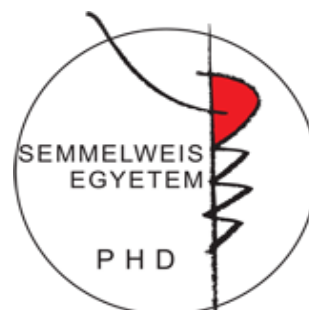


TRAUMATIC DENTAL INJURIES OF ANTERIOR PERMANENT TEETH IN PAEDIATRICS

PhD thesis

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1. Introduction

Traumatic dental injuries (TDIs) are one of the major dental public health problems among children and adolescents who seek emergency dental treatment [1].

These injuries affect approximately from 20 % to 30 % of permanent dentition [14] and between 9.4 % and 41.6 % of primary dentition [18]. The prevalence of dental trauma among children and adults varies from one country to another [19, 20]. This difference between the ratios is attributed to many factors, for instance, differences in populations studied, methodology used for the different studies and/or the variation in the evaluated variables and the diagnostic criteria (of TDIs) employed [21–24].

For a considerable period, clinical studies emphasised that the main factors predisposing children to TDIs were gender and age [3, 25]. In later studies, other factors have been reported, such as falls and bicycle accidents [26–31], collisions [32, 33], driving accidents, contact and noncontact sport, violence, foreign bodies striking the teeth, inadequate lip protection [34, 19, 35], sex and incisor overjet [36].

Regarding the consequences of TDIs may influence further tooth growth, resulting in irreversible damage if they occur during the initial stages of tooth development [2, 46]. Speaking and laughing can be negatively affected by such injuries, which in turn affects the child's self-confidence, self-esteem and quality of life in the long run [51–55].

Classification of TDIs

Traumatic dental injuries to anterior teeth are classified into two main groups [56]:

- Injuries to the hard dental tissues of the mouth.
- Injuries to periodontal tissues and/or supporting tissues of the teeth.

Injuries to the hard dental tissues of the mouth

Injuries to hard tissues are classified into [62]:

- a) Crown fracture
- b) Root-crown fracture
- c) Root fracture: These types of fractures are classified into horizontal root fractures (HRFs) and vertical root fractures (VRFs) [86].

Injuries to the periodontal or supporting tissues of the teeth

A trauma to the supporting tissues can lead to many complications such as pulp canal obliteration, necrosis and root resorption or luxation injuries [96, 97]. Various luxation injuries are possible depending upon the force and direction of the impact [101].

- a) Concussion
- b) Subluxation
- c) Extrusive luxation
- d) Lateral luxation
- e) Intrusive luxation
- f) Avulsion (total luxation)

Endodontic treatment traumatic injuries to immature permanent teeth

The endodontic treatment for traumatic immature permanent teeth is considered as a challenge for dentists if the pulp vitality is lost, especially with pulp necrosis in teeth with inadequate radicular development because an open apex in a permanent tooth takes approximately three years to close after tooth eruption [142–144]. If the apex is not completely formed, the standard treatment option for traumatised immature permanent teeth with necrotic pulp is apexification [145]. Many materials used in the treatment by apexification, for example, calcium hydroxide, mineral trioxide aggregate, iodoform paste and Biodentine.

Root-crown ratio of teeth

The R/C ratio is defined as the value between the root and the crown and may be classified as the anatomical R/C ratio or the clinical R/C ratio [173]. The definition of the R/C ratio of permanent teeth is of great importance. In paediatric dentistry, one can differentiate the developmental deficiencies of the teeth from the normal ones by defining the normal values and the variations of the R/C ratios [176]. In the present study, the aim was to compare the R/C ratios in the Hungarian, German and Japanese populations by using the same method.

2. Objectives

General objective

The general objective of this thesis was to increase the knowledge of the incidence, prevalence, risk, treatment of traumatic dental injuries to permanent teeth in children and adolescents.

Special objectives

I. To survey the prevalence of anterior tooth TDIs in children between 7 and 18 years old who presented for treatment at the Department of Paediatric Dentistry and Orthodontics, Semmelweis University, Faculty for Dentistry, Budapest, Hungary over a period of 10 years.

II. To correlate the prevalence of TDIs to the classification of traumas, to gender, age, type of affected teeth, type of trauma, aetiology, place of injury, season and to the arch over 10-years.

III. To determine the prevalence of TDIs among different age groups.

IV. To compare the present results with previously published Hungarian data in the years 1985–1999.

V. To present some of the cases treated.

VI. To compare the effectiveness of materials used in the treatment: calcium hydroxide, mineral trioxide aggregate, iodoform paste and Biodentine.

VII. To measure the root-crown ratio (R/C ratio) of teeth in healthy German, Japanese and Hungarian children.

3. Materials and methods

The study included traumatic dental injuries data collected from 7 to 18-year-old patients' files. The patients with a history of a traumatised permanent tooth were treated in the Department of Paediatric Dentistry and Orthodontics in Budapest for over a ten-year-long period between January 2007 and December 2016.

Also, a separate survey has been included in the present thesis. 95 Hungarian, 104 Japanese and 110 German young patients' panoramic radiographs were used to evaluate the R/C ratio. The Hungarian sample was obtained from the Department of Paediatric Dentistry and Orthodontics of Semmelweis. The Japanese data were received from the Department of Paediatric Dentistry of Asahi University, Hozumi, Japan, and the German sample from

Freiburg University, Freiburg, Germany. The determination of the R/C ratio of teeth was carried out by using the same method that Hölttä et al. did in 2004, which had been adapted from Lind's intraoral radiographic method [176, 177].

The following variables were collected from the patients' files: patient's gender, patient's age at the time of the trauma, tooth location, Type of TDIs, aetiology of dental trauma, the season in which the injury occurred, the reason that caused or led to dental trauma and the type of treatment.

TDIs were recorded according to the World Health Organization (WHO) classification system, which was slightly modified by Andreasen et al., and included two types of injuries [189]:

- Injuries to the hard dental tissues and pulp: enamel and enamel-dentin fractures without pulp exposure (uncomplicated crown fractures), enamel-dentin fractures with pulp exposure (complicated crown fracture), and root fracture.
- Injuries to the periodontal tissues: partial luxation and avulsion.

Statistical analysis

All the data obtained from the patient's documentation were entered into MS Excel 2007 for evaluation. The data were organised into files (Microsoft Excel) and analysed by using the Statistical Package for Social Sciences (SPSS), a software programme for statistical analysis, version 10.2 (IBM, 2015).

Statistical significance for the association between the occurrence of dental trauma and gender, age, place and cause were tested by using the *Chi-square* (χ^2) test of significance. p values ≤ 0.05 were considered statistically significant.

4. Results

The data collection of TDIs was completed for a total of 454 patients. A total of 899 injured permanent anterior teeth were included in the study with patients ranging in age from 7 to 18 years old. The total prevalence of TDIs among children in this study was 1 %. The peak incidence of the TDIs in our study was at 9 years of age. The results of the current study showed a higher prevalence of dental trauma among male patients than female ones. While 279 boys (61.45 %) suffered from TDIs, the number of the girls was 175 (38.54 %). Of all the 454 children, 247 (54.40 %) had one damaged tooth.

Regarding the R/C ratio evaluation, 95 Hungarian, 104 Japanese and 110 German young patients' panoramic radiographs were included in this thesis. Routine panoramic radiographs exposed between 2001 and 2006 were used.

Regarding the distribution of TDIs according to the different tooth-types. The maxillary central incisors were found to be the most affected by dental trauma at the rate of 63.62 % followed by maxillary lateral incisors (17.13 %).

There was a statistically significant relationship between gender and injured maxillary central incisors ($p=0.01$).

Regarding the distribution of TDIs according to age, the injuries were the most frequent between the ages of 8 and 10 years. The peak occurred at about the age of 9. Nine-year-old children comprised about 22.02 % of all the patients. They were followed by ten-year-old children who comprised 15.41 %.

Considering the distribution of dental trauma according to the type of injury, we could notice that luxation injuries were the most common type of trauma. They were present in 50 % of the teeth, followed by uncomplicated crown fractures (37.44 %) and complicated crown fractures (9.67 %), respectively. The prevalence of root fractures was the lowest among all types of TDIs by the rate of 1.02 %. A statistically significant difference between gender in the case of uncomplicated crown fractures was found ($p=0.001$), while there was no significant difference between boys and girls in the case of luxation injuries, complicated crown fractures, root fractures and avulsion ($p=0.6$, $p=0.09$, $p=0.5$, $p=0.7$ respectively).

Most accidents occurred during playtime (30 %) and sports activities (25 %). The percentage of children who suffered from dental trauma caused by a fall was 18 % and 15 % by cycling. The children who suffered from dental trauma caused by accidents and fights comprised 8 % and 4 %, respectively.

The most cases of dental trauma occurred at home (46.47 %) and in school (28.63 %). Playground cases comprised about 15 %.

The current survey recorded that the highest rate of dental trauma in children occurred in the spring, followed by autumn, as children who were affected by dental trauma in the spring made up 34.14 % of the total number of children. Children who suffered from TDIs during winter accounted for the lowest percentage (19.82 %). As far as the seasons are concerned, a statistically significant difference between boys and girls was found ($p=0.002$).

The most common therapy of TDIs was splinting, as it comprised about 58.48 % of all the total types of treatment, followed by treatment with $\text{Ca}(\text{OH})_2$ and protective crown [38.15 %]. The replantation ratio constituted 2.17 %. 0.84 % of total treatment was reposition. The lowest percentage was extraction [0.36 %].

Regarding the distribution of TDIs according to arch. From a total of 899 teeth that suffered from dental trauma, 807 (89.76 %) teeth were in the maxillary arch, and 92 (10.24 %) teeth were in the mandibular arch.

The present study recorded the distribution of infection with pulp necrosis of uncomplicated crown fracture according to the presence of luxation injury. from 291 teeth with uncomplicated crown fractures and without luxation injuries only 7 (2.41 %) teeth showed pulp necrosis. In the case of teeth with uncomplicated crown fractures with luxation injuries, 31.51 % of total teeth showed the incidence of pulp necrosis.

Based on the comparison between the current data over the period between January 2007 and December 2016 as well as the previously published data in the years 1985–1999, the results were compatible for the number of patients, gender, affected teeth and the most frequently affected teeth. While there was no agreement between the proportions concerning the most frequent type of dental trauma (luxation injuries current data (50%), enamel-dentin fractures (78.16 %)). As far as treatment methods are concerned, splinting was the most common type during the period between 2007–2016 with the rate of 58.48 %, while the treatment with $\text{Ca}(\text{OH})_2$ and temporary crown formed the highest ratio in the years 1985–1999. It comprised 38.15 %

Based on the comparison of the root-crown ratio in healthy German, Japanese and Hungarian populations, the lowest R/C ratios were found in teeth 16 and 17 in all the three populations. Low R/C ratios were found in tooth-types 11 and 14 in all the three populations. The highest R/C ratios were found in tooth-types 43 and 45 in all the three populations. In the German and Hungarian populations, tooth type 44 had the highest R/C values. The R/C ratios of teeth 15 and 13 were found high in the Japanese population, and the ratios were found medium in the Hungarian and German populations. No significant differences were found in the R/C ratios of the tooth-types in the three populations examined by us ($P > 0.05$). The German and the Japanese populations showed significant differences in all lower tooth-types ($P \leq 0.05-0.001$), the Japanese and Hungarian populations in almost all lower tooth-

types (except for 41, $P > 0.05$) ($P \leq 0,05-0,001$), the Hungarian and German populations showed significant differences in tooth-types 11, 16, 17, 47 ($P \leq 0,001$) and 41 ($P \leq 0,05$). In the upper arch, the German and Japanese populations showed significant differences in all of the tooth-types ($P \leq 0,05-0,001$); the Japanese and Hungarian populations in tooth-types 11, 12 and 13 ($P \leq 0,05-0,001$), the Hungarian and the German populations showed significant difference in tooth types 11, 16 and 17 ($P \leq 0,001$).

5. Discussion

In the present study, the total prevalence of TDIs among children was 1 %, which appeared to be relatively very low compared to other prevalence in the literature, for example, to the 30% reported by Forsberg and Tedestam [49]. The rate of 2.2 % reported by Lexomboon et al. is close to the current results [181]. The current Hungarian data reveal a clear decrease in the prevalence of TDIs in the last ten years (1 % current data, 2.5 % former data). The former data is reported by Gábris et al. [183]. The increased health awareness, the wide information and educational campaigns about the risk of dental trauma and prevention methods have largely contributed to this positive change.

We suppose that the decrease in the complications of dental trauma might be due to the increased use of mouthguards in Budapest. Unfortunately, no data is available to prove this fact in Hungary but many surveys in the literature hypothesise the effective role of mouthguards in this field. For example, significant risk reduction for complications following dental injuries in rugby union players in Australia after using mouthguards is reported by Ilia et. al. [184].

Large variability in the reported prevalence of TDIs can be found in the literature. Differences in sample composition as well as in the definitions and classifications of trauma make the comparison between various data on a uniform basis difficult [183, 186].

Different classification systems have been used in the literature. Noori and Al-Obaidi used Garcia Godoy's classification [187]. Chopra et al. [14] assessed dental injuries according to the Elis classification modified by Holland. In the present study, dental traumas were classified according to the World Health Organization [WHO] classification system, slightly modified by Andreasen et al. [189], which is the same classification that was used in the study by Bagattoni et al. [190].

In this survey, the results confirm the general findings in the literature that boys sustain dental trauma more frequently than girls as illustrated in the studies reported by Chen et al., Ritwik et al. [83], and Faus-Damia et al. [42]. The present results (61.45 % males, 38.54 % females) come close to the results (60 % male and 40 % female) published by Zengin et al. [182]. They are higher than the former results in Hungary (58.32 % males, 41.68 % females) [183]. The difference by gender is explained by the fact that boys are more inclined to pursue vigorous and aggressive leisure activities or sports with a greater risk of accident than girls [193].

Maxillary central incisors were the most commonly traumatised teeth in this study (63.62 %). This result was close to that of the previous study (63.6 %) by Ilia et al. [184], and higher than the rate (of 50 %) in the study reported by Costa et al. [194]. The prominent and most vulnerable position of the maxillary incisors makes these teeth more susceptible to injuries compared to the lower teeth [199].

The age when children are most susceptible to dental trauma was investigated in several studies. The variation in the peak incidence of dental trauma was observed in the literature. The highest frequency of TDIs in the permanent dentition was among 12-year-old Iraqi children in the study published by Yassen et al. [200], and among 8-year-old children in the study reported by Wang et.al [196]. Our results are similar to those of Ritwik et al., who also found the highest incidence of dental trauma at the age of 9 years [83]. The variation in the peak incidence of dental trauma from one study to another was attributed to the different restrictive age ranges [203]. When we compared the former Hungarian data published by Gábris et al. [183] to our findings, we noticed that there was a change in the peak incidence of TDIs from the age of 10 years in the earlier study to the age of 9 in the current study. The occurrence of peak dental trauma around the age of 9 can be explained by the fact that younger children have less sense of fear, which makes them more susceptible to dental injuries [186].

In the current study, the most common type of dental injury was luxation (50 %). This result is compatible with the result recorded by Toprak et al. in Turkish children in Istanbul as the most common type of dental injury was luxation (43.3 %) [204]. The recent outcome was contrary to the results of most studies, where uncomplicated crown fractures were the most common type of dental trauma [205–207].

Uncomplicated crown fractures comprised 37.44 % in the current survey. This result is higher than the average found by Sari et al. (25 %) [210].

Regarding complicated crown fractures, they comprised about 9.67 % in this study. This proportion compares well with the corresponding data of Altay N Gungör HC [213]. Overall, the proportion of crown fractures (complicated and uncomplicated) was 47.11 %. This rate is within the range reported by Andreasen et al. (26–76 %) [62].

Based on the comparison between current and former data, there has been a significant increase in luxation injuries in the last ten years and a significant decrease in crown fractures. Regarding avulsion injuries, the decrease in the proportion of avulsed teeth was considerable (1.85 % current data, 4.39 % former data). These changes between the previous and current data are attributed to the elasticity of alveolar bone in the younger studied age groups and the parents' increased awareness of the importance of mouthguards not only for certain sports activities but also with active children.

Many previously published surveys studied the aetiological factors of TDIs among children. Falls were the main factor of dental injuries among the patients in many studies [14], [3], [46], [34]. The main factors of dental injuries among the patients of this survey were play and sports injuries. Nemtoi et al. [191] and Agrawal et. al [216] stated that sporting activities were frequent causes of traumatic injuries with the rates of 23.1 % and 22.2 %, respectively, which was close to our data of 25.33 %.

The patients involved in this study often sustained dental trauma at home (46 %) followed by school (29 %). Our results come in line with those registered by Rouhani et al., as the dental injuries at home comprised 46.8 % and those in school comprised 29.9 % of the cases [34].

The relationship between seasons and dental trauma was studied, and there is a clear indication of increased traumatic injuries in the spring, as 34.14 % of children were affected by traumatic injuries during this season. This result is consistent with the outcome in Choi's study, where most of TDIs occurred in the spring there as well [32].

Splinting was the most common type of treatment in this study (58.48 %). The rate of treatment with calcium hydroxide and temporary crowns was 38.15 %. Unfortunately, there are no studies that report the prevalence of types of treatment in detail to compare our results with.

Regarding the distribution of TDIs according to arch, from a total of 899 teeth that suffered dental trauma, 807 (89.76 %) teeth were in the maxillary arch, and 92 teeth (10.24 %) were in the mandibular arch. This is in accordance with the reports of some previous studies [224–226]. This can be explained by the fact that in the sagittal plane, the maxillary arch is located more anteriorly than the mandibular arch as a result of which the impact of injury is more likely on the maxillary arch [39].

The findings in the present survey clearly showed the difference in the frequency of pulp necrosis (PN) according to the type of crown fracture. Low incidence of pulp necrosis appeared in the teeth with uncomplicated crown fractures and without luxation injuries, as 2.41 % of all cases of uncomplicated crown fractures without luxation injuries showed PN after trauma, while 31.51 % of uncomplicated crown fractures with luxation injuries suffered PN. The findings in the literature supported our results. The frequency of pulp necrosis was significantly higher in crown-fracture teeth with luxation injuries (34.0 %) than in crown-fracture teeth without luxation injuries (22.7 %) in Guan and Qin study [227]. Many factors play an important role in the healing and prevention of pulp necrosis after the occurrence of fractures. Pulp circulation due to concomitant subluxation as well as the stage of root development and the fracture depth seem compromised [65].

Based on the comparison between current and former data, there is compatibility concerning the gender and the tooth type the most affected by dental trauma. Regarding the most common type of TDIs, there has been a significant increase in luxation injuries in the last ten years, and a significant decrease in crown fractures (78.16 % crown fractures former data, 50 % luxation injuries current data). Concerning avulsion injuries, the decrease in the proportion of avulsed teeth was visible (1.85 % current data, 4.39 % former data). In the case of the type of treatment, splinting was the most common in 2007–2016 years, while the treatment with Ca(OH)_2 and temporary crown formed the highest ratio in the years 1985–1999. These changes between the previous and current data are attributed to the elasticity of alveolar bone in the younger age groups and the parents' increased awareness of the high importance of mouthguards for certain sports activities.

Regarding the measurement and comparison of the R/C ratio of tooth types in the three populations, Holttä et al.'s method was used In the present study [177]. The lowest R/C ratios were found in tooth-types 16 and 17 in all the three populations examined. This is

similar to the Finnish findings [177]. In the Japanese and Finnish populations, tooth-types 46 and 47 also had the lowest R/C values, which may be due to the differences in mandible anatomy.

Low R/C ratios were found in tooth-types 11 and 14 in all the three populations. In the Finnish sample, only tooth-type 11 showed even lower R/C ratios [177].

The highest R/C ratios were found in tooth-types 45 and 43 in all the three populations, as well as in the Finnish report. The R/C ratios of tooth-types 15 and 13 in the Japanese and the Finnish populations were found high, however, in the Hungarian and the German populations they were found medium.

There were no significant differences found in the R/C ratios of the tooth-types in the three populations examined by us which means that it is not possible to determine the nationality of a person depending on the root-crown ratio of their tooth-types.

More differences were found in the R/C ratio of the lower arch, which may be due to different mandible anatomy.

The German and the Japanese populations showed significant differences in all lower tooth-types, the Japanese and the Hungarian populations in almost all lower tooth-types, except for 41, which indicates that there has not been a mixture between these populations throughout history. The Hungarian and the German populations did not show significant differences except for tooth-types 11, 16, 17 and 47, which may be an indication of the mixture of these nations.

The R/C ratios are of great importance in paediatric dentistry as this method can be applied to follow the R/C ratio after various traumatic dental injuries. It can prove whether there is a difference one year later in the R/C ratio after dental trauma.

Clinical reports

Case no. 1: Apexification by using calcium hydroxide

- A 7-year-old boy was referred to the department with a traumatic injury.
- The clinical examination revealed a complicated crown fracture of the left maxillary central incisor
- Radiographic examination detected immature teeth with open apices and a large radiolucent area. The root developmental stage (2 to) 3 was established according to Moorrees et al. [228] (Figure 1).

- The canal was obturated with half heated gutta-percha and a sealer by applying the lateral condensation technique (Figure 3).



Figure 1.
Complicated crown fracture of the left maxillary central incisor



Figure 2.
Calcium hydroxide dressing of the root for tooth 2.1.



Figure 3.
Permanent gutta-percha root canal obturation; 1-year radiographic check-up

Case no. 2: Apexification by using mineral trioxide aggregate

- An 8-year-old boy was referred to the Department of Paediatric Dentistry and Orthodontics in Semmelweis University, Budapest for evaluation and treatment.
- The clinical examination revealed a complicated crown fracture of the right upper central incisor.
- Periapical radiographs demonstrated an incompletely formed root apex and periapical radiolucency (Figure 4).



Figure 4.

Incompletely formed root length of tooth 1.1. and wide-open apex for teeth 1.1, 1.2 and 2.2; complicated crown fracture with pulpal involvement of tooth 1.1; crown fracture without pulpal involvement for tooth 2.1.



Figure 5.

The MTA apical plug and gutta-percha filling



Figure 6.

Check-up after one year



Figure 7.

Check-up after two years

6. Conclusions

- The prevalence of traumatic dental injuries among children was 1 %. Higher prevalence of dental trauma was found among male patients than female patients (61.45 % male and 38.54 % female).

- Regarding the type of affected teeth, maxillary central incisors were the most affected by dental trauma with the rate of 63.62% followed by maxillary lateral incisors (17.13%). Traumatic dental injuries were most frequent between the ages of 8 and 10 years. The peak occurred at about the age of 9, as the nine-year-old children comprised about 22.02 % of all the patients.

- Luxation injuries were the most common type of TDIs as they comprised 50 % of all the injuries, followed by uncomplicated crown fractures (37.44 %) and complicated crown fractures (9.67 %).

- TDIs that occurred during playtime comprised 30 % of all the injuries, while 25 % of dental injuries were caused by sports activities. Regarding the place of occurrence of TDIs, most cases of dental trauma occurred at home (46.47 %) and in school (28.63 %).

- Concerning the distribution of traumatic dental injuries according to the seasons, the highest rate occurred in the spring with a rate of 34.14 %.

- From among the possible treatments of TDIs, splinting was the most common therapy as it comprised about 58.48 %, followed by treatment with Ca(OH)_2 and protective crown (38.15 %). Regarding the distribution of TDIs according to arch, from a total of 899 teeth that sustained dental trauma, 807 teeth (89,76 %) were in the maxillary arch.

- In the teeth with uncomplicated crown fractures and without luxation injuries very low incidence of pulp necrosis appeared (2.41 %) in comparison with uncomplicated crown fractures with luxation injuries (31.51 %).

- Regarding the materials used in the treatment of the roots of the teeth involved in dental injuries, calcium hydroxide is recommended as a temporary dressing for two months before applying other materials such as MTA, Biodentine and iodoform paste. The importance of the use of Ca(OH)_2 is due to its role in stimulating the apical closure process and keeping the root canal dry and free from infection and microorganisms. The purpose of using Ca(OH)_2 for short time was to avoid the possibility of cervical root fracture of the weakened teeth because of the desiccating properties of this material due to high pH.

- No significant differences were found in the R/C ratios of the tooth-types in these three populations, which means that it can't be possible to determine the nationality of a person depending on the root-crown ratio of their tooth-types. The German and the Japanese populations showed significant differences in all lower tooth-types, the Japanese and the Hungarian populations in almost all lower tooth-types, except for 41, which indicates that there has not been a mixture between these populations throughout history. The Hungarian and the German populations did not show significant differences except for tooth-types 11, 16, 17 and 47, which may be an indication of the mixture of these nations.

The R/C ratios are of great importance in paediatric dentistry as we can determine if the R/C ratios of teeth change after traumatic injuries.

7. New achievements of the present work

- The decrease in the prevalence of TDIs in the last ten years. The rate of TDIs was 1 % between January 2007 and December 2016, while it was 2.5 % in the years 1985–1999.
- A significant increase in luxation injuries in the last ten years, and a significant decrease in crown fractures. The luxation injuries were the most common type of TDIs among patients in the last ten years with the rate of 50 %, while crown fractures were the most common in the period of 1985–1999.
- Regarding avulsion injuries, the decrease in the proportion of avulsed teeth was evident (1.85 % current data, 4.39 % former data). These changes between the previous and current data are attributed to the elasticity of alveolar bone in the younger age groups studied.
- Regarding the type of treatment, splinting was the most common one from 2007 to 2016, while the treatment with Ca(OH)_2 and temporary crown formed the highest ratio between 1985 and 1999.

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