# Dental trauma that require fixation in a children's hospital

# Timothy Bruns<sup>1</sup>, Hiran Perinpanayagam<sup>2</sup>

<sup>1</sup>Department of Dental Medicine, Women & Children's Hospital of Buffalo, 219 Bryant Street, Buffalo, NY 14222, USA; <sup>2</sup>Schulich School of Medicine & Dentistry, University of Western Ontario, London ON N6A 5C1, Canada

Correspondence to: Dr Hiran Perinpanayagam, Schulich School of Medicine & Dentistry, University of Western Ontario, London ON N6A 5C1, Canada Tel.: +519 661 2111 ext 82230 Fax: +519 850 2459 e-mail: doctor.hiran@gmail.com

Accepted 23 March, 2006

Abstract – Children and adolescents who suffer traumatic injuries often seek emergency treatment at a Children's Hospital. Complex injuries to permanent teeth and their periodontium require immediate repositioning and stabilization. Many of these emergencies are treated by pediatric dental residents at the Women and Children's Hospital of Buffalo, Buffalo, New York. The purpose of this study was to characterize these complex injuries of permanent teeth that require emergency treatment in a Children's Hospital. All of the cases of dental trauma which had involved permanent teeth and which had been treated with a splint in 2001 and 2002 were reviewed. There were 79 patients that were between 5 and 19 years of age with twice as many males (54) as females (25). The number of males increased from childhood (5-10 years) to early adolescence (11-15 years) and then decreased rapidly in late adolescence (16-19 years), whereas the number of females decreased steadily with age. Most of the incidents occurred during the summer months (72%), particularly in June and July (42%), and Fridays and Saturdays were the busiest days of the week. Most of the injuries were caused by organized and recreational sporting activities (39%) and accidental falls (33%), followed by interpersonal violence (15%) and a few motor vehicle accidents (7%). The 173 permanent tooth injuries were mostly luxations (62%) or avulsions (20%), with only a few fractures of the alveolar bone (5%) or tooth root (1%). Most of the displacements were lateral luxations (40%) or extrusions (18%) with only a few intrusions (3%). These injuries most commonly afflicted the maxillary central incisors (54%), followed by the maxillary laterals (18%) and mandibular centrals (17%). The emergency treatment that was provided at the Children's Hospital included replantation and repositioning, and the placement of a semi-rigid or flexible splint.

Children and adolescents who require emergency dental services often present for treatment at a Children's Hospital (1). While many of these cases are caused by dental caries and its sequelae there is a substantial proportion that is caused by dental trauma (2). A study of 222 patients who presented for emergency dental treatment outside of normal clinic hours at the Children's Hospital of Buffalo over a 12-month period in 1983 and 1984 showed that the majority of cases were caused by dental trauma (1). A much larger study of 1456 unscheduled emergency visits with an oral complaint at the Children's Hospital of Pittsburgh found that nearly half (46%) were caused by trauma (3). Similarly, a large study of 1482 dental emergencies at the Seattle Children's Hospital and Medical Center between 1982 and 1991 found that more than half (60%) were caused by trauma (4).

Many of these dental injuries involve coronal fractures which are usually managed by simple restorative procedures alone or in combination with endodontics (5). Similarly, complex injuries to primary teeth are managed by a simple extraction (6). However, complex injuries to permanent teeth involving the tooth root and periodontal support apparatus require the provision of immediate and complicated treatment procedures (7). A comprehensive review of all of the emergency dental trauma at the Children's Hospital and Medical Center in Seattle between 1992 and 1994 found that in 487 patients there were 562 primary and 276 permanent tooth injuries (8). Most of the emergency treatment for primary teeth was limited to an examination alone (47%) or in combination with a simple extraction (43%). Likewise, the most common permanent tooth injury was an Ellis class II fracture of the crown (26%) that received only an examination or a temporary restoration during the emergency appointment. However, there were a substantial number of permanent teeth that had suffered complex injuries (56%) that required repositioning and stabilization.

These permanent tooth injuries, such as avulsions and luxations, as well fractures of the tooth root and alveolar bone require immediate repositioning and the placement of a semi-rigid or flexible splint for stabilization (9). Accordingly, these injuries require that a substantial amount of treatment be provided at the initial unscheduled emergency visit, in addition to follow-up evaluations and ongoing comprehensive care. Such complex cases often present for emergency dental treatment at the Women and Children's Hospital of Buffalo, Buffalo, New York. Their emergency dental treatment is provided by pediatric dentistry residents during normal business hours in addition to after hours and during the weekends. In contrast to the emergency dental services that are provided for adult patients, the majority of the dental emergencies in children is caused by traumatic injuries, and therefore constitutes a significant portion of the services provided by pediatric dental residents (1). Whilst these residents need provide only palliative care for the minor injuries, such as Ellis Class I and II fractures, at the time of their emergency visit, substantial emergency treatment is needed for the management of avulsions, luxations, and fractures of the tooth root and alveolar bone. Therefore the purpose of this study was to characterize these complex dental injuries in permanent teeth that require immediate repositioning and stabilization in a Children's Hospital. We anticipate that these findings will aid pediatric dentistry residents in their provision of emergency dental services in a Children's Hospitals.

## Materials and methods

# Emergency services for dental trauma

Children and adolescents who have been involved in a traumatic event will often present for emergency treatment at the Women and Children's Hospital of Buffalo, in Buffalo, New York. When these injuries involve the dentition and oro-facial tissues, they are sent to the Department of Pediatric Dentistry for their emergency treatment and comprehensive care. The emergency treatment begins with a visual and radiographic examination and assessment of the injuries. Then a provisional diagnosis and treatment plan are formulated and informed consent is obtained from the child's parent or guardian. Emergency dental treatment is provided which may involve simple extractions and restorations, or more complex alveolar reductions, replantations, and rigid and nonrigid fixation. Then, regular appointments are scheduled for follow-up evaluations and comprehensive care.

These services are provided by pediatric dentists and dental residents, who are encouraged to follow the 'Guideline on Management of Acute Dental Trauma' that was first adopted by the American Academy of Pediatric Dentistry in 2001 (10), and which was then revised in 2004 (11). These guidelines are congruent with the guidelines of the International Association of Dental Traumatology that were developed in 2001 (12–16). In addition, complex cases are managed with the aid of oral surgery, endodontic and orthodontic specialists.

# Case selection for study population

Approval was obtained from the Children and Youth Institutional Review Board at the Women and Children's Hospital of Buffalo. Then, all of the dental records from 2001 and 2002 were searched for the provision of emergency dental treatment which involved the replantation of a tooth and/or the placement of a semi-rigid or flexible splint. Such procedures were usually billed using the ADA code 7270 for reimplantation or stabilization. These records were then limited to those cases which involved permanent dentition. Each patients dental records and radiographs were reviewed to register their date of birth, gender, date of injury, age at the time of injury, the causative event, the nature of the injuries, the dentition involved and the types of emergency treatment that were provided.

#### Results

# Age and gender of patients

A comprehensive review of patient dental records at the Women and Children's Hospital of Buffalo from the years 2001 and 2002 revealed that there were a total of 79 children and adolescents who received treatment for dental trauma that involved replantation or the placement of a splint (Fig. 1). Of these 79 patients, there were more than twice as many males (54) as females (25). Most of the patients were children between 5 and 10 years of age (35) and young adolescents that were between 11 and 15 years of age (33). A much smaller number were older adolescents between 16 and 19 years of age (11).

The age distribution of the female patients declined steadily from a maximum of 15 children in the 5-10 year age group, to eight young adolescents in the 11-15 year age group, to a low of only two older adolescents in the 16-19 year age group (Fig. 1). In contrast, the number of male patients increased from 20 children in the 5-10 year age group, to 25 young adolescents in the 11-15 year age group, and then decreased to nine older adolescents in the 16-19 year age group.

#### Dates of occurrence

Between January 2001 and December 2002, the traumatic dental injuries that required stabilization at the Children's Hospital were most frequent during the month of July (18 patients), followed by June (15), and then September (11) (Fig. 2a). There were a moderate number of cases in August (7), October (7), January (7) and May (6), a few cases in February (2), March (2) and



Fig. 1. Age and gender distribution of patients.

April (3). There was only one case in December and there were none during the month of November.

In addition to this seasonal variation, there was a clear pattern in the frequency of their presentation over the days of the week (Fig. 2b). The fewest cases were seen on Mondays (6), and this was followed by a steady increase through Tuesdays (9), Wednesdays (12), Thursdays (13), and Fridays (14). This was followed by a plateau in the number of cases on Saturdays (14) and then a slight decrease in their numbers on Sundays (11).

# Causes of trauma

Of the 79 patients, 76 reported a specific event that lead to their experience of a traumatic dental injury (Fig. 3). The remaining three patients, two males and one female failed to specify the cause of their injury. The most common causes were accidental falls (25), followed by organized (16) and recreational (14) sporting activities, and then violent altercations (brawl, 10). The less frequent causes were motor vehicle accidents (MVA, 5), play (4) and assaults (2). In each category there were more males than females with the exception of recreational sporting activities and assaults for which there were an equal distribution. This preponderance of males over females was particularly evident in organized sports and violent altercations.



Fig. 2. (a) Month of occurrence. (b) Day of occurrence.



Fig. 3. Etiology of dental trauma.

# Types of injuries

The most common types of dental injuries were lateral luxations (69) that were more than twice as frequent as avulsions (35) or extrusions (31) (Fig. 4). The less commonly found injuries were alveolar fractures (8), intrusions (5), concussions (3), subluxations (2) and root fractures (2). In addition, all of these injuries were often associated with coronal fractures (28), and bruising and laceration to the soft tissues (14).

# Teeth injured

For most of the 79 patients there were multiple teeth that had been affected so that in total there were 173 permanent teeth with dental injuries. Patients with additional deciduous tooth injuries were excluded from this study. The maxillary central incisors (94) were by the far the most common and accounted for more than half of all of the injured teeth (Fig. 5a). The next most commonly afflicted dentition were maxillary lateral incisors (31) and mandibular central incisors (30) in nearly equal frequency (Fig. 5b). These were followed by the mandibular lateral incisors (13) and a single mandibular canine. In addition, there was one girl who had been kicked by a horse and had injuries which involved her maxillary right first molar, first and second premolars and canine.

#### **Emergency treatment**

The most common emergency treatment rendered was the placement of a resin-bonded monofilament as a flexible splint (Fig. 6). There were 67 patients who had received the flexible splint, whereas only 13 had received a resin-bonded orthodontic wire which served as a semirigid splint. One patient had received both a semi-rigid



Fig. 4. Classification of injuries.



*Fig. 5.* (a) Traumatized maxillary teeth. (b) Traumatized mandibular teeth.



Fig. 6. Emergency treatment provided.

and a flexible splint for the treatment of multiple injuries. Some patients had their avulsed teeth replanted before coming to the Children's Hospital (14), whereas the others had them replanted at the Hospital (21). Overall more than one-third of the patients (30) received a prescription for antibiotics, particularly those that had a avulsed tooth replanted. Some also had sutures placed (14) for their associated soft tissue lacerations. In addition to these procedures that were provided at their emergency visit, all of the patients were scheduled for follow-up evaluations and for comprehensive care.

# Discussion

This comprehensive review of the patient dental records and radiographs at a Children's Hospital over a complete 2 year period has provided a useful characterization of the more serious dental injuries that can afflict children and adolescents, and which require emergency treatment involving fixation of permanent teeth. Between January 2001 and December 2002 inclusive there were 79 patients that had experienced trauma to their permanent dentition which required the placement of either a semirigid or a flexible splint at the Women and Children's Hospital of Buffalo. These numbers together with the findings from previous studies, attest to the fairly common presentation of such advanced dental injuries for emergency treatment within the dental clinic of a Children's Hospital (1–3, 6, 8, 17).

Like the previous studies, we found that there were more males than females. In our study there were more than twice as many males as females and the males accounted for 68% of all the patients. The comprehensive review of 487 emergency dental trauma visits over a 3-year period at the Children's Hospital and Medical Center in Seattle found that 63% of the patients were males (8). The larger proportion of males in our study may have been because we limited the study to complex dental injuries in permanent teeth that required fixation. This would imply that males are more likely to incur such injuries. The Seattle study had included minor injuries and primary teeth and thereby included children as young as 8.5 months in age. They found that the highest incidence of dental trauma was in 2-year olds and that there was another smaller clustering at age eight. Our study was limited to traumatic injuries in permanent teeth and our voungest patient was already 5 years old at the time of the accident. Despite these differences we also found that the highest incidences was in younger children with a steady decline in their numbers through the early and late adolescent years. This decline in the frequency of trauma with an increase in age was clearly evident in female patients. However, for male patients there was actually an increase in their numbers from childhood to early adolescence before a subsequent marked decline in frequency within the late adolescent years. This increase in the incidence of trauma during early adolescence for boys may be due to an increase in the intensity of their participation in sporting and other physical activities. The decrease in the incidence of trauma in the older teenagers may reflect their maturation into adulthood and a concomitant decrease in physical activity.

For 76 of the 79 patients (96%) a specific event was reported as the causative agent. The most common events were accidental falls, organized and recreational sporting activities and violent altercations, which accounted for 86% of all the self-reported incidents. Amongst these, accidental falls were the most frequent and accounted for 33% of reported cases. However, if the organized and recreational sporting activities were combined they would then constitute the most common cause and account for 39% of the documented cases. The Seattle study also found that falls were the most common cause of injury (40%), but only a small number of their cases were due to sporting activities and even fewer of their cases were due to violence (8). The study at the Columbus Children's Hospital found that 63% of the cases were caused by trauma and 17% were caused by violence (2). An earlier study from the Children's Hospital of Pittsburgh found that falls accounted for 62% of the dental trauma, sporting activities for 20% and violence for only a few cases (3). However, all of these prior studies had included minor injuries and injuries to the primary teeth in infants, toddlers and young children. As our study was limited to complex injuries in permanent teeth that required fixation, only the substantive traumatic events were included.

As organized and recreational sporting activities accounted for the majority of cases, a pronounced seasonal variation and day of the week pattern was observed. The highest frequency of cases were seen in June and July and these were related to summer sporting activities. These 2 months alone accounted for 42% of the entire caseload. Subsequently in August there was a sudden and marked decrease in their frequency to a more moderate level that was probably due to a recess from organized sporting events. Together the summer months from May through September accounted for nearly three quarters of all the cases (72%). This same seasonal variation had already been demonstrated in the earlier study at the Children's Hospital of Buffalo (1). Similarly, the study at the Children's Hospital of Pittsburgh found that the summer months were particularly common for dental trauma (3). We also found a pattern in the frequency of cases during the course of each week. The fewest cases were seen on Mondays (8%) followed by a steady increase through Tuesdays (11%), Wednesdays (15%), and Thursdays (16%), which led to the highest frequencies being on Fridays (18%) and Saturdays (18%), and then a drop in the numbers on Sundays (14%). Similarly the Seattle study found that there was a consistent seasonal variation with the period from March till September being particularly common, and that Fridays and Saturdays were the most common days of the week (8).

The less common causes of these injuries were MVA (7%), generalized play (5%) and assaults (3%). However, the cases that were due to play could be included with recreational sports and the cases that were due to assaults and brawls could be combined to form a category of 'interpersonal violence' (15%). This would leave the MVA as the least common cause. The previous studies had reported an even smaller proportion of cases from MVA (1-1.5%), but again this was probably due to their inclusion of minor injuries and primary teeth (2, 8). In all of these categories we found that there were more males than females with the exception of recreational sporting activities and assaults for which there were equal numbers of each gender. The preponderance of males over females was particularly evident in organized sports and violent altercations which may reflect a higher frequency and intensity of participation in these activities by males.

In total, these 79 patients had 173 traumatized permanent teeth, in addition to 10 injured primary teeth that were excluded from the analyses. The most common type of dental injury to a permanent tooth that required stabilization and fixation were lateral luxations (40%) that were more than twice as frequent as any of the other type of injuries. Furthermore, if the numbers of lateral

luxations were combined with the intrusive and extrusive luxations and subluxations, they would together account for as much as 62% of all the injured teeth. These were all 'luxated' or displaced teeth that required repositioning and stabilization (18-20). The next most frequent category of injury were avulsions which accounted for a small but substantial proportion of teeth (20%). Some of these had already been repositioned within the socket prior to the patients arrival at the hospital, but there were many that had to be replanted by the pediatric dental resident during the emergency visit. The extrusive luxations or 'incomplete avulsions' were almost as frequent as the complete avulsions and accounted for 18% of the teeth. The less common injuries were fractures of the alveolar bone (5%), intrusive luxations (3%) and fractures of the tooth root (1%). In addition these complex injuries were associated with considerable collateral damage in the form of coronal fractures and soft tissue injuries. The associated fractures of the tooth crown were fairly common and afflicted 16% of the injured teeth. Similarly, at the Children's Hospital and Medical Center in Seattle, luxations were common, particularly lateral luxations and subluxations followed by extrusive luxations (8). They also found that avulsions were common, whereas intrusions, alveolar fractures and root fractures were less frequent occurrences. The earlier study of all of the dental emergencies that present to the Children's Hospital of Buffalo also reported a high incidence of luxations, avulsions and crown fractures in the permanent teeth (1). There were more than twice as many subluxations as lateral luxations. However, we found that most of the subluxated teeth had not received a splint and were thereby excluded from this study. The few concussions (3) and subluxations (2) that were included were secondary injuries to those that required a splint.

For most of these 79 patients multiple teeth had been injured so that in total there were 173 injured permanent teeth in addition to the 10 injured deciduous teeth that were excluded from the study. Therefore on average about two teeth were injured in each patient, although a few had only a single tooth injured and some had several that were affected. The most commonly injured permanent teeth were the maxillary central incisors which accounted for a little over half of all the injured teeth (54%). The next most commonly injured teeth were the maxillary lateral incisors and mandibular central incisors in almost equal frequency (17-18%). There were also some mandibular lateral incisors (8%) and a single mandibular canine. Additionally, the single incident of a horse kick had resulted in injuries to the maxillary right first molar, first and second premolars and canine of a young girl. This one case reiterated the importance of being prepared for the more unusual case on a not infrequent basis. Similarly, the earlier study at the Children's Hospital of Buffalo found that 61% of the traumatized permanent teeth were maxillary centrals, 19% were maxillary laterals, 13% were mandibular centrals, a few were mandibular laterals and there was a single canine from each arch (1). Likewise, the Seattle study found that the maxillary central incisors were the pervasive permanent teeth injured, followed by maxillary

lateral incisors and mandibular centrals (8). They also found that there were a few mandibular laterals and canines injured in each arch.

As all of these were complex injuries that involved the teeth and their periodontium, substantial treatment was needed during the initial emergency visit. Emergency treatment involved repositioning as needed and stabilization with a splint. The rationale was to perform the repositioning and stabilization as quickly and carefully as possible so as to maximize the chance of healing and minimize the chance of an adverse outcome (21-24). In this study, all of the 79 patients had received a splint. The great majority had received a flexible or physiologic splint (85%) for the stabilization of their avulsed and luxated teeth. The remaining patients had received a semi-rigid splint for the less frequent occurrence of a fracture of the tooth root and alveolar bone. In addition, one patient had received both a semi-rigid and a flexible splint for the management of their multiple injuries. A little over one quarter of the patients (27%) had also had their avulsed teeth replanted during the emergency visit. The documentary evidence in the patients records indicated that antibiotics had been prescribed in at least 38% of the cases and it is likely that several of the others had also received such a prescription. Additionally some patients (18%) had received sutures for their associated soft tissue lacerations. Similarly, the study in Seattle found that many of the permanent tooth injuries were treated with repositioning and the placement of a splint (8). However, as they had included minor injuries in their study, the most common procedures that had been performed during their emergency visit were examinations alone or in combination with the placement of a provisional restoration.

In summary, this comprehensive review of all of the dental trauma that required fixation at the Children's Hospital of Buffalo over a 2-year period has provided valuable information about the characteristics of the patients, their injuries, the causes of their injuries and their most likely times of occurrence. These complex injuries in permanent teeth that require fixation in a Children's Hospital are most often avulsions and luxations, particularly lateral luxations, and they most commonly involve the anterior teeth particularly maxillary central incisors. These injuries are most likely to occur in young adolescent males on Fridays and Saturdays during the summer months, and are most often because of organized and recreational sporting activities or accidental falls. Their emergency treatment involves replantation and repositioning as needed and stabilization with semi-rigid or a flexible splint.

# References

- 1. Majewski RF, Snyder CW, Bernat JE. Dental emergencies presenting to a children's hospital. ASDC J Dent Child 1988;55:339–42.
- Wilson S, Smith GA, Preisch J, Casamassimo PS. Epidemiology of dental trauma treated in an urban pediatric emergency department. Pediatr Emerg Care 1997;13:12–15.
- Battenhouse MA, Nazif MM, Zullo T. Emergency care in pediatric dentistry. ASDC J Dent Child 1988;55:68–71.

- 4. Zeng Y, Sheller B, Milgrom P. Epidemiology of dental emergency visits to an urban children's hospital. Pediatr Dent 1994;16:419–23.
- Al-Jundi SH. Dental emergencies presenting to a dental teaching hospital due to complications from traumatic dental injuries. Dent Traumatol 2002;18:181–5.
- 6. Nelson LP, Shusterman S. Emergency management of oral trauma in children. Curr Opin Pediatr 1997;9:242–5.
- Andreasen FM, Pedersen BV. Prognosis of luxated permanent teeth – the development of pulp necrosis. Endod Dent Traumatol 1985;1:207–20.
- Lombardi S, Sheller B, Williams BJ. Diagnosis and treatment of dental trauma in a children's hospital. Pediatr Dent 1998;20:112–20.
- 9. Andreasen FM. Pulpal healing after luxation injuries and root fracture in the permanent dentition. Endod Dent Traumatol 1989;5:111-31.
- American Academy of Pediatric Dentistry. Guidelines. Pediatr Dent 2001;23(Suppl. 7):29–90.
- American Academy of Pediatric Dentistry. Clinical guideline on management of acute dental trauma. Pediatr Dent 2004;26:120– 7
- Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;17:49–52.
- Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;17:1–4.
- Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;17:193–8.
- Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;17:145–8.
- Flores MT, Andreasen JO, Bakland LK, Feiglin B, Gutmann JL, Oikarinen K et al. Guidelines for the evaluation and management of traumatic dental injuries. Dent Traumatol 2001;17:97–102.
- 17. Gordy FM, Eklund NP, DeBall S. Oral trauma in an urban emergency department. J Dent Child (Chic) 2004;71:14–16.
- Andreasen FM, Andreasen JO. Diagnosis of luxation injuries: the importance of standardized clinical, radiographic and photographic techniques in clinical investigations. Endod Dent Traumatol 1985;1:160–9.
- Crona-Larsson G, Bjarnason S, Noren JG. Effect of luxation injuries on permanent teeth. Endod Dent Traumatol 1991;7:199–206.
- Crona-Larsson G, Noren JG. Luxation injuries to permanent teeth – a retrospective study of etiological factors. Endod Dent Traumatol 1989;5:176–9.
- Cvek M. Treatment of non-vital permanent incisors with calcium hydroxide. II. Effect on external root resorption in luxated teeth compared with effect of root filling with guttapucha. A follow-up. Odontol Revy 1973;24:343–54.
- 22. Andreasen FM, Zhijie Y, Thomsen BL. Relationship between pulp dimensions and development of pulp necrosis after luxation injuries in the permanent dentition. Endod Dent Traumatol 1986;2:90–98.
- Andreasen FM, Zhijie Y, Thomsen BL, Andersen PK. Occurrence of pulp canal obliteration after luxation injuries in the permanent dentition. Endod Dent Traumatol 1987;3:103–15.
- Oikarinen K, Gundlach KK, Pfeifer G. Late complications of luxation injuries to teeth. Endod Dent Traumatol 1987;3:296– 303.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.