to use silk threads or dental floss to tether the instrument tightly from outside the mouth if permitted.

- The removable devices should be designed to an adequate size, making it harder to be swallowed.

- When designing the aligners, the attachments and buffer areas should not be too large, as this may affect retention and strength.

- Doctors should teach patients the appropriate way to put on and take off the removable devices to reduce material fatigue caused by external forces.

- Removable devices should be ensured to have sufficient retention before placing in patient's mouth and supervised on every regular visit.

- The invisible aligners and retainers, due to their fragile structure, are easily damaged and fractured after wearing for a long time, so patients should be informed to return for follow-up visits in a timely manner and doctors should replace the appliances with compromised retention and strength as soon as possible.

There are also some advises for patients.

- Patients should avoid using hot water or chemical cleaners to clean the removable appliances, as this can cause the deformation and weaker strength.

- Patients need to maintain regular and timely follow-up visits.

- To avoid accidental ingestion, patients need to be told that when poor retention, crack or fracture occurs in any appliance, they should contact the attending doctor immediately and do not continue to wear it.

- Once ingestion or aspiration happens, they should go to the emergency department for examination and treatment in time to reduce the occurrence of complications.

Conclusions

Accidental ingestion and aspiration of orthodontic appliances can cause damage to the digestive and respiratory tracts and even pose a threat to life. CT scans can be useful to detect swallowed aligners. Orthodontics and general dentists should take actions to avoid dental objects from falling into patients' mouth during treatment and patients should be instructed to prevent such event and seek medical attention in a timely manner.

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Author contributions

H.J. drafted the manuscript. H.J. and X.Y. carried out the clinical data collection and prepared the figures. H.J. and P.Y. discussed the case. P.Y. critically reviewed the manuscript. All authors have read and approved the final version of the manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations**Ethics approval and consent to participate**

Written informed consent has been obtained from the patient for publication.

Consent for publication

Written informed consent has been obtained from the patient for publication of personal and clinical details without identifiable images in this study.

Competing interests

The authors declare no competing interests.

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