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Dental trauma characteristics in the primary dentition in Greifswald, Germany: a comparison before and after German unification

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Kurz Zusammenfassung (Deutsch)

Milchzahntrauma tritt häufig während der Entwicklung der motorischen Koordination auf. Seine Folgen betreffen nicht nur den traumatisierten Milchzähne, sondern können auch den darunter liegenden bleibenden Nachfolger betreffen. Seine Behandlung kann sehr hohe Kosten für Patienten und Versicherungen mit sich bringen und komplizierte Verletzungen können negative Auswirkungen auf die Lebensqualität von Vorschulkindern haben. Die Untersuchung der Ursachen und Muster von Traumata bei Milchzähnen sind dringend erforderlich, um auf präventive Maßnahmen zu zielen. Diese retrospektive Studie verglich die Muster von Zahntrauma-Verletzungen im Traumazentrum der Universität Greifswald/Deutschland für eine neuere Stichprobe (2014-16, 103 Kinder) mit einer historischen Stichprobe vor der deutschen Wiedervereinigung und der Reform des Gesundheitswesens (1974-1989, n=120). Die Daten enthielten Details zu Ätiologie, Verletzungsarten und durchgeführter Behandlung für 450 verletzte Zähne (247 historische, 203 neuere). In beiden Stichproben war das Auftreten häufiger bei Jungs als bei Mädchen (63% bzw. 55%) mit einem Altersgipfel von 2 bis 6 Jahren. Am häufigsten waren die oberen Schneidezähne betroffen (89,6%/88,6%, bzw.) und es dominierten Verletzungen des parodontalen Ligaments (77,8%/90,3%, bzw.).

Fast die Hälfte der Verletzungen ereignete sich zu Hause (46,6 %), meist durch Stürze (48,5 %) oder beim Spielen (37,8 %) in der neueren Stichprobe, die aufgrund von Versicherungsfragen und möglicher Sorge um Kindesmissbrauch bessere forensische Daten lieferte. Beratung und Nachsorge war die häufigste Vorgehensweise in der neueren Stichprobe (76 %).

Traumamuster im Milchgebiss scheinen aufgrund der Aktivitäten von Kleinkindern und ihrer anatomischen Gegebenheiten recht universell zu sein. Traumata im Milchgebiss traten meist zu Hause oder in den Kindergärten auf und sind möglicherweise durch Stürze oder Unfälle beim normalen Spielen kaum zu vermeiden. Auch nach 30 Jahren und einer Änderung des Gesundheitssystems durch die deutsche Wiedervereinigung bleiben die Muster ähnlich.

2. Short Summary (English)

Primary tooth trauma occurs commonly during the development of motor coordination. Its consequences do not only affect the traumatized primary tooth but may affect the underlying permanent successor as well. Its management may involve very high costs on patients and insurance companies and complicated injuries can have negative effects on the quality of life of preschool children. Investigating the causes and patterns of trauma in primary teeth are highly needed to aim for preventive measures. This retrospective study compared the patterns of dental trauma injuries at the trauma center at Greifswald University/Germany for a recent pediatric cohort (2014-16, 103 children) with a historic one before the German unification and the health care system reformation (1974-1989, n=120). The data contained details on etiology, injury types and treatment delivered for 450 injured teeth (247 historic, 203 recent). In both cohorts, the occurrence was more common in males than females (63%/55%, resp.) with an age peak from 2 to 6 years. Maxillary incisors were most affected (89.6%/88.6%, resp.) and periodontal ligament injuries dominated (77.8%/90.3%, resp.).

Almost half of the injuries occurred at home (46.6%), mostly due to falling (48.5%) or during playing (37.8%) in the recent pediatric cohort which provided better forensic data due to insurance issues and potential concern about child abuse. Advice and follow up was the most common approach in the recent pediatric cohort (76%).

Trauma patterns in the primary dentition seem to be rather universal due to the activities of small children and their anatomic conditions. Trauma to primary dentition occurred mostly at home or in the nurseries and possibly is hard to avoid due to falls or accidents during normal playing. Even after 30 years and a change in the health care system due to German unification, the patterns remain similar.

3. Introduction

The epidemiologic data on dental trauma injuries in the primary dentition are very rare and often contradictory. Bastone et al. (2000) criticized the use of different trauma classifications used and found variations for the study locations and included age groups possibly leading to a bias in the reported outcome. According to Cardoso and De Carvalho Rocha (2002), the greatest incidence of primary tooth trauma occurs during motor coordination development at the age of 2 to 3 years. In addition, a bias for the prevalence of dental trauma is very likely since not all cases report to the dental clinics or recorded uniformly. For example, Arikan et al. (2010) reported that parents do not tend to seek medical care in the absence of acute symptoms.

Trauma to the primary dentition may result in fracture of the tooth, the alveolar bone, luxation or subluxation injuries, concussion injuries as well as avulsion of the tooth. Periodontal tissue injuries were reported to be the most common type of injuries for trauma in primary teeth (Bastone et al. 2000; Andreasen 1970; Skaare and Jacobsen 2005). Bagattoni et al. (2017) reported avulsion injuries to be the commonly associated injuries with primary tooth trauma in children with special health care needs. Discoloration of the injured primary tooth is a common consequence which may be either persistent or temporary, characterized by a direct relationship between tooth discoloration and pulp necrosis in traumatized deciduous teeth (Boorum and Andreasen 1998; Cardoso and De Carvalho Rocha 2010).

Not only does dental trauma affect the primary dentition, but also its effect extends sometimes to the permanent successors such as esthetically relevant discoloration and hypoplasia (Sennhenn-Kirchner and Jacobs 2006). Furthermore, developmental effects such as malformation of the permanent successor, impaction and eruption disturbances could result too from such a trauma due to the close relationship between the injured primary tooth apex and the developing permanent tooth germ (Andreasen and Ravn 1971; Diab and Elbadrawy 2000).

The International Academy of Dental Traumatology (IADT) has issued a set of guidelines based on the literature for clinical management of tooth trauma including the evaluation on the history of the injury and its possible association to child abuse, especially in children younger than 5 years old (Kellogg 2005; Becker et al. 1978). Malecz (1979) noted that 25 cases of suspected child abused children in 1979 were reported by pediatric dentists. Moreover, Becker et al. (1978) reported 65% of 260 child abused children had suffered from orofacial injuries. This highlights the role of the

pediatric dentist in discovering, documenting, and reporting the presence of a possible child abuse.

Trauma evaluation requires a radiographic examination which is necessary to highly recommended to assess the extent of injury regarding the supporting tissues, the stage of root development as well as the relationship of the injured tooth to the permanent successor, as vitality and percussion tests are not reliable in small children (Malmgren et al. 2012). Due to these diagnostic and often also cooperation problems, extraction is usually the treatment of choice (Malmgren et al. 2012; Needleman 2011).

As traumatic dental injuries involve very high costs on patients and insurance companies and complicated injuries can have negative effects on the quality of life of preschool children, investigating the causes and patterns of trauma in primary teeth are highly needed (Borum and Andreasen 2001; Aldrigui et al. 2011).

The city of Greifswald, where this study occurred, lies in north east Germany, and was part of the communist eastern state before the German unification, where the health insurance system was under the authority of the socialist party and its ideology (Hurst 1991). Data on the progress of primary tooth trauma patterns, etiology and management in these two completely different health systems is missing in the literature. Thereupon this study aims to investigate the distribution patterns of dental trauma in relation to gender, age, cause, and management in a recent pediatric cohort and to compare findings with a historic pediatric cohort before the German unification.

Materials and Methods

This retrospective study compared the prevalence of primary tooth trauma, its causes and consequences in a recent pediatric cohort with a historic one before the German unification. The Ethics Committee at the Greifswald University approved the study on the 15th of March 2016 (Ethics approval Nr. BB 028/16). The data for the recent sample were collected from the 2014 to 2016 records of the Department of Pediatric Dentistry in Greifswald University being the current first entry gate for dental trauma. Data regarding the historic pediatric cohort during the socialistic, East German area were gathered from the records of the Department of Oral and Maxillofacial Surgery which was the primary entry point to the University Dental Clinics then (1974 and 1989).

The parameters included: age, gender of the traumatized child, cause and place of the trauma, and the type of the trauma with the treatment offered.

The recent pediatric cohort data was classified according to the IADT guidelines (Malmgren et al. 2012). Whereas in the historic pediatric cohort the trauma was recorded in categories from 1-5 for periodontal ligament injuries: grade 1 represented the occurrence of subluxations, grade 2 lateral luxation, 3 intrusions, 4 extrusions and 5 avulsions. Hard tissue injuries were graded from1 to 4: grade 1 for enamel fracture, 2 enamel dentine fracture without pulp involvement, 3 enamel dentine fracture with pulp involvement, 4 crown-root fractures. Still, this grading could easily be converted to the IADT system. Combined injuries were registered when more than one symptom was mentioned. The data were entered in an Excel spreadsheet, transferred, and then statistically analyzed using SPSS version 20. Descriptive statistics were calculated for all the collected data. We used the Chi-square test, the independent samples t-test and Wilcoxon signed rank test to assess the differences between the two cohorts.

Results

A total number of 223 patients was included in this retrospective study with 103 patients in the recent pediatric cohort and 120 patients in the historic one. The gender distribution revealed that more males than females reported with trauma to the dental clinics: 63% versus 37% in the recent pediatric cohort and 55% versus 45% in the historic one (Table 1).

The mean age of the patients is 3.8 years old in both samples (Table 1), with a range from 0 to 12 years old. The peak of trauma was between 2 and 6 years old (Figure 1) The total number of teeth injured was 450 deciduous teeth: 203 in the recent sample and 247 in the historic one.

Table 1: Demographic description of the cohort

	Total cohort N=223	**Recent cohort** N= 103	**Historic cohort** N=120
Gender (patient level)			
Male n (%)	131 (58.8%)	65 (63.1 %)	66 (55%)
Female n (%)	92 (41.2%)	38 (36.9%)	54 (45%)
Age mean in years (±SD)	3.85 (±2.05)	3.89 (±2.27)	3.84 (±1.85)
Number of teeth affected			
One (%)	84 (38%)	45 (44%)	39 (32%)
Two (%)	90 (40%)	39 (38%)	51 (42%)
more than 2 teeth (%)	49 (22%)	19 (18%)	30 (25%)
Mean number of affected teeth	1.9	1.97	2.05
Total number of teeth	450	203	247
Gender (tooth level)			
Male n (%)	265 (59%)	139 (68 %)	126 (51%)
Female n (%)	187 (41%)	64 (32%)	123 (49%)

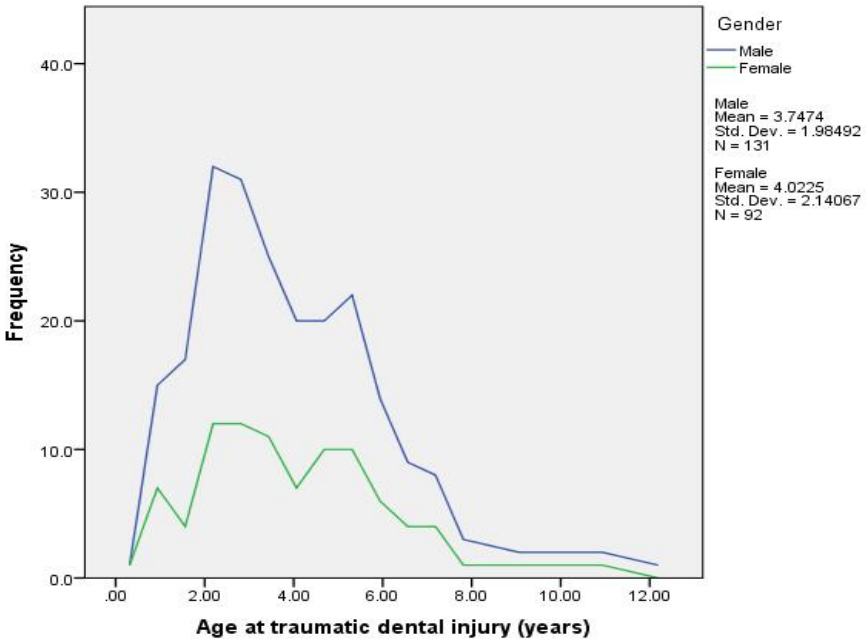


Figure 1: Age distribution of children reporting to a specialist center due to dental traumatic injuries in the primary dentition

Location and causes of traumatic dental injuries

In the recent pediatric cohort, most of the traumatic primary tooth injuries occurred at home (47%, n=48) followed by kindergartens (33%, n=34) mainly due to falling and slipping (49%) or during playing (38%, Table 2). Due to insurance issues and the concern on child abuse, the forensic documentation in the recent pediatric cohort was far more detailed than in the historic one.

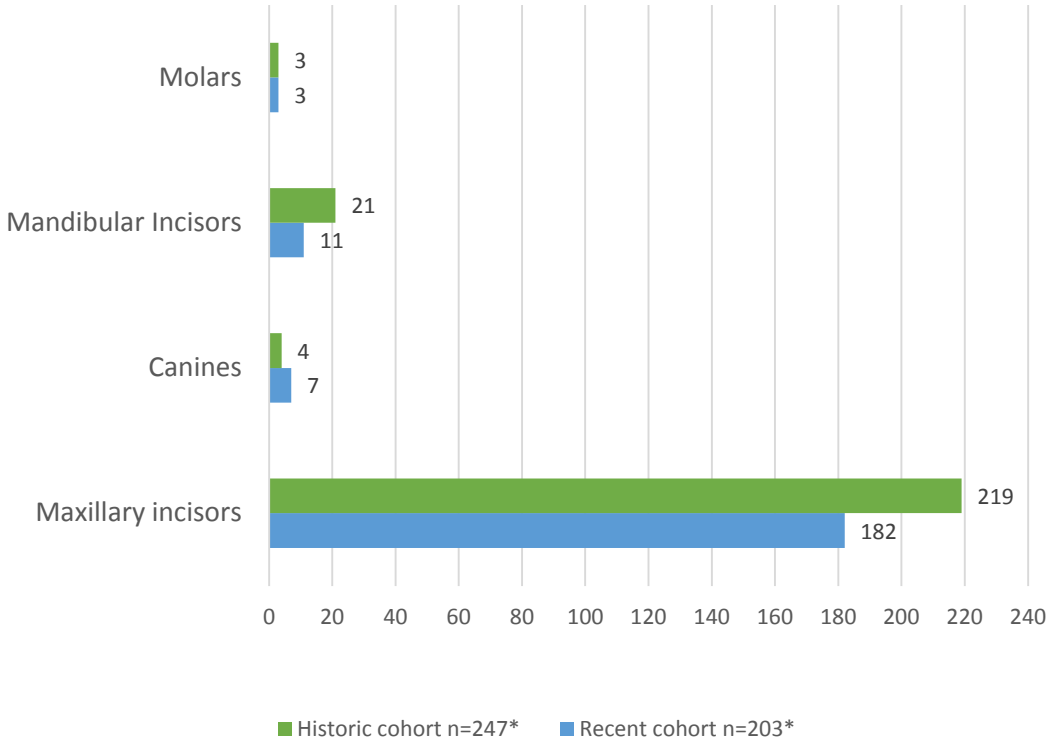
Table 2: Distribution of the causes of primary tooth trauma among children

	Recent n=103 (%)**	**Historic n=120 (%)****
Falling and slipping	50 (48.5%)	8 (6.6%)
Playing accidents	39 (37.8%)	18 (15%)
Others	11 (10.6%)	7 (5.8%)
Missing	3 (2.9%)	87 (72.5%)

*** on a patient level*

Patterns of traumatic dental injuries

The distribution of the injuries showed that the most affected teeth in the recent and historic pediatric cohorts were the maxillary incisors, while the least affected teeth were the molars (Figure 2).



** on a tooth level*

Figure 2: The distribution of the traumatized primary teeth in the recent and historic pediatric cohorts

Traumatic injuries were classified into hard tissue injuries, periodontal tissue injuries, soft tissue injuries and combined injuries. PDL injuries were the most common type of injuries in the recent and historic cohorts (Table 3). Hard tissue injuries include all the traumas affecting the dental structure or the alveolar bone, including enamel chipping, fracture of the teeth with pulp exposures or without, root and alveolar fractures.

Twenty-three percent of the children in the recent cohort presented with fracture injuries (n=47), most of them were just uncomplicated enamel dentine fracture with no pulp exposure, followed by complicated enamel dentine fracture with pulp exposure. However, a coronal fracture involving only the enamel was the most common type of fracture injury recorded in the historic cohort (p-value > 0.05). While the least common in both cohorts was crown root fractures with pulp exposure (Table 4).

Table 3: Distribution of the type of injuries resulting from primary tooth injury

	Hard tissue injuries*	PDL injuries*	Soft tissue injuries**	Combination injuries*	Missing*
Recent cohort n=203*	47 (23.2%)	158 (77.8)	57 (55%)	8 (3.9%)	3 (1.4%)
Historic cohort n= 247*	37 (14.9%)	223 (90.3%)	31 (25.8%)	17 (6.9%)	4 (1.6%)

*** on a patient level [N (recent)= 103, N (Historic)= 120]*

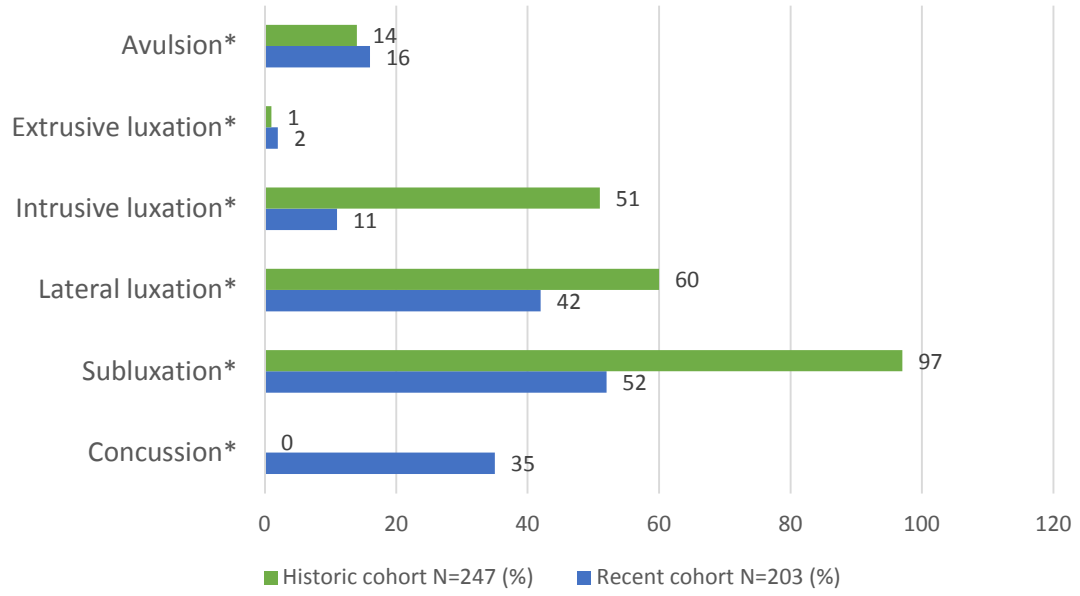
** on a tooth level*

Table 4: Distribution of the types of hard tissue injuries in both cohorts

	Recent cohort n=203 (%)*	Historic cohort n=247 (%)*
Enamel fracture	2 (0.9%)	18 (7.2%)
Enamel-dentin fracture without pulp exposure	22 (10.8%)	10 (4%)
Enamel-dentin fracture with pulp exposure	13 (6%)	4 (1.6%)
Crown-root fracture with pulp exposure	2 (0.9%)	0
Root fracture	4 (1.8%)	0
Alveolar fracture	4 (1.8%)	5 (2%)

** on a tooth level*

Injuries of the periodontal ligament (PDL) were defined as all the traumatic injuries affecting the tooth periodontium in any form ranging from concussions to complete avulsion of the teeth (luxation injuries), about 80% of the whole cohort (n=223 patient) suffered from PDL injuries. While subluxation was the most common PDL injury in both cohorts, extrusive luxation was the least common. No concussion injuries were reported at all in the historic cohort (Figure 3).



** on a tooth level*

Figure 3: Distribution of PDL injuries in the recent and historic cohorts

Soft tissue injuries which present with a wide range of symptoms such as lip injuries (swelling, abrasions and hematomas), gingival injuries, tongue injuries, intraoral mucosal as well as extraoral injuries affecting cheek, chin or other facial aspects are not the primary domain of the dental profession, but they are also recorded and possibly also treated. Lip injuries were the only relevant recorded soft tissue injury in both cohorts (Table 5).

Table 5: Distribution of soft tissue injuries in the recent and historic cohorts

	Recent cohort N=103 (%)**	**Historic cohort N= 120 (%)****
Lip injuries	36 (35%)	26 (21.7%)
Gingival injuries	15 (14.6%)	2 (1.7%)
Extraoral injuries	5 (4.9%)	1 (0.8%)
Tongue injuries	2 (1.9%)	2 (1.7%)
Intraoral soft mucosal injuries	4 (3.9%)	1 (0.8%)
Combined injuries	9 (8.7%)	1 (0.8%)
No soft tissue injury reported	46 (44.7%)	89 (74.2%)

*** on a patient level*

The intervention method used to manage PDL injuries differed from advice to extractions, splinting, suturing, trepanation or even referral to a surgeon. In the recent cohort, advice and follow up was the most common intervention approach (n=111, 76%), while in the historic cohort extractions were more frequent (n=48, 23%), though the difference was not statistically significant (p-value > 0.05). Unfortunately, the provided intervention method was missing in 65% of the historic cohort records on PDL injuries interventions (Table 6).

Moreover, hard tissue injuries in the recent pediatric cohort were most commonly handled by reassurance and advice as well (n=23, 53%), followed by immediate extractions (n=13, 30%), The historic pediatric cohort lacked information on the treatment of hard tissue injuries in 50% of the cases (Table 7).

Table 6: The distribution of the intervention methods used to manage PDL injuries in the recent and historic cohorts

n= 352* PDL injured teeth	**Recent cohort n=146***	**Historic cohort n=206***
Advice	111 (76%)	17 (8.3%)
Extractions	16 (11%)	48 (23.3%)
Splinting	2 (1.4%)	6 (2.9%)
Referral to a surgeon	4 (2.7%)	0
Suturing	10 (6.8%)	0
Trepanation	0 (0%)	1 (0.5%)
Missing data	2 (1.4%)	134 (65%)

** on a tooth level*

Table 7: The distribution of the intervention methods used to manage hard tissue injuries in both cohorts

N=63*	**Recent cohort n=43***	**Historic cohort n=20***
Advice	23	5
Restorations	6	1
Extractions	13	4
Referral to surgeon	1	0
Missing data	0	10

** on a tooth level*

Discussion

East Germany has experienced a severe structural change in almost any aspect of daily life, including the structure of the health care system, after German unification due to the conversion from a socialist system to a Western market economy. Therefore, it is amazing that the patterns of dental trauma in the primary dentition treated at a specialist center such as the university clinics remain very similar over more than thirty years and despite immense societal changes.

The sample size of the present study was representative for the region and comparable to other international and German trauma-related studies (Skaare and Jacobsen 2005; Blockland et al. 2013). Still, most of these studies carry the risk of a selection bias, as patients treated in private dental offices or in the hospital are not included. Furthermore, some parents might not attend a dentist for minor dental trauma injuries (Odersjö et al. 2018). Thus, conclusions can be made only on the range of injuries and the according treatment presenting at a specialist center and not on the fully epidemiology of dental trauma. However, this study contains valid information on how to train dental specialists for the management of dental trauma injuries or where to aim for preventive measures. The patterns and distributions of dental trauma in the primary dentition seem to be quite universal – even over time - with an age peak of small children of 2-4 years, predominantly more boys being affected while playing or just moving and mostly one injured upper central incisor (Skaare and Jacobsen 2005; Blockland et al. 2013; Beltrão et al. 2007).

Luxation injuries which affect the periodontal ligament were the most common injury in primary teeth, in both cohorts in this and other studies (Andersen and Raven 1972; Glendora et al. 1996). This is attributed to the shorter root and decreased attachment of primary teeth and the high elasticity of the PDL ligaments and surrounding bone. Thus, training general dentists and specialists to manage luxation injuries in the primary dentition of small children would be beneficial. Dental hard tissue fractures were recorded less frequently which coincides also with other studies (Sandalli et al. 2005; Mahmoodi et al. 2015).

Due to the young age of the children, often very little cooperation for complex treatments, predominately luxation injuries and no space maintaining function of primary incisors, treatment was usually restricted to advice and monitoring or in the fewer, more severe cases to extractions as in other studies (Sandalli et al. 2005;

Mahmoodi et al. 2015). The observed pattern of dental trauma injuries and the according treatment followed the recommendations and guidelines of the IADT (Malmgren et al. 2012). Only in the historical pediatric cohort a higher proportion of about one third of the cases were treated with immediate extractions which possibly could be attributed to the primary examination at the Dept. of Oral and Maxillofacial Surgery at that time.

The clear increase in documentation regarding the location and cause of trauma over time reflects the change in the health care system and the accompanying greater relevance of costs and insurance issues as well as the increased awareness of potential child abuse.

In general, this study shows that the pattern of traumatic dental injuries in the primary dentition presenting a specialized care facility has not changed significantly even after more than 30 years and despite the enormous structural changes in the political, social and health care systems. The main difference was that the documentation in the historic sample was less detailed, especially regarding forensic issues which are of greater concern nowadays (Charangowda 2010). Only precise documentation of all clinical aspects particularly in suspected cases of child abuse will fulfill the requirements of legal proceedings (Cairns et al. 2005).

Andreasen and Kahler (2015) also noted that inaccurate and incomplete data could result from the absence of a standardized documentation and examination protocol which would be necessary to allow for more valid scientific evaluation to improve prevention and treatment of dental trauma (Sae-Lim et al. 1995). Thus, information should be collected in standardized national or international documentation databases to analyse parameters regarding dental trauma injuries in the primary dentition more systematically.

Conclusion

The pattern of dental trauma in the primary dentition has not changed much in east Germany even with two different political, social, and medical systems and a time lap of 30 years. Luxation injuries in rather small children dominated. Current documentation and treatment followed basically the recommendations of the International Association of Dental Traumatology. Despite the sparse data from the literature, injury patterns of dental trauma in the primary dentition seem to be rather

universal due to the activities of small children and their anatomic conditions. Trauma to primary dentition occurred mostly at home or in the nurseries and possibly is hard to avoid due to falls or accidents during normal playing. Clear improvements could be observed in the precision of documentation and partially in the classification of dental trauma for the more recent sample.

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Dental trauma characteristics in the primary dentition in Greifswald, Germany: a comparison before and after German unification

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Dental trauma characteristics in the primary dentition in Greifswald, Germany: a comparison before and after German unification

Abstract

Background: Data on the distribution and pattern of dental trauma in the primary dentition are very rare.

Aim: To investigate primary dental trauma patterns in relation to gender, age, time, and cause for a recent paediatric cohort and to compare this with a historic one before German unification.

Methods: This retrospective study compared the patterns of dental trauma injuries at the trauma center at Greifswald University/Germany for a recent paediatric cohort (2014-16, 103 children) with a historic one (1974-1989, n=120). The data contained details on etiology, injury types and treatment delivered for 450 injured teeth (247 historic, 203 recent).

Results: In both cohorts, the occurrence was more common in males than females (63%/55%, resp.) with an age peak from 2 to 6 years. Maxillary incisors were most affected (89.6%/88.6%, resp.) and periodontal ligament injuries dominated (77.8%/90.3%, resp.).

Almost half of the injuries occurred at home (46.6%), mostly due to falling (48.5%) or during playing (37.8%) in the recent paediatric cohort which provided better forensic data due to insurance issues and potential concern about child abuse. Advice and follow up was the most common approach in the recent paediatric cohort (76%).

Conclusion: Even after 30 years and a change in the health care system due to German unification, the patterns of dental traumatic injuries in the primary dentition were similar.

Keywords: trauma, primary teeth, deciduous teeth, tooth injuries, Germany

Introduction

The epidemiologic data on dental trauma injuries in the primary dentition are very rare and often contradictory. Bastone et al. (2000) criticized the use of different trauma classifications used and found variations for the study locations and included age groups possibly leading to a bias in the reported outcome. According to Cardoso and De Carvalho Rocha (2002), the greatest incidence of primary tooth trauma occurs during motor coordination development at the age of 2 to 3 years. In addition, a bias for the prevalence of dental trauma is very likely since not all cases report to the dental clinics or recorded uniformly. For example, Arikan et al. (2010) reported that parents do not tend to seek medical care in the absence of acute symptoms.

Trauma to the primary dentition may result in fracture of the tooth, the alveolar bone, luxation or subluxation injuries, concussion injuries as well as avulsion of the tooth. Periodontal tissue injuries were reported to be the most common type of injuries for trauma in primary teeth (Bastone et al. 2000; Andreasen 1970; Skaare and Jacobsen 2005). Bagattoni et al. (2017) reported avulsion injuries to be the commonly associated injuries with primary tooth trauma in children with special health care needs. Discoloration of the injured primary tooth is a common consequence which may be either persistent or temporary, characterized by a direct relationship between tooth discoloration and pulp necrosis in traumatized deciduous teeth (Boorum and Andreasen 1998; Cardoso and De Carvalho Rocha 2010).

Not only does dental trauma affect the primary dentition, but also its effect extends sometimes to the permanent successors such as esthetically relevant discoloration and hypoplasia (Sennhenn-Kirchner and Jacobs 2006). Furthermore, developmental effects such as malformation of the permanent successor, impaction and eruption disturbances could result too from such a trauma due to the close relationship

between the injured primary tooth apex and the developing permanent tooth germ (Andreasen and Ravn 1971; Diab and Elbadrawy 2000).

The International Academy of Dental Traumatology (IADT) has issued a set of guidelines based on the literature for clinical management of tooth trauma including the evaluation on the history of the injury and its possible association to child abuse, especially in children younger than 5 years old (Kellogg 2005; Becker et al. 1978). Malecz (1979) noted that 25 cases of suspected child abused children in 1979 were reported by pediatric dentists. Moreover, Becker et al. (1978) reported 65% of 260 child abused children had suffered from orofacial injuries. This highlights the role of the pediatric dentist in discovering, documenting, and reporting the presence of a possible child abuse.

Trauma evaluation requires a radiographic examination which is necessary to highly recommended to assess the extent of injury regarding the supporting tissues, the stage of root development as well as the relationship of the injured tooth to the permanent successor, as vitality and percussion tests are not reliable in small children (Malmgren et al. 2012). Due to these diagnostic and often also cooperation problems, extraction is usually the treatment of choice (Malmgren et al. 2012; Needleman 2011).

As traumatic dental injuries involve very high costs on patients and insurance companies and complicated injuries can have negative effects on the quality of life of preschool children, investigating the causes and patterns of trauma in primary teeth are highly needed (Borum and Andreasen 2001; Aldrigui et al. 2011).

The city of Greifswald, where this study occurred, lies in north east Germany, and was part of the communist eastern state before the German unification, where the health insurance system was under the authority of the socialist party and its ideology (Hurst 1991). Data on the progress of primary tooth trauma patterns, etiology, and

management in these two completely different health systems is missing in the literature. Thereupon this study aims to investigate the distribution patterns of dental trauma in relation to gender, age, cause, and management in a recent paediatric cohort and to compare findings with a historic paediatric cohort before the German unification.

Materials and Methods

This retrospective study compared the prevalence of primary tooth trauma, its causes, and consequences in a recent paediatric cohort with a historic one before the German unification. The Ethics Committee at the Greifswald University approved the study on the 15th of March 2016 (Ethics approval Nr. BB 028/16). The data for the recent paediatric cohort were collected from the 2014 to 2016 records of the Department of Pediatric Dentistry in Greifswald University being the current first entry gate for dental trauma. Data regarding the historic paediatric cohort during the socialistic, East German area were gathered from the records of the Department of Oral and Maxillofacial Surgery which was the primary entry point to the University Dental Clinics then (1974 and 1989).

The parameters included: age, gender of the traumatized child, cause and place of the trauma, and the type of the trauma with the treatment offered.

The recent paediatric cohort data was classified according to the IADT guidelines (Malmgren et al. 2012). Whereas in the historic paediatric cohort the trauma was recorded in categories from 1-5 for periodontal ligament injuries: grade 1 represented the occurrence of subluxations, grade 2 lateral luxation, 3 intrusions, 4 extrusions and 5 avulsion. Hard tissue injuries were graded from1 to 4: grade 1 for enamel fracture, 2 enamel dentine fracture without pulp involvement, 3 enamel dentine fracture with

pulp involvement, 4 crown-root fractures. Still, this grading could easily be converted to the IADT system. Combined injuries were registered when more than one symptom was mentioned. The data were entered in an Excel spreadsheet, transferred, and then statistically analyzed using SPSS version 20. Descriptive statistics were calculated for all the collected data. We used the Chi-square test, the independent samples t-test and Wilcoxon signed rank test to assess the differences between the two paediatric cohorts.

Results

A total number of 223 patients was included in this retrospective study with 103 patients in the recent pediatric cohort and 120 patients in the historic one. The gender distribution revealed that more males than females reported with trauma to the dental clinics: 63% versus 37% in the recent paediatric cohort and 55% versus 45% in the historic one (Table 1).

The mean age of the patients is 3.8 years old in both samples (Table 1), with a range from 0 to 12 years old. The peak of trauma was between 2 and 6 years old (Figure 1) The total number of teeth injured was 450 deciduous teeth: 203 in the recent paediatric cohort and 247 in the historic one.

Location and causes of traumatic dental injuries

In the recent paediatric cohort, most of the traumatic primary tooth injuries occurred at home (47%, n=48) followed by kindergartens (33%, n=34) mainly due to falling and slipping (49%) or during playing (38%, Table 2). Due to insurance issues and the

concern on child abuse, the forensic documentation in the recent paediatric cohort was far more detailed than in the historic pediatric cohort.

Patterns of traumatic dental injuries

The distribution of the injuries showed that the most affected teeth in the recent and historic paediatric cohorts were the maxillary incisors, while the least affected teeth were the molars (Figure 2).

Traumatic injuries were classified into hard tissue injuries, periodontal tissue injuries, soft tissue injuries and combined injuries. PDL injuries were the most common type of injuries in the recent and historic paediatric cohorts (Table 3). Hard tissue injuries include all the traumas affecting the dental structure or the alveolar bone, including enamel chipping, fracture of the teeth with pulp exposures or without, root and alveolar fractures.

Twenty-three percent of the children in the recent paediatric cohort presented with fracture injuries (n=47), most of them were just uncomplicated enamel dentine fracture with no pulp exposure, followed by complicated enamel dentine fracture with pulp exposure. However, a coronal fracture involving only the enamel was the most common type of fracture injury recorded in the historic paediatric cohort (p-value > 0.05). While the least common in both cohorts was crown root fractures with pulp exposure (Table 4).

Injuries of the periodontal ligament (PDL) were defined as all the traumatic injuries affecting the tooth periodontium in any form ranging from concussions to complete avulsion of the teeth (luxation injuries), about 80% of the whole sample (n=223 patient) suffered from PDL injuries. While subluxation was the most common PDL injury in both cohorts, extrusive luxation was the least common. No concussion injuries were reported at all in the historic paediatric cohort (Figure 3).

Soft tissue injuries which present with a wide range of symptoms such as lip injuries (swelling, abrasions and hematomas), gingival injuries, tongue injuries, intraoral mucosal as well as extraoral injuries affecting cheek, chin or other facial aspects are not the primary domain of the dental profession, but they are also recorded and possibly also treated. Lip injuries were the only relevant recorded soft tissue injury in both cohorts (Table 5).

The intervention method used to manage PDL injuries differed from advice to extractions, splinting, suturing, trepanation or even referral to a surgeon. In the recent paediatric cohort, advice and follow up was the most common intervention approach (n=111, 76%), while in the historic paediatric cohort extractions were more frequent (n=48, 23%), though the difference was not statistically significant (p-value > 0.05). Unfortunately, the provided intervention method was missing in 65% of the historic paediatric cohort records on PDL injuries interventions (Table 6).

Moreover, hard tissue injuries in the recent sample were most commonly handled by reassurance and advice as well (n=23, 53%), followed by immediate extractions (n=13, 30%), The historic paediatric cohort lacked information on the treatment of hard tissue injuries in 50% of the cases (Table 7).

Discussion

East Germany has experienced a severe structural change in almost any aspect of daily life, including the structure of the health care system, after German unification due to the conversion from a socialist system to a Western market economy. Therefore, it is amazing that the patterns of dental trauma in the primary dentition treated at a specialist center such as the university clinics remain very similar over more than thirty years and despite immense societal changes.

The sample size of the present study was representative for the region and comparable to other international and German trauma-related studies (Skaare and Jacobsen 2005; Blockland et al. 2013). Still, most of these studies carry the risk of a selection bias, as patients treated in private dental offices or in the hospital are not included. Furthermore, some parents might not attend a dentist for minor dental trauma injuries (Odersjö et al. 2018). Thus, conclusions can be made only on the range of injuries and the according treatment presenting at a specialist center and not on the fully epidemiology of dental trauma. However, this study contains valid information on how to train dental specialists for the management of dental trauma injuries or where to aim for preventive measures. The patterns and distributions of dental trauma in the primary dentition seem to be quite universal – even over time - with an age peak of small children of 2-4 years, predominantly more boys being affected while playing or just moving and mostly one injured upper central incisor (Skaare and Jacobsen 2005; Blockland et al. 2013; Beltrão et al. 2007).

Luxation injuries which affect the periodontal ligament were the most common injury in primary teeth, in both paediatric cohorts in this and other studies (Andersen and Raven 1972; Glendora et al. 1996). This is attributed to the shorter root and decreased attachment of primary teeth and the high elasticity of the PDL ligaments and surrounding bone. Thus, training general dentists and specialists to manage luxation injuries in the primary dentition of small children would be beneficial. Dental hard tissue fractures were recorded less frequently which coincides also with other studies (Sandalli et al. 2005; Mahmoodi et al. 2015).

Due to the young age of the children, often very little cooperation for complex treatments, predominately luxation injuries and no space maintaining function of primary incisors, treatment was usually restricted to advice and monitoring or in the fewer, more severe cases to extractions as in other studies (Sandalli et al. 2005;

Mahmoodi et al. 2015). The observed pattern of dental trauma injuries and the according treatment followed the recommendations and guidelines of the IADT (Malmgren et al. 2012). Only in the historical paediatric cohort a higher proportion of about one third of the cases were treated with immediate extractions which possibly could be attributed to the primary examination at the Dept. of Oral and Maxillofacial Surgery at that time.

The clear increase in documentation regarding the location and cause of trauma over time reflects the change in the health care system and the accompanying greater relevance of costs and insurance issues as well as the increased awareness of potential child abuse.

In general, this study shows that the pattern of traumatic dental injuries in the primary dentition presenting at a specialized care facility has not changed significantly even after more than 30 years and despite the enormous structural changes in the political, social and health care systems. The main difference was that the documentation in the historic sample was less detailed, especially regarding forensic issues which are of greater concern nowadays (Charangowda 2010). Only precise documentation of all clinical aspects particularly in suspected cases of child abuse will fulfill the requirements of legal proceedings (Cairns et al. 2005).

Andreasen and Kahler (2015) also noted that inaccurate and incomplete data could result from the absence of a standardized documentation and examination protocol which would be necessary to allow for more valid scientific evaluation to improve prevention and treatment of dental trauma (Sae-Lim et al. 1995). This information should be collected in standardized national or international documentation databases to analyse parameters regarding dental trauma injuries in the primary dentition more systematically.

Conclusion

- The pattern of dental trauma in the primary dentition has not changed much in east Germany even with two different political, social, and medical systems and a time lap of 30 years.
- Luxation injuries in rather small children dominated.
- Current documentation and treatment followed basically the recommendations of IADT.
- Injury patterns of dental trauma in the primary dentition seem to be rather universal due to the activities of small children and their anatomic conditions. Trauma to primary dentition occurred mostly at home or in nurseries being hard to avoid due to falls or accidents during normal playing.
- Clear improvements could be observed in the precision of documentation and partially in the classification of dental trauma for the more recent paediatric cohort.

Conflict of interest: The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Table 1: Demographic description of the sample

	Total cohort N=223	Recent cohort N= 103	Historic cohort N=120
Gender (patient level)			
Male n (%)	131 (58.8%)	65 (63.1 %)	66 (55%)
Female n (%)	92 (41.2%)	38 (36.9%)	54 (45%)
Age mean in years (±SD)	3.85 (±2.05)	3.89 (±2.27)	3.84 (±1.85)
Number of teeth affected			
One (%)	84 (38%)	45 (44%)	39 (32%)
Two (%)	90 (40%)	39 (38%)	51 (42%)
more than 2 teeth (%)	49 (22%)	19 (18%)	30 (25%)
Mean number of affected teeth	1.9	1.97	2.05
Total number of teeth	450	203	247
Gender (tooth level)			
Male n (%)	265 (59%)	139 (68 %)	126 (51%)
Female n (%)	187 (41%)	64 (32%)	123 (49%)

Table 2: Distribution of the causes of primary tooth trauma among children

	Recent n=103 (%)**	Historic n=120 (%)**
Falling and slipping	50 (48.5%)	8 (6.6%)
Playing accidents	39 (37.8%)	18 (15%)
Others	11 (10.6%)	7 (5.8%)
Missing	3 (2.9%)	87 (72.5%)

*** on a patient level*

Table 3: Distribution of the type of injuries resulting from primary tooth trauma

	Hard tissue injuries*	PDL injuries*	Soft tissue injuries**	Combination injuries*	Missing*
Recent cohort n=203*	47 (23.2%)	158 (77.8)	57 (55%)	8 (3.9%)	3 (1.4%)
Historic cohort n= 247*	37 (14.9%)	223 (90.3%)	31 (25.8%)	17 (6.9%)	4 (1.6%)

*** on a patient level [N (recent)= 103, N (Historic)= 120]*

** on a tooth level*

Table 4: Distribution of the types of hard tissue injuries in both cohorts

	Recent cohort n=203 (%)*	Historic cohort n=247 (%)*
Enamel fracture	2 (0.9%)	18 (7.2%)
Enamel-dentin fracture without pulp exposure	22 (10.8%)	10 (4%)
Enamel-dentin fracture with pulp exposure	13 (6%)	4 (1.6%)
Crown-root fracture with pulp exposure	2 (0.9%)	0
Root fracture	4 (1.8%)	0
Alveolar fracture	4 (1.8%)	5 (2%)

** on a tooth level*

Table 5: Distribution of soft tissue injuries in the recent and historic cohort

	Recent cohort N=103 (%)**	Historic cohort N= 120 (%)**
Lip injuries	36 (35%)	26 (21.7%)
Gingival injuries	15 (14.6%)	2 (1.7%)
Extraoral injuries	5 (4.9%)	1 (0.8%)
Tongue injuries	2 (1.9%)	2 (1.7%)
Intraoral soft mucosal injuries	4 (3.9%)	1 (0.8%)
Combined injuries	9 (8.7%)	1 (0.8%)
No soft tissue injury reported	46 (44.7%)	89 (74.2%)

*** on a patient level*

Table 6: The distribution of the intervention methods used to manage PDL injuries in the recent and historic pediatric cohorts

n= 352* PDL injured teeth	Recent cohort n=146*	Historic cohort n=206*
Advice	111 (76%)	17 (8.3%)
Extractions	16 (11%)	48 (23.3%)
Splinting	2 (1.4%)	6 (2.9%)
Referral to a surgeon	4 (2.7%)	0
Suturing	10 (6.8%)	0
Trepanation	0 (0%)	1 (0.5%)
Missing data	2 (1.4%)	134 (65%)

** on a tooth level*

Table 7: The distribution of the intervention methods used to manage hard tissue injuries in both cohorts

N=63*	Recent cohort n=43*	Historic cohort n=20*
Advice	23	5
Restorations	6	1
Extractions	13	4
Referral to surgeon	1	0
Missing data	0	10

** on a tooth level*

Figure 1: Age distribution of children reporting to a specialist center due to dental traumatic injuries in the primary dentition

Figure 2: The distribution of the traumatized primary teeth in the recent and historic cohorts

Figure 3: Distribution of PDL injuries in the recent and historic cohorts

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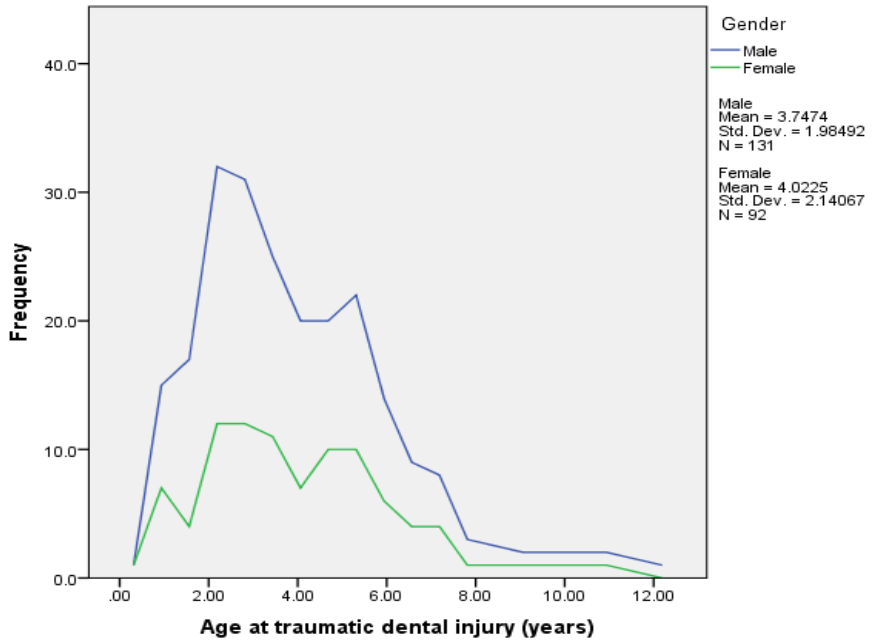

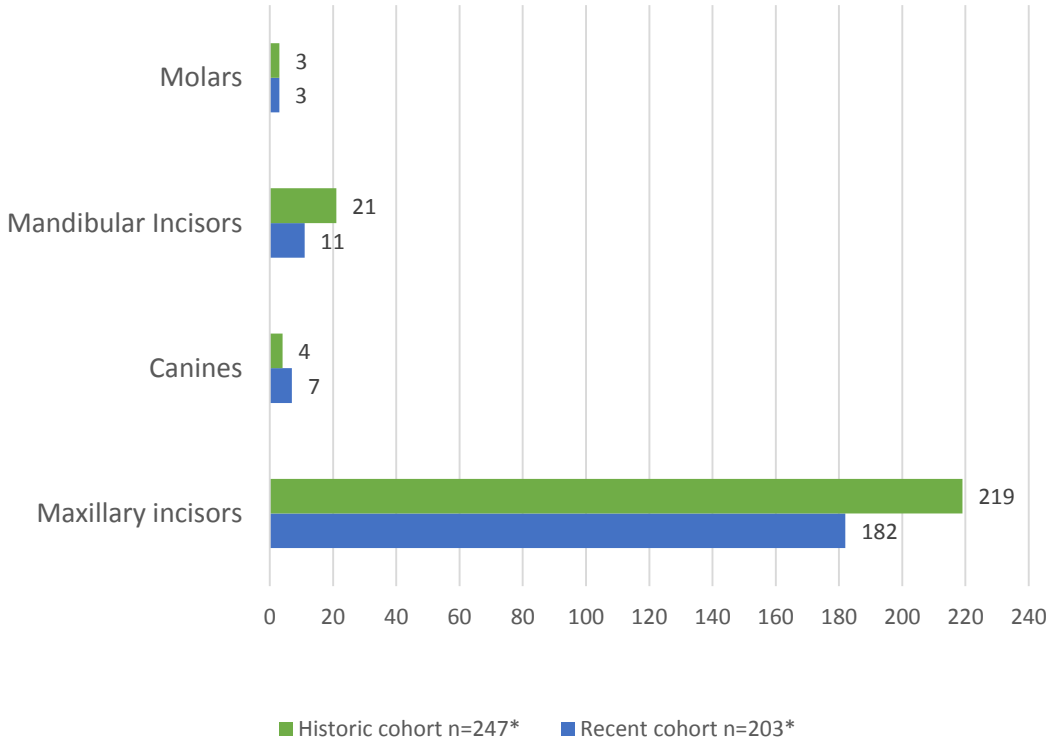

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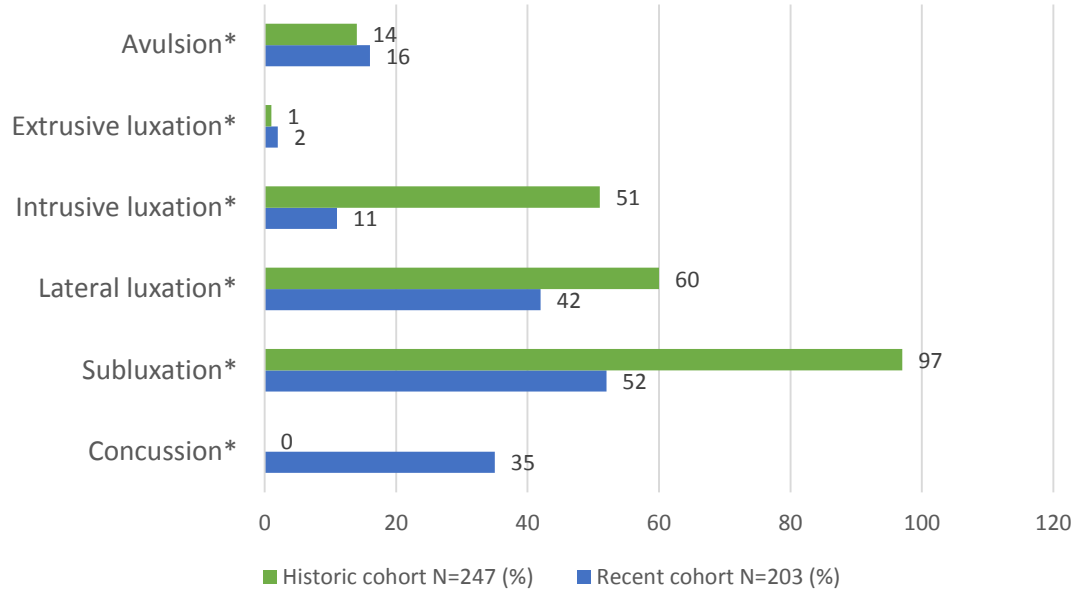

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Thank you for the helpful comments which we have addressed accordingly.

Editor:

1. Please change the title as follows: 'Dental trauma characteristics in the primary dentition in Greifswald, Germany. A comparison before and after German unification'

Answer: Title has been changed as recommended by the editor

2. Please try to avoid political terms. Therefore, the aim of the study in the end of the introduction should be as follows:
'This study aims to investigate the distribution patterns of dental trauma in relation to gender, age, cause and management in a recent paediatric cohort and to compare findings with a historic sample before the German unification.'

Answer: The aim has been corrected avoiding political terms as suggested by the editor

3. In the conclusions please make it shorter and use bullets to separate different meanings as follows:

- The pattern of dental trauma in the primary dentition has not changed much in east Germany even with two different political, social, and medical systems and a time lap of 30 years.
- Luxation injuries in rather small children dominated.
- Current documentation and treatment followed basically the recommendations of IADT.
- Injury patterns of dental trauma in the primary dentition seem to be rather universal due to the activities of small children and their anatomic conditions. Trauma to primary dentition occurred mostly at home or in nurseries being hard to avoid due to falls or accidents during normal playing.
- Clear improvements could be observed in the precision of documentation and partially in the classification of dental
trauma for the more recent paediatric cohort.

Answer: The conclusion has been modified to bullet points as suggested by the editor

4. Generally in your paper use better the term 'paediatric cohort' instead of sample

Answer: the word sample has been replaced with the term paediatric cohort in the whole article

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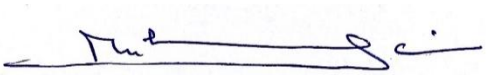

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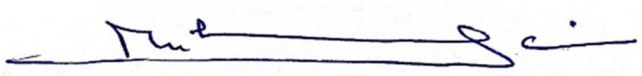

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