

## REVIEW

# Is it safe to use a toothbrush?

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## Abstract

**Aim.** To systemically collect and summarize the literature on case reports concerning adverse events associated with the oral use of a toothbrush. **Materials and methods.** Two electronic databases were searched for articles published up to October 2013 to identify appropriate studies using focused search terms and ‘case reports’ as a filter. **Results.** A comprehensive search identified 419 unique titles and abstracts. Ninety-four studies met the eligibility criteria. In total, 118 subjects (age range = 1–60 years) presented adverse events related to the oral use of a toothbrush. Events could be summarized in five categories, of which ingestion was the most reported problem among the individuals (50 cases). This was followed by impaction of a toothbrush (27 cases). Reports more frequently involved females and children were more likely to have injuries compared to males and adults. Most of the cases that presented with adverse events of the oral use of a toothbrush were referred for treatment to a physician. **Conclusions.** The combined evidence related to serious adverse events as presented in case reports showed that the oral use of a toothbrush can be associated with ingestion, impaction, instant trauma, gingival traumatic injury and seizures. Given the incidence of reporting, important recommendations are that a toothbrush should not be used to induce vomiting, nor should people walk or run with this device in their mouths, especially children.

**Key Words:** toothbrushing, adverse events, trauma, ingestion, impaction

## Introduction

Toothbrushing has become an integral part of people’s daily routine [1]. People brush their teeth to feel fresh and confident, have a nice smile, avoid bad breath and avoid disease [2]. A toothbrush is one of the most familiar devices of everyday use and few people would ever think about its associated risks [3]. However, in view of the universal availability and presence and the frequency with which toothbrushes are used, adverse events can be expected [4] and occur during routine daily use, with potential serious morbidity [5].

Self-inflicted injuries to the hard and soft tissues of the mouth in adult patients are often associated with the excessive or long-term use of a toothbrush [6]. There are a few case reports describing such injuries or accidents involving the ingestion or impalement of a toothbrush [7,8].

Case reports are an important part of the literature because they often provide the first identification of side-effects and are a major source of the detection of rare adverse events [9]. Physicians are more likely than dentists to treat cases of adverse events associated with toothbrushing because the complications are related to general health. Therefore, it may be helpful for dental care professionals to have an overview of various injuries and accidents associated with toothbrushing so that these professionals can inform their patients of possible adverse events that may result from current oral hygiene practices involving a toothbrush.

Therefore, the aim of this study was to systematically gather and summarize case reports describing the adverse events resulting from the oral use of a toothbrush, as available in both the dental and medical literature, using a comprehensive search strategy.

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The results may be used by dental professionals when making recommendations to their patients.

## Materials and methods

This review was conducted in accordance with the guidelines of the Transparent Reporting of Systematic Reviews and Meta-analysis (PRISMA) [10].

### Search strategy

The following two electronic databases were used to search for papers fulfilling the study purpose: The National Library of Medicine (PubMed-MEDLINE) and EMBASE (Excerpta Medical Database by Elsevier).

The search was conducted up to October 2013 and was designed to include any publication that reported an adverse event associated with the oral use of a toothbrush. A comprehensive search strategy was performed using 'case reports' as a filter. The terms used in the search strategy are presented in Table I. All reference lists from the selected studies were searched by two reviewers for additional papers that met the eligibility criteria.

### Screening and selection

Two reviewers (SCO and GAW) independently screened the titles and abstracts for eligibility. The inclusion criteria used were papers written in English, being 'case reports' concerning adverse events associated with the use of a toothbrush in the oral cavity. If any information applicable to the eligibility criteria was present in the title and/or abstract, the paper was selected for a full reading of the text.

Following selection, the papers were carefully read in full by one reviewer (SCO). The papers that fulfilled the eligibility criteria were processed for data extraction. Any uncertainty was resolved by discussion with the other reviewers.

### Definition of the outcome

The outcome of interest was any adverse event resulting from the oral use of a toothbrush.

Table I. Search terms used for PubMed-MEDLINE and EMBASE. The search strategy was customized according to the database being searched.

The following strategy was used in the search: {(Intervention) AND (filter)}

{(Intervention: <[MeSH terms] toothbrushing OR [text words] Toothbrush\* OR Toothbrush)

AND

(Filter: Case Reports)}

The asterisk (\*) was used as a truncation symbol

### Reporting quality

Based on a critical review of guidelines for reporting case reports [11,12], the following factors were evaluated in the present review: age, gender, situation, location, signs and symptoms, diagnosis and treatment.

When a paper lacked one of these seven criteria, it was classified as having moderate reporting quality. If a paper lacked two or more of these criteria, it was classified as having low reporting quality, as proposed by van der Weijden et al. [13]. If a paper reported two or more cases, a missing item was counted as a separate missing value. If the same item was missing in all cases, it was assessed as one missing item.

### Data extraction and analysis

Data were extracted by the two reviewers (SCO and DES) from the selected case reports with regard to the research question. Disagreements were resolved after additional discussion.

For this review, the intent of which was to provide a comprehensive summary of case reports, it was not feasible to perform a quantitative analysis of the data. Instead, the data are presented descriptively, with outcomes clustered by similar types of adverse events.

## Results

### Search and selection results

The PubMed-MEDLINE and EMBASE searches identified 419 papers using the specified search terms (Figure 1). The screening of the titles and abstracts resulted in 98 papers that met the eligibility criteria and were subsequently read in full. After reading the entire text of the articles, 12 of the papers were excluded. Table II shows the reasons for exclusion. Additional hand-searching of the reference lists from the selected studies yielded eight papers. Ultimately, 94 papers were processed for data extraction, presenting 118 case reports for this analysis. The cases were divided into the following five categories according to the main reported outcome: ingestion, impaction, instant trauma, gingival traumatic injury and seizures. Moreover, these categories were further classified into adverse events and serious adverse events, the former being characterized as any event that causes death or permanent damage or requires hospitalization [14].

Of the 118 reported adverse events associated with the oral use of a toothbrush, 50 cases involved ingestion, 27 cases involved impaction of the toothbrush, 15 cases involved instant trauma, 15 cases involved gingival traumatic injury and 11 cases involved seizures as a result of the use of a toothbrush (Table III [15]; for more details, see the Supplementary Appendices).

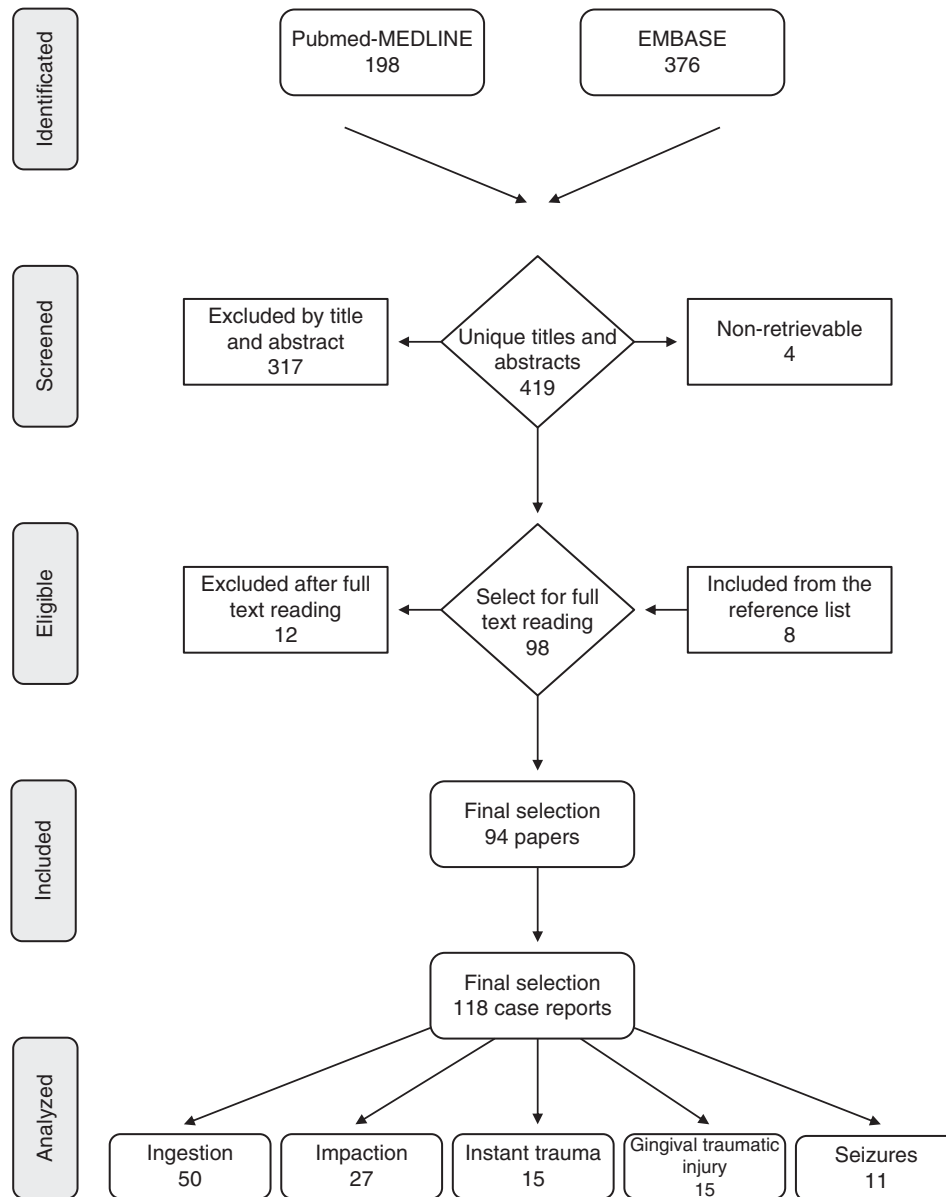


Figure 1. Flowchart of databases search outcome and literature selection.

One paper [16] provided three cases, of which one of ingestion and two as cases of impaction were analyzed.

Among all 50 ingestion cases, 19 were due to an attempt to provoke vomiting. Of these cases, 10 were associated with patients who had been diagnosed with bulimia [17–21], five occurred while brushing the teeth [22–26] and four occurred while brushing the back part of the tongue or pharynx [16,27–29]. There

was one case report [30] in which the toothbrush was swallowed as an effort to remove a foreign body, one case in which the subject ingested the toothbrush in an attempt to commit suicide [31] and another case of ingestion that led to death [7]. In most of the cases, the toothbrush did not pass the stomach, but there were cases in which the observed toothbrush location was the esophagus, duodenum, colon, liver and oropharynx.

Table II. Overview of the studies that were excluded and the reason for exclusion after full reading of the text.

| Reason for exclusion                        | Author(s), year and reference number                                                                                                                            |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No adverse event due to use of a toothbrush | Lee et al. [64]; Rizzolo and Chiodo [65]; Guihot et al. [66]; Gottlob et al. [67]; Nukina et al. [68]; Gupta and Bhattacharya [69]; Sanchez-Cordero et al. [70] |
| Non-oral use of a toothbrush                | Kumar [57]; Udawadia et al. [59]; Wigle [61]; Price [60]                                                                                                        |
| Non-English article                         | Ollero Fresno [71]                                                                                                                                              |

Table III. Summary of case reports regarding (serious) adverse events of the oral use of a toothbrush as compiled by the authors.

|                       | Adverse event             | Reference number                   | Number of cases and gender  | Mean age and range        | Situation                                                                | Location                                                         | Treatment                                                                                          | Reporting quality                                                                         |
|-----------------------|---------------------------|------------------------------------|-----------------------------|---------------------------|--------------------------------------------------------------------------|------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Serious adverse event | Ingestion                 | [7,16–31,39,41–43,62,72–89]        | 50 subjects                 | 27.6 years                | 19 vomiting induction                                                    | 33 stomach                                                       | 33 endoscopy                                                                                       | High [16–18,22,23,25,26]                                                                  |
|                       |                           |                                    | 20 ♂*<br>30 ♀*              | 15–60 years               | 5 brushing the teeth<br>4 cleaning the tongue/pharynx<br>3 intentionally | 7 esophagus<br>6 duodenum                                        | 9 laparotomy<br>8 gastrotomy                                                                       | [28–31,39,41–43,62,72–76,78–84,86,87,89]<br>Moderate [7,19,20,24,27,77,88]<br>Low [21,85] |
|                       | Impaction                 | [1,3,4,8,16,32,33,44,47–50,90–102] | 23 subjects                 | 8.1 years                 | 23 fall                                                                  | 11 oropharynx                                                    | 26 surgical exploration and retrieval                                                              | High [1,3,8,32,33,47–50,90–94,96,97,99–101]                                               |
|                       |                           |                                    | 16 ♂*<br>9 ♀*               | 1.5–45 years              | 2 bristle impaction                                                      | 8 adjacent to the mandibular ramus<br>4 inside the buccal mucosa | 4 antibiotics                                                                                      | Moderate [4,44,50,98,102]<br>Low [16,95]                                                  |
|                       | Instant trauma            | [5,46,103–113]                     | 15 subjects                 | 9.6 years                 | 10 injury due to a fall with a toothbrush in the mouth                   | 5 tonsil<br>4 buccal fat pad<br>3 oropharynx<br>3 soft palate    | 10 antibiotics<br>6 surgical intervention                                                          | High [5,46,103–111,113]<br>Moderate [112]                                                 |
|                       |                           |                                    | 5 ♂*<br>10 ♀*               | 1–43 years                | All cases caused by excessive toothbrushing                              | 15 gingiva<br>1 central incisors                                 | 4 diminish frequency and duration<br>4 refrain from brushing in the involved areas<br>3 mouthrinse | High [52,114,115,117]<br>Moderate [51,116]                                                |
| Adverse event         | Gingival traumatic injury | [51,52,114–117]                    | 15 subjects<br>8 ♂*<br>7 ♀* | 37.4 years<br>15–66 years |                                                                          |                                                                  |                                                                                                    |                                                                                           |
|                       | Seizures                  | [34,35,53–56,58,118,119]           | 11 subjects                 | 32.2 years                | All 11 cases caused by toothbrushing (1 by a powered toothbrush)         | 2 temporal lobe<br>2 frontocentral region<br>2 postcentral gyrus | 7 antiepileptic drugs<br>2 brushing gently<br>1 surgical resection                                 | High [34,35,53,54,56,58,118]<br>Moderate [55,119]                                         |
|                       |                           |                                    | 4 ♂*<br>7 ♀*                | 11–57 years               |                                                                          |                                                                  |                                                                                                    |                                                                                           |

♂ Male; ♀ Female.

The majority of the impaction cases described was caused by an accidental fall while brushing the teeth or while just holding the toothbrush in the mouth. Frequently, the age of the subjects involved was less than 10 years. The main locations of the embedded toothbrush were the oropharynx or an area adjacent to the mandibular ramus. There were two reports of an impaction of the bristles of a toothbrush in the oral tissues [32,33]. The instant trauma category included cases in which the toothbrush did not become embedded in any structure but only caused trauma. In addition, the predominant cause of this outcome was an accidental fall with a toothbrush in the mouth. The affected structures were the oropharynx, tonsillar area, soft palate and buccal fat pad.

All cases of gingival traumatic injury were related to the excessive use of a toothbrush and primarily involved the gingiva. Seizures were triggered by manual toothbrushing in nine of the cases and by a powered toothbrush in one case [34]. There was one report of toothbrushing-induced seizures triggered by the brushing of the patient's teeth by another person ('passive toothbrushing') [35].

Most patients with a history of toothbrush ingestion were treated by physicians, with the exception of one patient who was treated by a dentist. In the cases of impaction and instant trauma, both professionals evaluated the patient (20 were physicians and 12 were dentists). The patients who had gingival traumatic injury were all seen by dentists and the patients who had seizures due to toothbrushing were mostly seen by physicians (except for one patient) (for more details, see the Supplementary Appendices).

## Discussion

Toothbrushes are the primary dental hygiene products used for cleaning teeth [36]. Despite the fact that these devices were designed to maintain or improve human wellbeing, there is the possibility of harmful side-effects [37]. The adverse events resulting from the use of a toothbrush are reviewed in this summary of case reports in which 94 papers were included and were classified into the following outcome categories: ingestion, impaction, instant trauma, gingival traumatic injury and seizures. All physicians, except Sagar et al. [1], published their case reports in medical journals. Likewise, all dentists published their case reports in dental journals, except for Haytac et al. [34], who published in a medical journal.

Most of the cases reported in this review are cases of serious adverse events related to ingestion of a toothbrush, which requires prompt medical attention. The vast majority of ingested foreign bodies pass through the gastrointestinal tract within 2–12 days without causing complications. A wide range of object

dimensions were reported by the authors. Weltman et al. [30] suggested that an object thicker than 2 mm and longer than 5 cm tends to lodge in the stomach, while Quinn and Connors [38] stated that the maximum size of an object can be 2.5 cm in width and 13 cm in length. Only one of the case reports reported a toothbrush that passed spontaneously without intervention or complications [20]. The fact that all other toothbrushes did not pass may be due to their length being longer than 13 cm. In cases in which the object was lodged in the stomach, early removal was advised to minimize gastritis, ulceration and obstruction, as well as to avoid perforation [19]. The latter option may be associated with a considerably high mortality and morbidity [39].

The first case of toothbrush ingestion followed by gastrotomy was reported in 1882 and the first reported death from a toothbrush occurred in 1889 as a result of gastric perforation 3 days after toothbrush ingestion [40]. Ingestion of a toothbrush can result from swallowing while brushing the teeth and tongue or from an effort to provoke vomiting. Some cases also involved patients that had accidentally fallen and subsequently swallowed the toothbrush [41,42]. One way to determine whether a patient was attempting to vomit when the toothbrush was swallowed is to check the position of the handle of the toothbrush in the gastrointestinal tract through radiological examination [22]. Vomiting is usually induced with the handle rather than the head of the toothbrush. Thus, the reversed orientation of the toothbrush handle could disclose the cause of the ingestion. Moreover, the toothbrush orientation will also influence treatment because it is easier to grasp the head rather than the handle by endoscopy [22]. In the case of ingestion after an attempt to provoke vomiting, it has been suggested that the patient should be checked by a health professional, as it is possible that the patient actually suffers from bulimia or anorexia nervosa [43]. In the present review, 10 out of 19 cases of vomiting induction were reported as bulimia cases.

In several cases included in this review, the occurrence of ingestion of a toothbrush followed an attempt to clean the tongue. Tongue cleaning is part of oral hygiene practices in various countries around the world [26]. Therefore, providing instructions to patients on how to brush the tongue, as well as warning them of the possible adverse events that this practice may lead to, appears to be important.

According to Younessi and Alcaino [44], another adverse event commonly encountered in emergency rooms is penetrating injuries to the oropharynx, which can be quite devastating and cause significant morbidity or even death. Matsusue et al. [45] analyzed the records of impalement injuries from 144 patients aged 7 months to 10 years. Among all the impaled objects, the toothbrush was the most

prevalent (20.8%) and generally involved boys (64.6%) of less than 5 years of age (91.7%). Such accidents occur mainly among toddlers because they tend to carry potentially dangerous objects in their mouths for oral stimulation and also tend to fall easily because of their lack of co-ordination. Electric toothbrushing adds to the penetrating trauma, a potentially devastating effect deriving from the rotation and hooking of the filament into the tissues [46]. Most of these injuries are minor and heal spontaneously without complications [47]. Superficial abrasions or lacerations of the soft palate or posterior pharynx can be observed in such individuals and most of these traumas will heal uneventfully [48]. However, because there is a tendency to trivialize injuries when bleeding is not significant, potentially serious sequelae are not rare. Such sequelae include deep neck abscesses, widespread emphysema, internal carotid thromboses and strokes. Moreover, for a small proportion of children, complications such as cerebral ischemia caused by thrombosis of the internal carotid artery can arise. Given the delayed onset of neurological signs, this life-threatening condition can be easily overlooked. Removal of intra-oral foreign bodies, especially when soft tissue penetration is suspected, must never be performed before complete investigation of the case [1]. Aggarwal et al. [49] stated that computed tomography imaging not only delineates the location of the foreign body but also shows any injury to important structures such as the carotid artery. In addition, orofacial trauma requires imperative and meticulous examination to identify retained pieces of a toothbrush or simply a tooth or foreign body [48]. Some authors advise that tetanous toxoid should be administered and appropriate antibiotics should be prescribed for the patient [3,50].

A common adverse event that results from the use of a toothbrush is trauma to the oral soft tissues (gingiva and mucosa). This trauma generally occurs due to the habit of excessive toothbrushing. Such cases have been extensively reported in the literature [6]. The presence of these traumatic lesions is associated with gingival recession and tooth wear. Even though these types of trauma can be classified as adverse events associated with the oral use of a toothbrush, the documented lesions arise from continuous episodes of persistent traumatic toothbrushing, which may lead to different injuries, including gingival abrasion, gingival fissures, clefts, ulcerations and fenestrations [51]. Endo et al. [52] reported three cases in which patients expressed great interest in oral hygiene as a result of fear of losing their teeth to periodontal disease. They practiced excessive toothbrushing for long periods of time, resulting in serious gingival trauma. For these individuals, it is important to provide adequate educational instruction about oral hygiene procedures and approaches. Signs of

gingival injury may be noted early; thus, prevention of serious damage is imperative [51].

An interesting adverse event arising from brushing the teeth is epileptic seizures. Epilepsy associated with toothbrushing is an unusual form of reflex epilepsy in which seizures are precipitated exclusively by the act of brushing the teeth [53–56]. Such epilepsy involves a persistent rhythmic oral sensory stimulus, which is likely to evoke the neuronal synchronization necessary to induce seizures [57]. This mechanism may explain how this trigger is more likely to evoke the necessary neuronal synchronization to induce seizures compared with other stimuli, such as eating. The ability to induce seizures by brushing either side of the mouth suggests that oral somatosensory inputs have bilateral projections. Toothbrushing is a complex programmed task involving motor, proprioception and somatosensory networks with stimuli of variable frequencies, durations and intensities required for neuronal synchronization to provoke the seizures [58]. In this review, one case was observed in which the subject developed seizures due to toothbrushing with the use of an electric toothbrush [34].

Apart from the outcomes related to the oral use of a toothbrush, there are also reports concerning other uses of this device. Udwadia et al. [59] reported a case of an assault in which the assailant was using a toothbrush. The device had broken during the attack and the bristle end remained stuck in the ethmoid sinus of the victim. Price [60] related a case of self-mutilation with a toothbrush in which a schizophrenic patient used the instrument to penetrate the abdomen. Interesting reports of the use of toothbrushes for other purposes, such as rectal insertion, were published by Kumar [57] and Wigle [61].

PubMed is the National Library of Medicine's online interface with Medline. For the present review, a comprehensive search was performed with the Mesh terms and textwords associated with toothbrushes. In addition, the filter 'Case Reports' was used. Based on hand-searching the reference list of the selected papers, eight additional papers were included, which were not identified in the designed search. Of these eight papers, two [47,62] used the terminology 'case' in the title and one paper [26] was marked by the journal as a case report. This result means that the filter used is probably not sensitive. It is possible that additional suitable papers may be missing due to this issue. It is imperative that published articles and texts are correctly indexed and classified. Evidence-based practice requires healthcare decisions to be based on the highest quality research information available. Previously, a similar issue was raised concerning the accuracy of Medline's classification of meta-analyses in orthodontics [63]. The proportion of correctly classified meta-analyses was determined and appeared to be correct in ~50% of the cases. Therefore, due to the inadequate

indexing and classification of papers, filters should be diligently used in systematic reviews.

In conclusion, the oral use of a toothbrush can lead to adverse events, such as gingival traumatic injury and seizures, as well as to serious adverse events, such as ingestion, impaction and instant trauma. Given the large number of toothbrushes that are used worldwide, the occurrence of these events can be classified as incidental as deduced from these case reports, although it is likely that not all cases have been reported.

The authors of this review recommend the public be made aware that a toothbrush is not appropriate for inducing vomiting and that people should not walk or run with this device in their mouths. Small children, special needs patients and (uncontrolled) epileptics must always be supervised by parents or caretakers when brushing their teeth. Although dental hygiene should be encouraged, toothbrushes must not be presented as toys.

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## Supplementary material available online

### Supplementary Appendices