Age, gender and degree of inclusion are predictors of timing for spontaneous repositioning of intruded primary teeth in pre-school children

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Abstract

Aim To investigate the timing for spontaneous repositioning of primary teeth with intrusive luxation in relation to degree of inclusion, gender and age of injured children.

Methods This retrospective study analysed records of 1- to 6-year-old children referred to the Section of Paediatric Dentistry, C.I.R. Dental School, University of Turin (Italy) between January 2009 and December 2020 for traumatic intrusion of primary teeth. Time to the total re-eruption was calculated, and related factors were explored using Cox and Kaplan-Meier analyses.

Results Data from 151 intruded teeth in 104 children (56 boys and 48 girls, median age 2.3 years) were reviewed. One hundred twenty (77.9%) teeth were totally and 31 (22.1%) were partially intruded. Trauma involved most the maxillary central incisors and it was more common at home. All teeth re-erupted spontaneously in a few months. Time to total re-eruption varied from 2 weeks to 11 months with a mean time of 4.3 months. All partially intruded teeth completely re-erupted within the first 5 months, with no significant impact of gender and age. In contrast, male gender and age at trauma were statistically associated to the time of re-eruption of totally included teeth ($p < 0.001$). In children younger than 2 years eruption occurred within a maximum of 5 months after trauma, while in those older than 2 years it usually required 5 to 11 months.

Conclusion Timing for spontaneous re-eruption seems to be associated to age, particularly as far as total intrusion of primary teeth is concerned. This observation could be related to the degree of bone mineralisation, which is modified during growth.

KEYWORDS Dental trauma; Primary dentition; Re-eruption; Tooth intrusion.

Introduction

Traumatic dental injuries (TDIs) affect both permanent and primary dentitions and occur so frequently that their management deserves special attention. They are a serious global public health issue due their high prevalence rate in pre-school and school age groups, expensive treatment cost and long-term consequences to oral health [Abanto et al., 2011; Alhadda et al., 2019; Coutinho and Rodrigues Cajazeira, 2011; Unal et al., 2014]. As a consequence, they should always be considered emergency situations and must be treated expediently and efficiently to reduce pain and restore function and appearance. In spite of their frequent occurrence, a bibliometric analysis emphasised that the majority of the available literature concerned the permanent teeth, with few studies focusing exclusively on the primary dentition [Liu et al., 2020]. However, the risk of sequelae on primary teeth and developmental disturbances on permanent successors should not be neglected [Defabianis, 2009; Moccellini et al., 2022; Tewari et al., 2018]. Recent systematic reviews reported pooled estimates for prevalence of TDIs in primary teeth of 22.7% to 24.2% [Patnana et al., 2021; Petti et al., 2018] with intrusion and avulsion being the most frequent ones, mainly in the age interval of 1 to 4 years [de Paula Barros et al., 2019; Liu et al., 2022]. This is because the alveolar bone has large bone marrow spaces and high flexibility. Intrusion is a form of luxation trauma that displaces the tooth deeper into the alveolus; it is considered complete when the surrounding tissues envelope the tooth or partial when part of the crown is still visible [Andreasen et al., 2007]. This type of trauma involves more commonly the maxillary incisors because of their vulnerable position in the dental arch [Bardellini et al., 2017; Oncag et al., 2021].

Management of intrusive luxation is complex and requires correct diagnosis and treatment plan [Day et al., 2020; Re et al., 2014]. The most commonly recommended approach is waiting for the spontaneous repositioning, provided that the intruded tooth is positioned away from the developing permanent tooth germ. This is not a normal developmental eruption process and the outcome is not always predictable, nor is the time needed for this to happen [Hurley et al., 2018]. The percentage of intruded anterior teeth that fail to erupt ranges from 0% to 20% [Arikan et al., 2010; Diab and Elbadrawy, 2000, Hirata et al., 2011; Holam and Ram, 1999] and the time for complete repositioning varies between 1 and 6 months [Gurunathan et al., 2016], in some cases it can take more than 1 year [Day et al., 2020]. Some studies reported that the degree of intrusion did not influence the ability of a tooth to re-erupt, while others observed that partially intruded teeth re-erupted faster than those completely or severely intruded

[Colak et al., 2009; Holan and Ram, 1999]. The possibility of re-eruption was found to be higher among children injured around 2 years of age [Altun et al., 2009].

Considering the paucity and variability of data related to primary dentition, the aim of this study was to investigate the timing for spontaneous repositioning of intruded primary teeth in relation to the degree of inclusion, gender and age of injured children.

Methods

Study design

This retrospective study was based on clinical and radiographic documentation of TDIs collected over a period of 12 years at the Section of Paediatric Dentistry, C.I.R. Dental School, University of Turin (Italy). This is one of the reference centres for TDIs in Piedmont delivering diagnostic confirmation and complex therapy of dental injuries during childhood. The study was carried out in accordance with the ethical principles of the Declaration of Helsinki and reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Written consent was obtained from each parent or legal guardian.

Patient selection

Data were extracted from dental records of children who were consecutively enrolled for intrusive luxation [Andreasen et al., 2007] affecting a single tooth or multiple teeth from January 2009 to December 2020. Subjects qualified for participation in the study were to be systemically healthy, aged 1 to 6 years and cared for tooth intrusion with spontaneous repositioning. Cases of TDIs on permanent dentition, and/or subjects with TDI other than intrusion or who did not return for the scheduled clinical and radiographic follow-up appointments were excluded. When TDIs involved both permanent and primary teeth, only data on intruded primary teeth were recorded.

Data extraction

Data were recorded anonymously by two independent clinicians to guarantee completeness and accuracy and entered into a dataset for statistical analysis.

The characteristics of TDI were categorised according to the following aspects: i) age and gender; ii); cause, place, date and circumstances under which TDI occurred; iii) number and localisation of traumatised primary teeth; iv) degree of intrusion [Andreasen et al., 2007]. Intrusion was classified as total or partial, according to the depth of injury. It was considered total when the tooth was completely inside the gingival tissues and partial when it was possible to see the crown in part. Periapical radiographs confirmed the complete intrusion of the tooth and its position in relation to the underlying bud of the permanent successor.

The first clinical examination and the management of traumatic dental injuries were performed in accordance to the clinical guidelines [Cagetti et al., 2019; Malmgren et al., 2012]. Children were examined and cared for by Paediatric Dentistry postgraduate students who are trained and constantly supervised by a professor of the Paediatric Clinic. The follow-up sessions were planned at 1 week, 2 weeks, 4 weeks, and monthly thereafter. Radiographic examinations were routinely performed at the first visit, at 1, 6 and 12 months and at any other time when needed.

Variables	
Age, median (IQR) (years)	2.3 (1.5)
Age category	n (%)
< 2 years	35 (33.7)
2 – 3 years	40 (38.5)
> 3 years	29 (27.9)
Gender, male/female	56/48
Place of trauma	n (%)
Inside home	72 (69.2)
Outside home	19 (18.3)
Kindergarten	13 (12.5)
Number of intruded teeth	n (%)
1	65 (62.5)
2	32 (30.8)
3	6 (5.8)
4	1 (1.0)
Time for extrusion, median (IQR) (months)	4.0 (4.2)
Time for extrusion category	n (%)
< 5 months	61 (58.7)
5 – 8 months	30 (28.8)
> 8 months	13 (12.5)

IQR, interquartile range

TABLE 1 Sociodemographic and trauma-related variables in the sample population.

Statistical analysis

Quantitative data were presented as mean and standard deviation or median and interquartile range, while categorical data were presented as frequency. The Shapiro–Wilk test and Q-Q normality plots were applied to verify the normal distribution of quantitative variables. The Chi-square or Fisher exact tests and the Mann-Whitney U test were used to compare the distribution of categorical and quantitative variables, respectively, according to the degree of intrusive luxation and the children's age group at the time of TDI (< 2 years, 2-3 years, > 3 years). To illustrate the effects of variables significantly related to the time for the spontaneous repositioning, Kaplan-Meier survival analysis and Cox hazard regression analysis were conducted. All data were analysed using SPSS software (24.0; IBM Inc.). The level of significance was set at 0.05.

Results

From January 2009 to December 2020, 1421 patients were referred to the Department of Paediatric Dentistry, University of Turin (Italy) for TDIs. Of these a total of 104 children (56 boys and 48 girls) sustained an intrusive luxation injury and 151 primary teeth occurred as intruded, accounting for 7.3% of the total TDIs. As reported in Table 1, the median age of the patients at the time of injury was 2.3 years (range 1–6 years) with most of them being 3-year old or younger (72.2%). There were slightly more injured boys (53.8%) than girls (46.2%), but no association emerged between gender and age at injury (p=0.908). Most accidents occurred at home (69.2%) and outdoors (18.3%).

Sixty-five children had intrusion of only one tooth, 32 children had two intruded teeth, and seven children had three to four intruded teeth. Total intrusion was the most frequent

Variables	Age (years)			P-value
	< 2 years (n = 35)	2 – 3 years (n = 40)	> 3 years (n = 29)	
Gender, male/female	20/15	21/19	15/14	0.889
Severity of intrusion	n (%)	n (%)	n (%)	0.378
Total intrusion	29 (35.8)	32 (39.5)	20 (24.7)	
Partial intrusion	6 (26.1)	8 (34.8)	9 (39.1)	
Place of trauma	n (%)	n (%)	n (%)	< 0.001
Inside home	34 (47.2)	27 (37.5)	11 (15.3)	
Outside home	1 (5.3)	8 (42.1)	10 (52.6)	
Kindergarten	0 (0.0)	5 (38.5)	8 (61.5)	
Number of intruded teeth	n (%)	n (%)	n (%)	0.633
1	20 (30.8)	25 (38.5)	20 (30.8)	
2	11 (34.4)	13 (40.6)	8 (25.0)	
3	4 (66.7)	1 (16.7)	1 (16.7)	
4	0 (0.0)	1 (100.0)	0 (0.0)	
Time for extrusion	n (%)	n (%)	n (%)	< 0.001
< 5 months	33 (54.1)	17 (27.9)	11 (18.0)	
5 – 8 months	1 (3.3)	17 (56.7)	12 (40.0)	
> 8 months	1 (7.7)	6 46.2)	6 (46.2)	

TABLE 2 Factors associated to age at traumatic intrusion in the sample population.

form, involving 81 children (77.9% of cases). Thirty-one injured teeth (20.5%) were partially intruded and 120 (79.5%) teeth were fully intruded. All injured teeth were maxillary anterior teeth and mostly central incisors (76.2%) followed by lateral incisors (23.8%). All teeth completely re-erupted. The time for complete re-eruption ranged from 2 weeks to 11 months with a mean of 4.3 months and a median of 4 months. In 61 cases (58.7%) teeth extruded in less than 5 months, in 30 children (28.8%) in a time interval between 5 and 8 months and in 13 cases (12.5%) in more than 8 months.

As summarised in Table 2, the age of children at traumatic intrusion was associated with both time of spontaneous tooth repositioning (p <0.001) and reason for trauma (p <0.001), but not with gender, severity of intrusion and number of intruded teeth (all p >0.05).

When data were stratified on the degree of intrusion (Table 3), no differences were observed between gender, age at trauma, type and number of injured teeth, and place of trauma (all p >0.05), while higher time for spontaneous repositioning was observed for totally intruded teeth (p <0.001).

Tables 4 and 5 summarise the association between time for re-eruption and potential explicative variables in relation to the degree of intrusion. Considering 23 children suffering from partial intrusion (Table 4), 22 of them (95.6%) had spontaneous extrusion of all teeth within less than 5 months. Among them, 6 (27.2%) were younger than 2 years, 8 (36.4%) were between 2 and 3 years of age and 8 (36.4%) were older than 3 years. Only one lateral incisor took 5 months to erupt in a 3 year-old child. None of the analysed variables were associated to the outcome (all p >0.05).

Age at trauma, gender and place of trauma were significantly associated to the time of re-eruption among children who experienced complete tooth intrusion (Table 5). All but three teeth completely re-erupted within a maximum of 5 months after the trauma in children younger than 2 years, while most of the intruded teeth in children 2- to 6-year-old re-erupted in a time span between 5 and 11 months. Male children had shorter time of tooth re-eruption than females (p <0.001) as well as children who experienced TDI at home (p=0.016).

Kaplan-Meier univariate survival analysis confirmed the differences related to gender and age in the time for spontaneous repositioning of injured teeth (Fig. 1). The corresponding estimates of the mean and median time for tooth re-eruption are shown in Table 6. When multiple Cox stepwise regression analysis was performed gender (hazard ratio [HR]=2.56 for males vs. females, p <0.001) and age were still significantly associated to the time of re-eruption, but only for children younger than 2 years (HR=5.96 for children younger than 2 years vs. children older than 3 years, p <0.001; HR=1.61 for children of 2-3 years vs. children older than 3 years, p=0.108).

Variables	Total intrusion (n = 81)	Partial intrusion (n = 23)	P-value
Age, median (IQR) (years)	2.2 (1.4)	2.5 (1.9)	0.476
Age category	n (%)	n (%)	0.387
< 2 years	29 (82.9)	6 (17.1)	
2 – 3 years	32 (80.0)	8 (20.0)	
> 3 years	20 (69.0)	9 (31.0)	
Gender, male/female	45/36	11/12	0.637
Place of trauma	n (%)	n (%)	0.085
Inside home	53 (73.6)	19 (23.4)	
Outside home	15 (78.9)	4 (21.2)	
Kindergarten	13 (100.0)	0 (0.0)	
Number of intruded teeth	n (%)	n (%)	0.635
1	50 (76.9)	15 (23.1)	
2	24 (75.0)	8 (25.0)	
3	6 (100.0)	0 (0.0)	
4	1 (100.0)	0 (0.0)	
Time for extrusion, median (IQR) (months)	5.0 (4.2)	1.2 (2.0)	< 0.001
Time for extrusion category	n (%)	n (%)	< 0.001
< 5 months	39 (63.9)	22 (36.1)	
5 – 8 months	29 (96.7)	1 (3.3)	
> 8 months	13 (100.0)	0 (0.0)	

IQR, interquartile range.

TABLE 3 Sociodemographic and trauma related variables according to the degree of tooth intrusion.

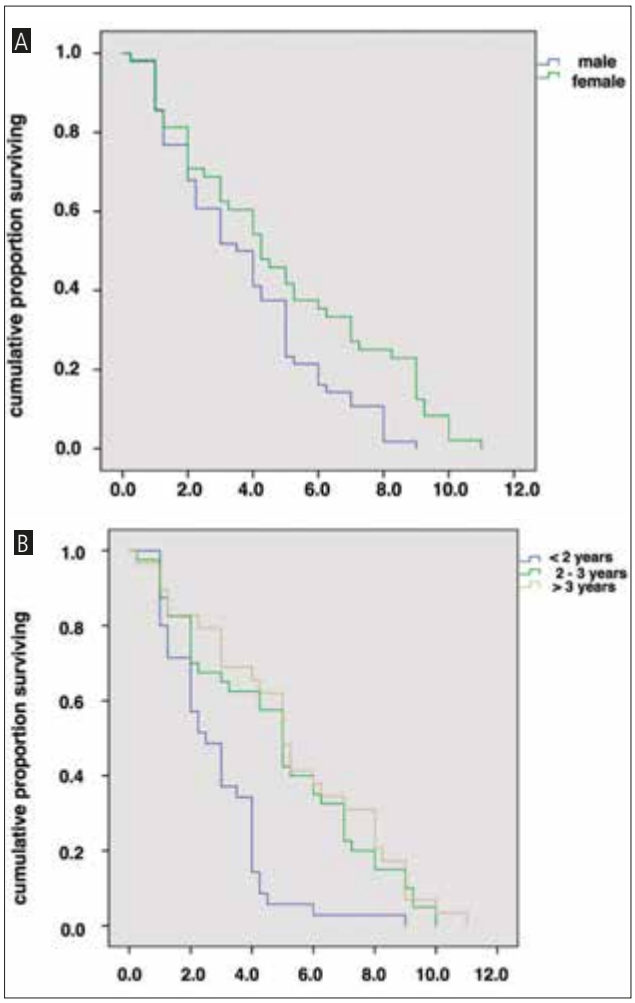

FIG. 1. Kaplan-Meier curves showing the time to spontaneous re-eruption of totally intruded teeth in relation to gender (A) and age at the time of dental trauma (B).

Discussion

In this retrospective study, the frequency of intrusive luxation, and the factors related to the time for spontaneous re-eruption of intruded primary teeth in pre-school children were analysed. We used the WHO classification system of dental trauma as modified by Andreasen et al. [2007] to classify luxation injuries and their severity.

Intrusive luxation accounted for 7.3% of the total TDI cases occurred over a 12-year observation period with total intrusion being the most frequent type involving 77.9% of the children. There was no statistically significant difference between girls and boys, corroborating other studies [Andrade et al., 2021; Colak et al., 2009, Odersjö et al., 2018]. This may be explained because pre-school children of both genders perform the same activities and they are exposed to the same risks [Bani et al., 2015].

The median age of affected children was 2.3 years with a peak in the age span 1–3 years (77.2%), which is consistent with previous findings [Colak et al., 2009; Liu et al., 2022]. During this time period, children are developing their motor coordination and still have few defensive reflexes; as a consequence they are more prone to falling accidents promoting damage to the orofacial area [Liu et al., 2022; Oncag et al., 2021; Patnana et al., 2021]. Besides, the bone of growing patients has higher elasticity and the roots of primary teeth are short; this may explain the higher percentage of total intrusion [de Paula Barros et al., 2019].

In line with data from previous studies, intrusive luxation usually involved a single primary tooth, mainly one maxillary central incisor due to its position in the dental arch [Bardellini et al., 2017; Oncag et al., 2021; Patnama et al., 2021]. Moreover, approximately 69% of all children and 94.7% of those in the toddler stage experienced intrusive luxation in their home environment [Andrade et al., 2021]. Since children at this age spend most of their lifetime at home, injuries are mainly due to falls or collisions against furniture [Ali et al., 2019; Antipovienė et al., 2021]. This underscores the importance of educational programmes about prevention and home care of TDIs in order to increase health awareness for parents and caregivers [Cagetti al. 2019; de Paula Barros et al., 2019].

None of the intruded teeth appeared to pose a risk to their successors because of the direction of intrusion, thus they received no active treatment but they were allowed to spontaneously re-erupt [Cagetti et al., 2019; Day et al., 2020]. This is explained by the tendency for the apex of primary upper incisors to be displaced towards the buccal bony plate owing to the labial curvature of the root. Interestingly, the frequency of spontaneous re-eruption was 100% and the mean time to complete re-eruption was 4.3 months. Most children (58.7%, 61 cases out of 104) experienced re-extrusion within a maximum of 5 months after TDI, in agreement with the time range reported in the literature [Gurunathan et al., 2016].

We found that the number of intruded primary teeth did not affect the ability of the teeth to re-erupt, while gender and child's age at TDI significantly influenced the time for spontaneous tooth repositioning. Male children experienced shorter time of tooth re-eruption than females and times of tooth repositioning tended to increase with increasing age. This could possibly be related to the lower grade of mineralisation and to the higher resilience of the alveolar bone surrounding the tooth. This makes re-extrusion easier, besides making intrusion injuries more frequent among younger children. This trend was observed both in the whole sample and in the group of patients who suffered for total intrusion; it was not possible to state the same for children with partial intrusion, whereas in 95.6% of them teeth extruded in less than 5 months, irrespective of their age.

Data in the literature are largely heterogeneous. Wilson [1995] found that teeth severely intruded rarely re-erupt, while Holan and Ram [1999] observed no significant difference according to the degree of intrusion, and Silva et al. [2020] reported higher proportion of re-eruption for severely intruded teeth. Colak et al. [2009] stated that complete re-eruption occurred within 6 months after trauma with mildly/moderately displaced teeth relocating faster. Finally, Lauridsen et al. [2017] found that the majority of intruded teeth (83.7%) re-erupted within the first year but they did not stratify data on the degree of intrusion. Few studies reported an association between the child's age at the time of injury and the possibility for spontaneous re-eruption, which was found to be greater in children aged 2 years or younger [Altun et al., 2009; Colak et al., 2009]. In contrast, Hirata et al. [2011] did not find any association and Holan and Ram [1999] observed that primary teeth re-erupted in ectopic position when children were injured at 24 to 35 months.

Variables	Time for re-extrusion				
	< 5 months (n = 22)	5 – 8 months (n = 1)	> 8 months (n = 0)	Total (n = 23)	P-value
Age category	n (%)	n (%)	n (%)	n (%)	1.000
< 2 years	6 (100)	0 (0.0)	0 (0.0)	6 (26.1)	
2 – 3 years	8 (100)	0 (0.0)	0 (0.0)	8 (34.8)	
> 3 years	8 (88.9)	1 (11.1)	0 (0.0)	9 (39.1)	
Gender, male/female	11/11	1	0 (0.0)	11/12	1.000
Place of trauma	n (%)	n (%)	n (%)	n (%)	1.000
Inside home	19 (100)	0 (0.0)	0 (0.0)	19 (82.6)	
Outside home	3 (75.0)	1 (25.0)	0 (0.0)	4 (17.4)	
Kindergarten	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Number of intruded teeth	n (%)	n (%)	n (%)	n (%)	1.000
1	14 (93.3)	1 (6.7)	0 (0.0)	15 (65.2)	
2	8 (100)	0 (0.0)	0 (0.0)	8 (34.8)	
3	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	

TABLE 4 Factors associated to time for spontaneous eruption in children with partial tooth intrusion.

Variables	Time for re-extrusion				
	< 5 months (n = 39)	5 – 8 months (n = 29)	> 8 months (n = 13)	Total (n = 81)	P-value
Age category	n (%)	n (%)	n (%)	n (%)	< 0.001
< 2 years	27 (93.1)	1 (3.4)	1 (3.4)	29 (35.8)	
2 – 3 years	9 (28.1)	17 (53.1)	6 (18.8)	32 (39.5)	
> 3 years	3 (15.0)	11 (55.0)	6 (30.0)	20 (24.7)	
Gender, male/femalele	24/15	20/9	1/12	45/36	< 0.001
Place of trauma	n (%)	n (%)	n (%)	n (%)	0.016
Inside home	33 (62.3)	12 (22.6)	8 (15.1)	53 (65.4)	
Outside home	4 (26.7)	8 (53.3)	3 (20.0)	15 (18.5)	
Kindergarten	2 (15.4)	9 (69.2)	2 (15.4)	13 (16.0)	
Number of intruded teeth	n (%)	n (%)	n (%)	n (%)	0.827
1	22 (44.0)	20 (40.0)	8 (16.0)	50 (61.7)	
2	12 (50.0)	2 (29.2)	7 (20.8)	24 (29.6)	
3	4 (66.7)	2 (33.3)	0 (0.0)	6 (7.4)	
4	1 (100.0)	0 (0.0)	0 (0.0)	1 (1.2)	

TABLE 5 Factors associated to time for spontaneous eruption in children with total tooth intrusion.

Variables	Mean	95% CI	Median	95% CI	P-value
Age category	n (%)	n (%)	n (%)	n (%)	< 0.001
< 2 years	3.1	2.5 – 3.8	3.0	2.3 – 3.7	
2 – 3 years	5.6	4.7 – 6.6	5.2	4.2 – 6.3	
> 3 years	6.7	5.6 – 7.8	6.2	4.1 – 8.4	
Gender	45/36	11/12	0.637		0.002
Male	4.3	3.7 – 4.9	4.2	3.6 – 4.9	
Female	5.8	4.8 – 6.9	5.2	3.4 – 7.1	
Place of trauma	n (%)	n (%)	n (%)	n (%)	
Inside home	3.8	3.2 – 4.5	3.0	2.0– 4.0	0.100
Outside home	5.0	3.7 – 6.2	5.0	4.3 – 5.7	
Kindergarten	6.0	5.0 – 7.1	5.2	4.5 – 6.0	

TABLE 6 Kaplan–Meier estimated mean and median time of re-eruption according to gender, age and site of trauma in the group with total intrusion.

The present study is the first to demonstrate that the influence of child's age on the time of tooth repositioning is strictly related to the degree of intrusion. Spontaneous eruption should be anticipated within 5 months after trauma for partially intruded teeth, irrespective of the age of the child, and for completely intruded teeth in children below 2 years of age. This is most likely due to the immature root development of the primary incisors at this age. For older children complete tooth re-eruption should be expected in a time interval between 5 and 11 months. These results reinforce the importance of the watchful waiting approach in cases of dental intrusions in primary teeth and may help in the elaboration of tailored conservative treatment plans. Understanding that re-eruption time is different according to the level of intrusion and age at injury is important in formulating care strategies for pre-school children.

According to some authors, in case of severe intrusions the treatment of choice should be tooth extraction [Andreasen, 1993]. Extraction is considered as the main therapy to be adopted both in case of infection and extreme tooth mobility, and when an injury to the permanent successor is suspected. According to other authors, if damage occurs, this is at the time of the impact; it is important to inform parents/caregivers about this possibility and thus to keep patients under strict control in order to identify the above-mentioned signs. When visiting a young child it is fundamental to take a complete anamnesis and to collect data about time, place and dynamics of TDI for medico-legal issues. It is also necessary to minimise children and parents anxiety and to obtain their cooperation [Cagetti et al., 2019; Day et al., 2020., Carli et al., 2021; Lardani et al.,2022]. Furthermore, it is critical to schedule regular follow-ups with the aim to monitor the progress of spontaneous extrusion and to early intercept any possible complication.

The main limitation of this study regards the retrospective design that is prone to selection, performance and reporting bias. However, it has the advantages to report data on intrusive luxation diagnosis and management over a 12-year observation period. When interpreting the results from this study, it should also be considered that they refer to pre-school children attending only one dental trauma centre at a university setting.

Conclusions

The following conclusions can be drawn.

- The age with the highest frequency of intrusive luxation is between 1 and 3 years, and the average is around 2 years.
- There is no significant difference about the injury frequency in primary dentition between male and female.
- Total intrusions are the most frequent.
- There is a statistically significant relationship between age, gender and re-extrusion time for totally intruded teeth.

Considering the high prevalence of intrusive luxation to primary incisors and the high potential for disturbances of the developing germs of their successors due to their close anatomic relationship, it would be useful to increase public

awareness about injury prevention and management in order to educate the population at greatest risk for TDI. Consequences may be largely variable depending on the intensity and the direction of the impact injury.

Conflict of interest

The authors declare the absence of any potential conflict of interests.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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