

## Original Article

# Tooth ‘aches’: Injuries related to toothbrush use

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### Abstract

**Objectives:** A toothbrush is a medical device that is widely used for oral hygiene practices at almost all ages. Descriptive studies of toothbrush-related injuries (TRI) are fairly limited, with existing studies mainly focusing on case reports. The present study sought to describe TRIs in Canada, including the contexts within which they occur.

**Methods:** The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) database, years 1990 to 2016, was queried for cases of TRI. The circumstance, mechanism and type of injury are described based on an examination of narrative text, using data mining techniques and corresponding variable codes. Average annual percent change estimates are presented to describe trends over time.

**Results:** The rate of TRIs is low (16.9 of 100,000 CHIRPP cases among ages 14 years and below [0.02%], and 2.4 of 100,000 CHIRPP cases among ages 15 years and above [0.002%]) and has been relatively stable over the past quarter century. A majority of cases occurred among individuals aged 14 years and below; falls were the most common circumstance (50.0%) and mechanism (39.8%) of injury and laceration to the internal mouth was the most frequent type of injury (51.9%). Intentional injuries due to a toothbrush were only observed among individuals aged 15 years and older, such as in cases of inducing vomiting.

**Conclusions:** Although rare, TRIs are occurring in Canada and risk can be mitigated. Behaviours associated with routine habits of toothbrushing are an area that might assist with injury prevention efforts. The safe and appropriate use of toothbrushes should be considered at all ages.

The widely recommended standard to prevent dental caries is to establish and maintain good oral hygiene and to begin this practice by 1 year of age (1). Toothbrushing is the primary mechanical means to prevent oral diseases through the removal of plaque (a dental build-up of bacteria) and is used to maintain dental aesthetics (2). Toothbrushes may be broadly classified as either manual or electric based on their mode of operation, with several studies examining the effectiveness of each for the maintenance of dental health (3,4). In addition to studies examining the oral health benefits of toothbrushes, there are many case reports of specific injuries related to toothbrush use (5–7). However, there are limited studies assessing toothbrush-related injuries (TRI) and the context surrounding such injury (8).

In Canada, manual toothbrushes are regulated as class 1 medical devices (lowest risk class) and power toothbrushes are

typically classified as class 2 medical devices as per the *Medical Devices Regulations* associated with Canada’s *Food and Drugs Act* (9). Although the toothbrush is considered to be a medical device, they are generally regarded as being innocuous. The main risk associated with toothbrush use is believed to be the possibility of disease transmission (10). The present study seeks to describe TRIs captured within the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) and provide a description of the circumstances surrounding the injury event.

### METHODS

#### Data source

Data collected from the CHIRPP (11), a dynamic web-based injury and poisoning surveillance system managed by the Public

Health Agency of Canada, were used to examine TRI. Patients' accounts of pre-event injury circumstances (narratives of 'what went wrong') are collected using the Injury Reporting form, a questionnaire completed during their visits to the emergency department. The attending physician or other staff adds clinical data to the form and data coders extract other information found in patients' narratives. As a result, the CHIRPP captures a more complete picture of an injury event, one that includes risk and protective factors, than hospital administrative or mortality data alone and also identifies less serious injury cases that do not require hospitalization. Information for all ages from the CHIRPP database between January 1, 1990 and June 7, 2016, was extracted for the present analysis (N=2,944,022).

### Key variables

Records that included bilingual (English or French) terms similar to *toothbrush* or *brosse à dents* in the narrative variable and/or that contained direct cause or factor coding indicating the involvement of toothbrushes (variable code 684) were identified for initial screening as toothbrush-related injury cases. Circumstance of injury describes the general context or environment wherein the injury occurred and these were identified through data mining techniques using narrative coding. The mechanism of injury, or the external cause of injury, was identified through a combination of data mining of narrative codes and use of existing external cause codes. Type of injury was ascertained from a combination of data mining of narrative codes and use of existing nature of injury codes. To provide as much detail as possible, cases were described using derived variables for circumstance, mechanism, and injury; e.g., a case where an individual collided with a door, had an impaction, and experienced a bruise to the internal mouth. Some overlap may exist with circumstance and mechanism coding, particularly for falls. Intent of injury was also examined using data mining techniques and existing variable codes, including a search for cases where there was intent to induce vomiting.

### Statistical analyses

Data mining syntax (PERL regular expressions) was used when assessing narrative text and an analyst optimized the query language by comparing random samples of cases identified through data mining techniques with their corresponding narrative text. Manual resolution was conducted to ensure accuracy and precision of identified events. Year-to-year variations, likely due to small sample sizes, were smoothed by applying a three-point central moving average to the normalized proportions (12). These estimates were used to describe trends over time, such as the average annual percent change (AAPC). Descriptive methods were used to present injury characteristics (circumstance, mechanism and type of injury). All analyses were conducted using SAS Enterprise Guide version 5.1 (SAS Institute Inc., Cary, NC, USA).

## RESULTS

A total of 383 cases of TRI were identified among all age groups but the skew of cases toward individuals under the age of 15 (94.5%, Figure 1) led to the decision to focus our examination of TRIs within this younger age range (n=362 among those 14 and younger, and n=21 among those 15 years and above). The highest prevalence of TRIs was among 1-year olds (57.2 of 100,000 CHIRPP cases, 32.4% of TRI cases) and boys were more likely to experience a TRI than females (58.6% males). Injuries were more commonly reported for a manual toothbrush (97.0%) than for an electric one (3.0%). When examining for temporal trends in TRI between 1990 and 2016, no significant changes were observed (AAPC=1.3%, 95% confidence interval: 0.0–2.5, P=0.04, Figure 2). The apparent increase in the proportion of TRI occurring after 2013 should be treated with caution as incidents reported from years 2014 to 2016 are still being updated in the database. On average, TRIs are rare with only 16.9 TRIs/100,000 CHIRPP cases (0.02%) reported since 1990 among individuals 0 to 14 years old.

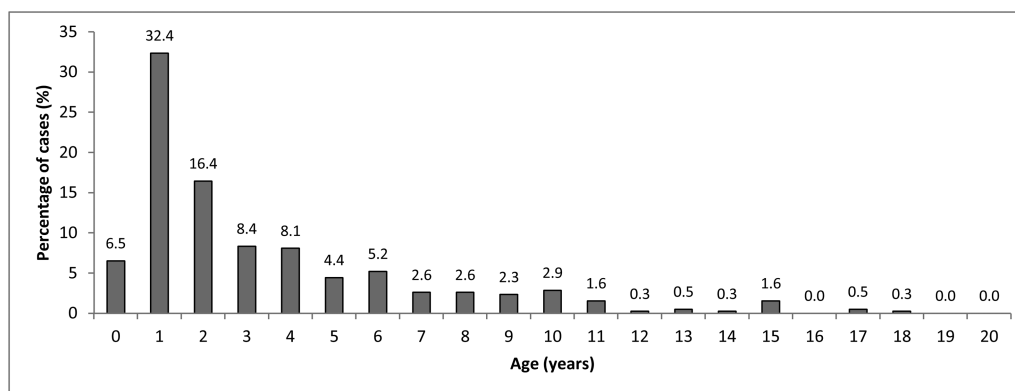
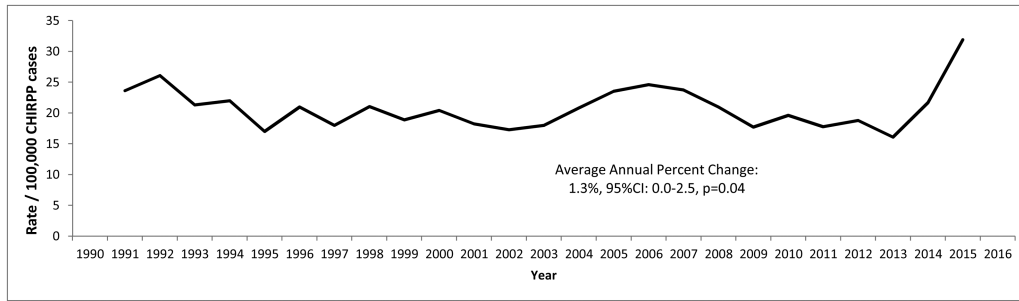
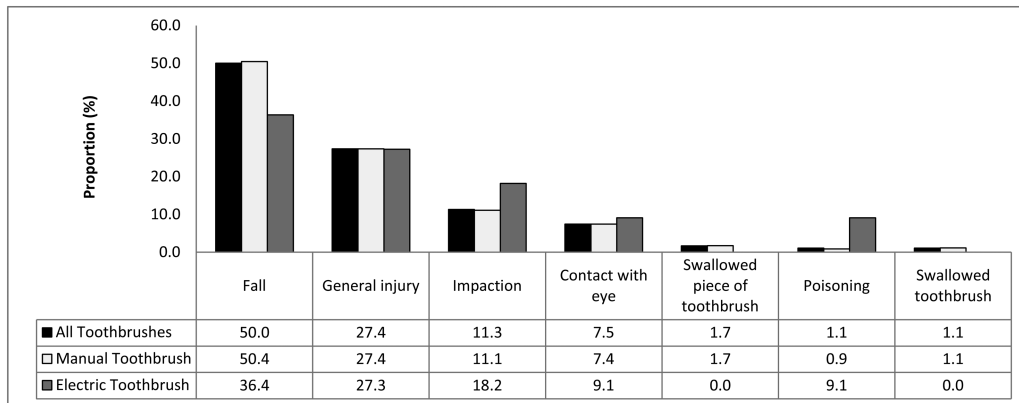


Figure 1. Distribution of toothbrush-related injury cases by age, CHIRPP, 1990–2016\*. Ages 20 years old and below. Information for cases 21 years old and above were suppressed (n=12, 3.1% of cases). Toothbrush-related injury was identified based on factor and/or narrative codes indicating toothbrush-related injury use. \*Records entered on or before June 7, 2016. CHIRPP Canadian Hospitals Injury Reporting and Prevention Program.



**Figure 2.** Incidence of toothbrush-related injuries by year, 3-point central moving average (adjusted annual proportions), CHIRPP, 1990–2016\*. Ages 14 years and below. Toothbrush-related injury was identified based on factor and/or narrative codes indicating toothbrush-related injury use. \*Records entered on or before June 7, 2016. CHIRPP Canadian Hospitals Injury Reporting and Prevention Program.



**Figure 3.** Circumstance of injury among toothbrush-related injury cases based on the type of toothbrush, CHIRPP, 1990–2016\*. Ages 14 years and below. Poisoning cases include those where a substance was on the brush, e.g., paint thinner and battery liquid. General injury includes cases such as lacerations to the palate and abrasions to the throat or mouth. Impaction cases did not include situations where a fall occurred. Toothbrush-related injury was identified based on factor and/or narrative codes. \*Records entered on or before June 7, 2016. CHIRPP Canadian Hospitals Injury Reporting and Prevention Program.

All TRI injuries were listed as unintentional in nature, and no cases were identified where an individual intended to induce vomiting among those 14 years and below. To better understand how these injuries occurred, the circumstances surrounding the injury events were examined based on the type of toothbrush used. Figure 3 demonstrates how a fall was the most common overall circumstance associated with TRI, but that some variation in circumstances was observed depending on the type of toothbrush used (manual or electric). It was further observed that eye injuries and injuries due to a substance on the brush (e.g., battery fluid) were more common among electric toothbrush users than manual toothbrush users (Figure 2). It is interesting to note that 15 cases (4.1% of TRI cases) involved a child falling from or stepping off of a foot stool, with 2 of these 15 (13.3%) cases involving 6-year olds, 7 (46.7%) involving 2-year olds, 4 (26.7%) involving 3-year olds and 2 (13.3%) involving 1-year olds (data not shown). The majority of these foot stool-related TRIs resulted in a laceration to the internal mouth (86.7%, n=13), followed by a bruise to the internal mouth (6.7%, n=1) or an eye injury (6.7%, n=1).

Looking at the mechanism that led to a TRI, and the specific type of injury that occurred, a predominance of fall-based injuries was observed (Table 1). Overall, the high percentage of cases with lacerations resulting from TRI (52.5%) highlights the type of injury that is most frequently reported in association with a seemingly innocuous toothbrush. Reports of more serious injury were extremely infrequent but included cases of mandibular fracture, airway trauma and pharyngeal laceration. Injuries occurred in a variety of locations in the home with top venues including bathroom (46.2%), bedroom (24.1%), living room and hall (11.9% for each). Another individual was reported to be present in at least 15.8% of cases.

A minority of TRIs (6.7%) were serious enough to result in the patient being admitted to the hospital. In these 24 cases, all individuals were between the ages of 0 to 7 years and 15 of these cases (62.5%) were associated with children 3 years of age and younger. These cases include lacerations to the palate, mouth or cheek, while other more severe cases include an airway trauma and a pharyngeal laceration.

Examining cases among individuals 15 years and older, 21 more cases of TRI were identified, and 4 of these resulted in

**Table 1.** Mechanism and type of injury among toothbrush-related injuries, CHIRPP, 1990–2016\*

Injury descriptor		Count (N)	Proportion (%)
Mechanism	Fall	161	44.5
	Struck by/against object	118	32.6
	Cut/pierce	66	18.2
	Inhaled/ingested any other object except food	17	4.7
Type	Laceration: internal mouth	188	51.9
	Bruise: internal mouth	59	16.3
	Eye (Globe)	41	11.3
	Foreign body	17	4.7
	Laceration: face	13	3.6
	Dental	6	1.7
	Injury to facial blood vessel	4	1.1
	Bruise: face	1	0.3
	Mandibular fracture	1	0.3
	Not further specified	32	8.8

Ages 14 years and below.

Toothbrush-related injury was identified based on factor and/or narrative codes.

\*Records entered on or before June 7, 2016.

admission to the hospital. These cases spanned between the age of 15 and 79 years old, and were much rarer than with younger individuals; TRIs occurred a rate of 2.4 of 100,000 CHIRPP cases (0.002%). The distribution of cases by circumstances was general injury (n=6), eye (n=4), fall (n=4), swallowed piece (n=3), swallowed toothbrush (n=2), impaction (n=1), substance on toothbrush (n=1); for mechanism of injury was inhaled/ingested any other object (n=8), struck by/against object (n=5), eye (n=4), fall (n=2) and cut/pierced (n=2); and for type of injury was foreign body (n=6), laceration to internal mouth (n=6), eye (n=4), not further specified (n=4) and bruise to internal mouth (n=1). There were five cases of individuals within this age group trying to induce vomiting, all between the ages of 15 to 18 years. All of the admitted cases (n=4) were ones of intentional injury: three where the patient tried to induce vomiting and inadvertently swallowed the toothbrush, and one which was described as self-mutilation.

## DISCUSSION

A review of the CHIRPP over the period of 1990 to 2016 for TRIs revealed 383 cases, with a large majority involving individuals below the age of 15 years. Although TRIs are a rare injury in

Canada, they have been occurring at a steady rate over the past quarter century. Cases more frequently occurred among manual toothbrush users, which may reflect the population prevalence of manual toothbrush use as opposed to an increased injury risk specific to the type of toothbrush.

Among cases for individuals aged 15 years and below, oral lacerations were reported in just over half of them and the most common mechanism leading to TRI was a fall. Across all circumstances of injury where another party was not involved, and where the TRI did not involve stumbling or stepping off a stool, a commonly observed element was that the injured individual was deviating from engaging in toothbrushing behaviour. A similar observation was made in another study assessing TRIs which was based on a systematic review of case reports (8). In this study, jumping on a bed, running down the hall, siblings playing with one another or dipping a toothbrush in paint thinner were examples of nontraditional behaviours related to TRIs. In the same way that the routine of regular toothbrushing supports oral hygiene, routines regarding behaviours while brushing teeth might assist with injury prevention (13).

Cases among individuals above the age of 15 years were different in that these cases began to include those of intentional injury, such as with inducing vomiting and self-mutilation. Bulimia nervosa is a disorder wherein individuals attempt to regulate their own weight and eating behaviour by inducing vomiting, and which is often associated with distorted perceptions of their weight and body shape (14). Ingestion of the toothbrush, which may occur in such situations, is also a rarity, but one that we observed in our dataset as well (14).

## Limitations

It is important to note that the injuries described here only represent those captured by CHIRPP and likely do not represent all injuries in Canada, only those presenting to participating emergency departments. However, a number of studies have indicated that the patterns can be representative of the Canadian context (15,16). In addition to older teens and adults, Aboriginal persons and people who live in rural areas are also under-represented in the CHIRPP database because most CHIRPP hospitals are located in major cities. Estimates in the CHIRPP database are being updated daily and some information for years 2014 to 2016 is still being entered into the CHIRPP system.

## CONCLUSION

TRIs have been occurring at a relatively stable rate over the past 27 years in Canada. Our Federal health department, Health Canada, partners with Canadians to mitigate toothbrush-related risks. Any concerns related to the safety, effectiveness or quality of a toothbrush that have been detected during use or identified

prior to use can be reported to Health Canada by completing a Health Product Complaint Form (FRM-0317) available on the Health Canada website (17). Furthermore, public recalls or alerts may be issued when concerns regarding health or consumer products, including toothbrushes, arise (18). Injuries related to toothbrush use are most often captured in the clinical setting. Information from the various sources assists with ongoing surveillance and monitoring, and facilitates an understanding of population level trends. Supervising young children while they brush their teeth, not walking with the toothbrush, exercising caution with the use of step stools and ensuring that electric or manual toothbrushes are in working order can work to prevent TRIs. Despite the toothbrush being a widely used product marketed for oral hygiene, the factors and behaviours described in the present analysis should be considered by health care professionals and parents when counselling children on the safe use of toothbrushes.

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