FEDERAL UNIVERSITY OF UBERLÂNDIA
SCHOOL OF DENTISTRY

DANIELLA ALVES DINIZ

AVALIAÇÃO DE LESÕES DENTÁRIAS TRAUMÁTICAS EM UM SERVIÇO PÚBLICO BRASILEIRO DE TRAUMATISMO DENTÁRIO – UM ESTUDO RETROSPECTIVO

EVALUATION OF TRAUMATIC DENTAL INJURIES IN A PUBLIC BRAZILIAN DENTAL TRAUMA SERVICE – A RETROSPECTIVE STUDY

UBERLÂNDIA
2021

DANIELLA ALVES DINIZ

AVALIAÇÃO DE LESÕES DENTÁRIAS TRAUMÁTICAS EM UM SERVIÇO PÚBLICO BRASILEIRO DE TRAUMATISMO DENTÁRIO – UM ESTUDO RETROSPECTIVO

EVALUATION OF TRAUMATIC DENTAL INJURIES IN A PUBLIC BRAZILIAN DENTAL TRAUMA SERVICE – A RETROSPECTIVE STUDY

Trabalho de conclusão de curso apresentado a Faculdade de Odontologia da Universidade Federal de Uberlândia, como requisito parcial para obtenção do título de Graduado em Odontologia.

Orientadora: Prof[a]. Dr[a]. Priscilla Barbosa Ferreira Soares

.

UBERLÂNDIA
2021

AGRADECIMENTOS

Aos meus pais, Ana Claudia e Clayton, por me apoiar nas minhas escolhas, por me proporcionado uma base forte, pelo amor incondicional e por estarem sempre presentes. Sem vocês a realização desse sonho não seria possível.

As minhas irmãs, Angéllica e Giulliana, por serem os meus maiores exemplos de força e coragem, por todos os momentos dedicados a mim, pelos conselhos, pelo amor, pelo afeto e pela amizade.

Ao meu namorado e grande amigo, Marcos Vinícius, que jamais me negou apoio, carinho e incentivo, e por sempre se manter presente mesmo estando longe. Obrigada por entender minha ausência em diferentes momentos. Obrigada por tanto.

A todos os meus amigos, especialmente Carol, Isabella, Nayane e Wilton, pelo companheirismo inigualável, por estarem sempre presentes mesmo distantes, e agregar tanto ao meu crescimento.

A todos os meus amigos da faculdade, especialmente Fernanda, João, Lorena e Lucas, por todo apoio dentro e fora da faculdade, por todos os conselhos, por cada momento vivido e por cada um ser especial e único.

As minhas amizades concretizadas em Uberaba, especialmente Isabella, Fernanda e Tayllan, que foram de extrema importância no início da minha trajetória na graduação, por terem sido a minha base por 2 anos e por todas as experiências e momentos vividos.

A minha orientadora, Profª. Drª. Priscilla Soares. Em conjunto com a Drª. Milena e Ms. João Lucas, me deram todo o suporte com suas correções e incentivos. Manifesto aqui minha gratidão eterna por compartilharem sua sabedoria, o seu tempo e sua experiência.

A Universidade Federal de Uberlândia, casa que sempre estimarei e protegerei avidamente, a qual me proporcionou crescimento pessoal e profissional. Sou grata à cada membro do corpo docente, à direção e a administração dessa instituição de ensino. E a todos que de alguma forma contribuíram para a realização desse trabalho.

ABSTRACT

The aim of this retrospective study was to analyze data from records of patients seen in the dental trauma reference clinic of a general hospital (Federal University of Uberlândia) between 2014 and 2018 and evaluate predictions factors for the TDI of hard dental tissue and pulp. A total of 301 dental records were analyzed between 2014 and 2018. Demographic, socioeconomic and clinical characteristics of the patients were evaluated as well as the location and the etiology of the TDI. The outcome of the study was the number of tooth surfaces fractured. A descriptive analysis of the predictor variables according to the mean number of fractured tooth surfaces was also performed. Unadjusted analyses were performed to provide a preliminary assessment of the association between predictor variables and outcome. An unadjusted and adjusted Poisson regression model was used to evaluate the association between sample characteristics and mean fractured tooth surfaces. Only variables with $p<0.05$ were retained in the final adjusted model. The confidence interval was 95% (95% CI). The mean age was 19 years and 66.8% of the subjects were male, with falls or collisions being the main cause (36.6%). In relation to trauma-related characteristics, the occurrence in traffic accidents (RM 1.50; 95%CI 1.23-1.83) and the occurrence of the mandible or maxilla fracture (RM 1.37; 95%CI 1.03-1.81) caused a 50% and 37% increase in the mean number of tooth surfaces affected, respectively. We conclude that men are more exposed to traumas and automobile accidents result in more complex dentoalveolar injuries.

Key words: Dentoalveolar trauma, epidemiology, complex injuries.

SUMÁRIO

1 INTRODUCTION 6
2 DEVELOPMENT 7
2.1 Material and Methods 7
2.2 Results 8
3 DISCUSSION 12
4 CONCLUSIONS 15
REFERENCES 16

1 Introduction

Defined as an injury caused by external impacts acting on the dental organ, traumatic dental injury (TDI) is considered a public dental health problem in many countries. TDI can cause adverse impact on the quality of life of the affected individual and their family [1,2]. Besides, the treatment can often be complex requiring several areas of specialist to be involved [3] and is likely to need follow-up for many years [4]. Thus, adequate diagnosis, treatment planning, and follow-up are the key factors for a favorable prognostic [5].

Injuries to the hard dental tissues and pulp have been described as crown, crown-root, and root fractures. Crown fractures can involve the enamel and/or dentin. When a fracture reaches enamel, dentin, and cementum and extends below the gingival margin, it is defined as crown-root fracture. They are considered uncomplicated when the pulp is not exposed and complicated when pulp exposure is observed. In cases of root fractures, only the root is affected without the enamel involvement and it can occur at the apical, middle, or cervical third. [6].

TDI can affect not only the tooth but also the supporting structures. Injuries to the periodontal ligament (luxations), alveolar bone and soft tissues of variable extent, intensity, and severity often occur. Luxation injuries are the most commonly occurring ones in the primary dentition, whereas crown fractures are more frequently reported for the permanent teeth [7]. The combination of these injuries further increases the complexity of the treatment [8]. Most of the cases results in pain, emotional damage, loss of function, and aesthetic damage [9,10]. Thus, the negative impact of TDI cannot be neglected, and it becomes the role of health professionals to identify the causes and risk factors of TDI, so as to prevent its occurrence [11].

In Brazil, the prevalence of TDI has increased [12] becoming a public health problem. Besides the elevated number of cases, TDI is also a public concern because of its negative impact on quality of life [13] and the high cost of its treatment [14]. Thus, epidemiological studies are necessary to provide an overview of the cases, as well as to identify the groups of risk and the prevalence of the existing injuries. Most of the studies has investigated the TDI involving periodontal tissues [5,15], however, few have focused on the indicators/risk factors for crown, crown-root, and root fractures. Therefore, the purpose of this retrospective study was to analyze data from records of patients seen in the dental trauma reference clinic of a general hospital (Federal University of Uberlândia) between 2014 and 2018 and evaluate predictions factors for the TDI of hard dental tissue and pulp.

Material and methods

This retrospective study has been approved from the Human Research Ethics Committee of the Universidade Federal de Uberlândia under the process CAAE 09518018.3.0000.5152, in compliance with Resolution 196/96 of the Conselho Nacional de Saúde (CNS - Brazilian National Health Council). Data were extracted from a database containing the clinical records of patients treated at the Dental Trauma reference Clinic conducted at the Hospital of the Federal University of Uberlândia, Brazil. All the necessary treatment to the patients (children, adolescents and adults) who have suffered from TDI is provided by researchers and specialists of several areas, such as endodontic, periodontal, orthodontic and restorative field.

Sample characteristics

Data from 301 clinical records of patients treated in the Dental Trauma reference Clinic between 2014 and 2018 were collected. Demographic, socioeconomic and clinical characteristics of the patients were extracted as well as the location and the etiology of the TDI. The clinical characteristics and diagnosis were based on the classification of Traumatic dental injuries (TDIs) proposed by Andreasen and Andreasen based on a system adopted by the World Health Organization [4]. The presence of soft tissue injuries and bone fractures was confirmed by cautious clinical investigation, palpation and radiographic exams. Missing information in the patient record were not excluded being reported as “not informed”.

Data were analyzed using the statistical program STATA 14.0 (StataCorp. 2014. Stata Statistical Software: Release 14.0. College Station, TX: StataCorp LP). A descriptive analysis of the demographic, socioeconomic, and clinical characteristics of the sample was performed, as well as a description of the distribution of the different oral and trauma-affected structures. The outcome of the study was the number of tooth surfaces fractured. The injuries were categorized in scores: (1) enamel crack (2) enamel fracture (3) enamel-dentin fracture (4) enamel-dentin fracture with pulp exposure (5) crown-root fracture (6) root fracture. A descriptive analysis of the predictor variables according to the mean number of fractured tooth surfaces was also performed. In this analyze, mesial, distal, buccal, lingual, incisal/occlusal surfaces were considered.

Unadjusted analyses were performed so as to provide a preliminary assessment of the association between predictor variables and outcome. An unadjusted and adjusted Poisson regression model was used to evaluate the association between sample characteristics and the mean number of fractured tooth surfaces (score $\geq$ 1). The predictor variables that had a p-value <0.20 in the unadjusted analysis were included in the adjusted model. Only variables with a p-value <0.05 were fitted in the final adjusted model. Results are presented as the ratio of means (RM) and 95% confidence interval (95% CI).

2.2 Results

The sample consisted of 301 trauma-injured individuals treated at the Dental Trauma Clinic. The mean age was 19.0 [standard deviation (SD) 12.1] years. Table 1 shows the distribution of the sample according to demographic, socioeconomic, and clinical characteristics. Approximately, 66.8% of the subjects were male, and 38.0% had less than 8 years of education (incomplete elementary school). About trauma-related characteristics, 36.6% were due to falls or collisions, and 28.2% due to traffic accidents. Considering the environment where the trauma occurred, 33.6% were at home, 12.9% at school or work, and 32.5% in traffic.

Table 1. Distribution of the sample according to demographic, socioeconomic, and clinical characteristics of the patients (n=301).

Variables	**n**	**%**
Individual Characteristics		
Gender		
Male	201	66,8
Female	100	33,2
Age group		
Child	100	36,0
Adolescent	69	24,8
Adult	109	39,2
Education level		
$\geq$ 8 years of formal education	145	62,0
< 8 years of formal education	89	38,0
Occupational employment		
Employed	74	29,4
Unemployed	172	70,6
Use of medication		
No	248	83,2

Yes	50	16,8
Trauma-related characteristics		
Reason for trauma		
Fall / collision	109	36,6
Sports / martial arts	32	10,7
Traffic accident	84	28,2
Accident at work	18	6,0
Another reason	55	18,5
Environment where the trauma occurred		
At home	99	33,6
Work / school	38	12,9
Traffic	96	32,5
Another	62	21,0
Soft tissue injury		
Absent	118	41,7
Present	165	58,3
Maxillary fracture		
Absent	246	97,2
Present	7	2,8
Maxilla/Mandibular fracture		
Absent	289	96,0
Present	12	4,0

Values under 301 are due to missing data.

The distribution of the different types of lesions and structures affected are shown in Table 2. The most affected soft tissue was the gingiva (11.7%) and the most prevalent type of injury was cuts (37.4%). Dental structures were the most affected among the hard tissues (73.5%). Regarding the number of fractured tooth surfaces, an average of 4.3 (SD 4.9) tooth surfaces were affected by any type of fracture and 4.9 (SD 5.9) by a severe dental fracture (score $\geq$ 3). Higher means of fractured tooth surfaces were observed in males, adults and individuals with higher level of education. Regarding the circumstances of trauma, higher means were observed in traffic accidents and when fracture of the mandible and maxilla occurred (Table 3).

Table 2. Distribution of the different types of injuries and structures affected by trauma (n=301)

Oral structures affected by trauma	
Soft tissues [n (%)]	
Inferior labial frenulum	5 (1,8)
Upper labial frenulum	10 (3,5)
Gingiva	33 (11,7)
Tongue	7 (2,5)
Jugal mucosa	14 (5,0)
Types of soft tissue injury [n (%)]	
Abrasion	23 (8,2)
Bruise	5 (1,8)
Cut	105 (37,4)
Laceration	52 (18,5)
Hard tissues [n (%)]	
Tooth	206 (73,5)
Mandibular	9 (3,6)
Maxilla	7 (2,8)
Hard palate	2 (0,7)
Number of fractured tooth surfaces [average (SD)]	4,3 (4,9)
Number of fractured tooth surfaces affected by severe trauma* [average (SD)]	4,9 (5,7)
Number of teeth with post-trauma mobility [average (SD)]	0,8 (1,3)
Number of surfaces with post-trauma color change [avarage (SD)]	0,4 (1,1)
Number of teeth that presented sensitivity [avarage (SD)]	1,5 (2,6)
Number of teeth that presented fistula [avarage (SD)]	0,3 (1,0)

*Severe trauma: score $\geq$ 3; SD, standard deviation.

Table 3. Sample characteristics according to the number of fractured tooth surface.

Variables	**Number of fractured tooth surfaces**
	Avarage (SD)
Individual Characteristics	
Gender	
Male	4,6 (5,1)
Female	3,6 (4,5)
Age group	
Child	3,8 (3,4)
Adolescent	3,6 (4,6)
Adult	5,1 (6,0)
Education level	
$\geq$ 8 years of formal education	4,8 (5,8)
< 8 years of formal education	3,8 (4,0)
Occupation employment	
Employed	4,4 (5,0)
Unemployed	3,9 (4,1)
Use of medication	
No	4,2 (4,9)

Yes	4,5 (4,9)
Trauma-related characterstics	
Reason for trauma	
Fall / collision	3,2 (3,5)
Sports / martial arts	4,2 (3,5)
Traffic accident	5,8 (6,4)
Accident at work	4,2 (5,6)
Another reason	4,1 (4,7)
Environment where the trauma occurred	
At home	3,5 (3,4)
Work / school	3,7 (5,0)
Traffic	5,6 (6,0)
Another	3,9 (4,7)
Soft tissue injury	
Absent	4,1 (4,9)
Present	4,5 (5,1)
Maxilla/Mandibular fracture	
Absent	4,2 (4,5)
Present	7,6 (10,9)

Values under 301 are due to missing data; SD, standard deviation.

Table 4 presents the unadjusted and adjusted association between the predictor variables and the mean number of tooth surfaces fractured after TDI. In the unadjusted analysis, gender, age, education level, the reason for trauma, and the mandible or maxilla fracture were associated with the highest number of fractured tooth surfaces ($p<0.05$). In the adjusted analysis, it was observed that female had lower mean of fractured tooth surfaces than male (RM 0.63; 95%CI 0.53-0.74). Regarding age group, adult subjects showed 39% higher mean of affected surfaces (RM 1.39; 95%CI 1.16-1.68). Regarding trauma-related characteristics, the occurrence due to traffic accidents (RM 1.50; 95%CI 1.23-1.83) and the occurrence of the mandible or maxilla fracture (RM 1.37; 95%CI 1.03-1.81) entailed a 50% and 37% increase in the means, respectively.

Table 4. Unadjusted and adjusted association between predictor variables and the mean number of fractured tooth surfaces, determined using Poisson regression.

Variable	**Number of fractured tooth surfaces**		
	Unadjusted RA (CI 95%)	**P-value**	**Adjusted* RA (CI 95%)**
Individual Characteristics			
Gender		0,00	
Male	1		1

Female	0,77 (0,68-0,87)		0,63 (0,53-0,74)
Age group		0,00	
Child	1		1
Adolescent	0,94 (0,80-1,11)		0,81 (0,65-1,01)
Adult	1,35 (1,19-1,54)		1,39 (1,16-1,68)
Education level		0,01	
≥ 8 years of formal education	1		-
< 8 years of formal education	0,79 (0,69-0,90)		
Occupational employment		0,09	
Employed	1		-
Unemployed	0,89 (0,78-1,01)		
Use of medication		0,40	
No	1		-
Yes	1,06 (0,92-1,22)		
Trauma-related characteristics			
Reason for trauma		0,03	
Fall / collision	1		1
Sports / martial arts	1,29 (1,05-1,57)		1,13 (0,88-1,44)
Traffic accident	1,77 (1,55-2,03)		1,50 (1,23-1,83)
Accident at work	1,29 (1,01-1,66)		1,26 (0,93-1,71)
Another reason	1,26 (1,07-1,49)		1,00 (0,79-1,26)
Environment where the trauma occurred		0,64	
At home	1		
Work / school	1,04 (0,86-1,27)		-
Traffic	1,60 (1,40-1,83)		
Another	1,11 (0,94-1,31)		
Soft tissue injury		0,42	
Absent	1		-
Present	1,04 (0,93-1,17)		
Maxilla/Mandibular fracture		0,00	
Absent	1		1
Present	1,81 (1,46-2,24)		1,37 (1,03-1,81)

RA, ratio of averages; CI, confidence interval; *Variables tested in the final model: p<0,20; Variables fitted in the final model: p<0,05;

3 Discussion

This study evaluated the distribution of the TDI and analyzed the predictor factors for tooth fractures with or without pulp exposure according to the mean number of traumatized tooth surfaces. Data were extracted from dental records of 301 patients treated in the dental trauma reference clinic of a general hospital (Federal University of Uberlândia) between 2014 and 2018. Most of the cases were due to falls/collisions (36.6%), and traffic accidents (28.2%.); and the dental structures were the most affected among the hard tissues (73.5%). Regarding tooth fractures with or without pulp exposure, higher means of affected surfaces were observed in males and adults. The occurrence of TDI due to traffic accidents and the occurrence of the

mandible or maxilla fracture increased the mean number of fractured tooth surfaces in 50% and 37%, respectively.

The Dental Trauma Clinic where this study was performed is a regional reference center because is the only regional public service specialized in TDI. It treats minor facial trauma including soft tissue lacerations with tooth involvement and therefore can be considered to cover the TDI assistance and treatment among the low socio-economic population in Uberlândia and region, Brazil. Epidemiological studies, mainly those from public health assistance, are important to create preventive actions. They provided recent information to identify the most affected groups by a particular disease or condition, as well as its repercussions on various aspects of human life [2,5,16,17]

Considering the type of injury, crown fractures with or without pulp exposure are the most frequently reported types of dental trauma whereas crown-root fractures occurrence are not frequent [18,19]. Tooth fractures requires special attention, due to their prevalence, variety of etiology factors, and the differences clinical solutions proposed for the treatment. In this study, the predictor variables were evaluated according to the mean of fractured tooth surfaces in order to assess the extension of the trauma. The adjusted analysis demonstrated that adult subjects showed 39% higher mean of affected surfaces. Regarding trauma-related characteristics, the occurrence of tooth fracture due to traffic accidents and the presence of concomitant mandible or maxilla fracture entailed a 50% and 37% increase in the means, respectively. This results support the general finding that the main causes of TDI depend on the age of the group [8,20,21]. For children, it has been reported that the main causes of TDI are falls, whereas in adolescents it is more related to sports. In adults, more severe traumas occur caused by motorized vehicle accidents [18,22].

The injury pattern also varies according to local biological factors of the involved tissues. The biomechanical properties are different across age groups. Children's bones are more resilient as it is less mineralized than adults skeleton [23]. It has been demonstrated [24,25] that the stress distribution in a tooth after an impact is altered if the cushioning effect of the surrounding tissues is increased. In others words, a more flexible bone and a larger periodontal ligament of a child can absorb the energy from a trauma but the same impact may lead to a root fracture in an adult.

Our results demonstrated an increase of 50% in the means of tooth surface affected by fracture in TDI caused by traffic accidents. Traffic accidents were the second most frequent

cause of oral trauma (28.2%), after falls or collisions (36.6%) which is in accordance with the literature [6]. However, the extension of dental fractures represented by the means of fractured surfaces were expressively higher in cases of traffic accidents. It has been shown that TDIs usually affect a single tooth, but some trauma circumstances such as sports, fights, and traffic accidents lead to multiple tooth injuries [3]. Another important finding is that more tooth surfaces were affected by fracture when the mandible or maxilla was also fractured. Rahimi-Nedjat, Sagheb, & Walter (2014) also observed that the extent and severity of the traumas are more complex in patients with combined dental and facial fractures as they often have sustained their injuries from high-speed impacts. Thus, preventive measures to avoid or reduce the consequences of severe impacts in traffic accidents are feasible as well as a detailed clinical and radiographic examination to identify possible tooth alterations when fractures of

Wearing seatbelts in a car, and using a helmet when riding a motorcycle is mandatory in several countries. Severe head injuries can be avoid using bicycling helmets however, this type of helmet do not offer any mouth or dental protection [27]. The use mouthguards reduces the consequences of such impacts. Finite element models demonstrated that mouthguards are efficient at decreasing the stress and strain values on the tooth in front of an impact reaching more than 90% of shock absorption when well adapted [28]. During sports and other activities in which there is a risk of falling or being hit by an object, wearing a faceguard or mouthguard still seems to be the only way to prevent or at least significantly reduce the seriousness of dental injuries protection [27].

The predictors variables for periodontal injuries were not investigated once the periodontal lesions due to TDI are not assessed through the evaluation of affected tooth surface which was the evaluated outcome in the current study. However, it is important to emphasize that any impact that lead to tooth fracture is likely to also cause a luxation injury [29]. Therefore, the clinician should be aware and investigate if any luxation injury occurred in all crown-fractured teeth. Treatment delay may influence the diagnostic and special attention is required mainly in late referral cases in which there is a risk of overlooking a possible luxation lesion [8]. Establish the extent of tooth fractures and a careful evaluation to detect possible additional luxation is essential for a thorough diagnosis.

In dental traumatology, retrospective analyses are commonly performed [30] but some limitations are implicated with the study design. All data was extracted from patient records,

documents and radiographs. Thus, missing information could not be compensated with another source. Divergent diagnostic might occur in epidemiological studies performed in references centers for TDI due to the different levels of experience and knowledge of the professionals [31]. This limitation was minimized in our study since the diagnostic and treatment plan were carried out only by the same consolidated group in TDI treatment which consists of 3 researchers during the analyzed period (2014-2018).

4 Conclusions

In this retrospective study, adults showed 39% higher mean of fractured tooth surfaces. The occurrence of tooth fracture due to traffic accidents was associated with an increase of 50% in the mean of affected surfaces and the presence of concomitant mandible or maxilla fracture entailed a 37% increase. The negative impact of TDI cannot be underestimated and epidemiological studies elucidate the causes and risk factors of TDI. Thus it is possible to plan, execute and evaluate actions for health education, with a focus on the prevention of dental trauma.

5 References

1. Carvalho Oliveira Coutinho D, de França Perazzo M, Antônio Martins-Júnior P, Martins Paiva S, Silva Marques L, Ramos-Jorge ML. Mild traumatic dental injuries did not impact the oral health-related quality of life of children aged 8 to 10 years old of low socioeconomic status. J Public Heal. 2018;
2. Lam R. Epidemiology and outcomes of traumatic dental injuries: A review of the literature. Aust Dent J. 2016;
3. Glendor U. Epidemiology of traumatic dental injuries - A 12 year review of the literature. Dent Traumatol. 2008;
4. Andreasen JO, Andreasen FM, Andersson L. Textbook and Color Atlas of Traumatic Injuries to the Teeth. Stomatol EDU J. 2019;
5. Mesquita GC, Soares PBF, Gomes CCM, Roscoe MG, Paiva SM, Soares CJ. A 12-year retrospective study of avulsion cases in a public Brazilian dental trauma service. Braz Dent J. 2017;
6. Bourguignon C, Cohenca N, Lauridsen E, Flores MT, O'Connell AC, Day PF, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 1. Fractures and luxations. Dental Traumatology. 2020.
7. Levin L, Day PF, Hicks L, O'Connell A, Fouad AF, Bourguignon C, et al. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: General introduction. Dental Traumatology. 2020.
8. Lauridsen E, Hermann NV, Gerds TA, Kreiborg S, Andreasen JO. Pattern of traumatic dental injuries in the permanent dentition among children, adolescents, and adults. Dent Traumatol. 2012;
9. DiAngelis AJ, Andreasen JO, Ebeleseder KA, Kenny DJ, Trope M, Sigurdsson A, et al. Guidelines for the management of traumatic dental injuries: 1. Fractures and luxations of permanent teeth. Pediatric Dentistry. 2018.
10. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, DiAngelis AJ, et al. Guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Pediatric Dentistry. 2018.
11. Ain TS, Telgi RL, Sultan S, Tangade P, Telgi CR, Tirth A, et al. Prevalence of traumatic dental injuries to anterior teeth of 12-year-old school children in Kashmir, India. Arch Trauma Res. 2016;
12. Cunha Bonini GADV, Marcenes W, Oliveira LB, Sheiham A, Bönecker M. Trends in

the prevalence of traumatic dental injuries in Brazilian preschool children. Dent Traumatol. 2009;

13. Berger TD, Kenny DJ, Casas MJ, Barrett EJ, Lawrence HP. Effects of severe dentoalveolar trauma on the quality-of-life of children and parents. Dent Traumatol. 2009;
14. Glendor U, Jonsson D, Halling A, Lindqvist K. Direct and indirect costs of dental trauma in Sweden: A 2-year prospective study of children and adolescents. Community Dent Oral Epidemiol. 2001;
15. Goswami M, Rahman B, Singh S. Outcomes of luxation injuries to primary teeth-a systematic review. Journal of Oral Biology and Craniofacial Research. 2020.
16. Frérot M, Lefebvre A, Aho S, Callier P, Astruc K, Glélé SA. What is epidemiology? Changing definitions of epidemiology 1978-2017. PLoS ONE. 2018.
17. Guedes OA, de Alencar AHG, Lopes LG, Pécora JD, Estrela C. A retrospective study of traumatic dental injuries in a Brazilian dental urgency service. Braz Dent J. 2010;
18. Hecova H, Tzigkounakis V, Merglova V, Netolicky J. A retrospective study of 889 injured permanent teeth. Dent Traumatol. 2010;
19. Atabek D, Alaçam A, Aydintuğ I, Konakoğlu G. A retrospective study of traumatic dental injuries. Dent Traumatol. 2014;
20. Caldas ADF, Burgos MEA. A retrospective study of traumatic dental injuries in a Brazilian dental trauma clinic. Dent Traumatol. 2001;
21. Castro JCM, Poi WR, Manfrin TM, Zina LG. Analysis of the crown fractures and crown-root fractures due to dental trauma assisted by the Integrated Clinic from 1992 to 2002. Dent Traumatol. 2005;
22. Skaare AB, Jacobsen I. Etiological factors related to dental injuries in Norwegians aged 7-18 years. Dent Traumatol. 2003;
23. Hart NH, Nimphius S, Rantalainen T, Ireland A, Siafarikas A, Newton RU. Mechanical basis of bone strength: Influence of bone material, bone structure and muscle action. Journal of Musculoskeletal Neuronal Interactions. 2017.
24. Huang HM, Tsai CY, Lee HF, Lin CT, Yao WC, Chiu WT, et al. Damping effects on the response of maxillary incisor subjected to a traumatic impact force: A nonlinear finite element analysis. J Dent. 2006;
25. Vilela ABF, Soares PBF, de Oliveira FS, Garcia-Silva TC, Estrela C, Versluis A, et al. Dental trauma on primary teeth at different root resorption stages—A dynamic finite

element impact analysis of the effect on the permanent tooth germ. Dent Traumatol. 2019;

26. Rahimi-Nedjat RK, Sagheb K, Walter C. Concomitant dental injuries in maxillofacial fractures - a retrospective analysis of 1219 patients. Dent Traumatol. 2014;
27. Bourguignon C, Sigurdsson A. Preventive Strategies for Traumatic Dental Injuries. Dental Clinics of North America. 2009.
28. Veríssimo C, Bicalho AA, Soares PBF, Tantbirojn D, Versluis A, Soares CJ. The effect of antagonist tooth contact on the biomechanical response of custom-fitted mouthguards. Dent Traumatol. 2017;
29. McTigue DJ. Overview of Trauma Management for Primary and Young Permanent Teeth. Dental Clinics of North America. 2013.
30. Petti S, Glendor U, Andersson L. World traumatic dental injury prevalence and incidence, a meta-analysis—One billion living people have had traumatic dental injuries. Dental Traumatology. 2018.
31. Bissinger R, Müller DD, Reymus M, Khazaei Y, Hickel R, Bücher K, et al. Treatment outcomes after uncomplicated and complicated crown fractures in permanent teeth. Clin Oral Investig. 2020;