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A retrospective study of intrusive injuries in primary dentition

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Abstract – *Objective*: The aim was to evaluate epidemiological aspects of intrusive injuries in primary teeth, extent and severity of injuries, provided treatment, and complications to the primary and permanent dentition. *Methods*: This was a retrospective study based on the clinical and radiographic data of 102 intruded teeth in 70 patients. Follow-up period varied from 6 months to 6 years, with the mean time of 2.7 ± 1.5 years. Data were collected through dental files and dental trauma forms. The following parameters were analyzed at control examinations: rate of spontaneous re-eruption, presence of complications, time elapsed between the injury and complication, and possible sequels on permanent successors. *Results*: Mean age of the patients was 2.5 ± 1.3 years. Fifty-six children were injured because of the fall while walking or running. Most of children had one intruded tooth. Maxillary central incisors were the most frequently injured teeth. Seventy injured teeth were < 2 mm intruded. Mean time elapsed from the injury until the professional help was 45.0 ± 67.3 h. Within 2 months after trauma, 48 intruded teeth re-erupted spontaneously. Crown discoloration occurred in 10 intruded teeth, pulp necrosis was diagnosed in nine cases and pathologic root resorption was found in five injured teeth. *Conclusions*: The most common mechanism of injury was fall. Spontaneous re-eruption occurred in the majority of intruded primary teeth. In comparison with moderate or severe intrusions, mildly intruded teeth took less time to re-erupt. Mildly intruded teeth exhibited less complications in comparison with moderately and severely intruded teeth.

Comparing with the permanent dentition, supportive structures of primary dentition have very high flexibility and resilience. Also, developing bone tissue has larger trabecular spaces. These are the reasons why the supportive tissue injuries are more often recorded in deciduous than in permanent dentition, i.e. in early childhood period (1). Related literature has shown that one of the most frequent tooth injuries during early childhood is a tooth intrusion (2, 3). Intruded tooth is dislocated into the interior of alveolar bone while periodontal ligament and neurovascular fibers are damaged.

To insure the best prognosis, the child should be evaluated as soon as possible after the injury. Bleeding and severe lacerations require special control and attention. Bruises, cuts and other soft tissue damages must be assessed and treated as well. In addition, the extent of trauma is not always evident during the first examination, so the treatment requires both immediate intervention and long-term follow up (4).

A thorough clinical and radiographic examination is necessary to determine the extent of trauma in deciduous teeth because of the proximity of the developing permanent successors to the root of primary teeth (5, 6). Depending on the direction of the impact, apex of the intruded tooth is most often displaced in a vestibular direction and the germ of permanent successor remains not affected. However, the root of the injured tooth may take position in unfavorable palatinal direction, i.e. more close to the developing germ.

In most cases, the treatment of choice is waiting for spontaneous re-eruption to occur (7), or a tooth extraction (8). Thus, follow-up controls after the injury are required. Despite the fact that monitoring of trauma is very important for achieving the best treatment, most of parents do not give importance to that.

International Association of Dental Traumatology (IADT) provides the guidelines for the management of traumatic injuries in primary dentition (9) which contain recommendations for diagnosis and treatment. However, there are many factors that can influence the treatment selection in children, such as child's maturity and ability to cope with emergency situation or the time for shedding of the injured tooth and the occlusion. The constant dilemma whether to treat or just observe traumatized primary teeth derives from the fact that management of young children is a challenge. Therefore, it is not always possible to follow the recommendations from the guidelines.

Objective

The aim of the present study was to evaluate epidemiological aspects of intrusive injuries in primary teeth, extent and severity of injuries, provided treatment, and complications to the primary and permanent dentition.

Methods

A retrospective study was carried out at the Department of Paediatric and Preventive Dentistry, Faculty of Dentistry, University of Belgrade, Serbia, and comprised the patients who attended the clinic in a period from 1 July 2002 to 1 July 2008. Follow-up period varied from 6 months to 6 years, with the mean time of 2.7 ± 1.5 years.

Data were collected through dental files and dental trauma forms comprising the following items: age, gender, extraoral and intraoral examination, radiographic examination and diagnosis, history of previous dental trauma, cause of dental intrusion, number and type of teeth involved, and concomitant injuries. Immediate care, time elapsed between the injury and immediate care, and further therapy procedures were analyzed as well. Five clinicians with minimum 5 years work experience who were trained in pediatric dentistry examined the patients and filled in patient records according to the protocol at our department. The treatment was classified as 'immediate care' when a professional help was provided to a child within the first 12 h after the injury. The extent of intrusion was classified as follows: mild <2 mm, moderate 2–4 mm and severe >4 mm (Fig. 1–3). Radiographic examinations were performed in 92 of 102 teeth. Ten teeth were not radiographicaly assessed because of the lack of patients' cooperation or a tooth was less than 1 mm intruded and a risk for the permanent successor was not suspected.

According to the current protocol at our department, control examinations were performed after 1 week, 3–4 weeks, 3 months, 6 months, 1 year and once a year until the tooth exfoliation. Twenty-seven teeth were followed-up for less than a year because of the exfoliation

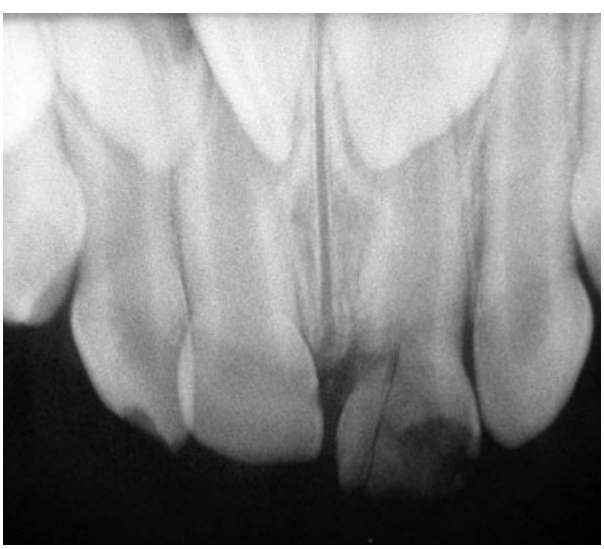

Fig. 1. Intrusive injury 0–2 mm.

Fig. 2. Intrusive injury 2–4 mm.

Fig. 3. Intrusive injury >4 mm.

or intrusion happened within the last year of the study. The following parameters were analyzed at control examinations: rate of spontaneous re-eruption, presence of complications, time elapsed between the injury and complication, and possible sequels on permanent successors.

Complications were categorized according to: color changes, pulp necrosis, pulp canal obliteration, gingival retraction, permanent displacement after luxation, pathological root resorption, disturbances in physiological root resorption and premature tooth loss (10). Only permanent discolorations were included in this study. Transient discolorations that occurred during the first month after the injury were not considered as complications.

Two investigators evaluated patient records. Ten percent of each investigator's sample was randomly assessed by another investigator to check inter-examiner reliability in recording data. Kappa inter-examiner reliability score was 0.94. In addition, two investigators evaluated the extent of intrusions, presence of pathologic changes in alveolar bone, pathologic root resorption, root fracture and visible pathologic changes in dental pulp using dental radiographs. Ten percent of each investigator's sample was evaluated by another investigator to assess the inter-examiner reliability. Kappa value for inter-examiner reliability was 0.82.

Data were processed in SPSS (Statistical Package for the Social Sciences; SPSS Inc., Chicago, IL, USA), Windows version 15.0. Methods of standard descriptive statistics were primarily used. Comparative statistical evaluation was performed using chi square test, with the level of significance set at $P < 0.05$.

Results

During the 6 years period, 369 children referred to the Department of Paediatric and Preventive Dentistry, Faculty of Dentistry, University of Belgrade, Serbia because of the traumatic injuries of primary teeth. Of these, 70 children (39 boys, 31 girls) sustained an intrusion injury and 102 teeth occurred as intruded.

Mean age of the patients at the time of injury was 2.5 ± 1.3 (range 1–6 years). Most of the patients were 2 years old and younger (65.7%). There were slightly more boys (55.7%) who suffered the trauma than girls (44.3%) ($P > 0.05$, chi-squared test).

Fall while walking or running (80%) was the most common reason of intrusive injury when compared with fall while playing with other children or with bicycle (12.9%), and the impact against the hard object (7.1%) ($P < 0.05$, chi-squared test).

Most of the patients (67.1%) had only one intruded tooth, 24.3% children had two intruded teeth. Three as well as four intruded teeth were diagnosed in 4.3% of the children. Maxillary central incisors were the most frequently injured teeth (73.5%), followed by maxillary lateral incisors (23.6%). One patient occurred with trauma of two mandibular incisors. Also, there was one maxillary canine tooth intruded.

Seventy injured teeth were less than 2 mm intruded, 24 teeth were intruded between 2 and 4 mm, while eight teeth were completely covered with soft tissues and placed eminently high into the alveolar bone (intruded more than 4 mm) (Table 1).

Mean time elapsed from the injury until the professional help was almost 2 days (45.0 ± 67.3 h). Only 17 (24.3%) parents whose children suffered the trauma sought professional care within 12 h after the injury. Mean time for the 'immediate care' was 3.1 ± 3.4 h. At the first visit to the clinic, most of the children were only examined and given appropriate advice.

Ninety-five intruded teeth were available at the control examinations. Within 2 months after the trauma, 48 intruded teeth re-erupted spontaneously. Seventeen teeth took 2–4 months to re-erupt. Ten teeth did not erupt completely or were extracted before complete re-eruption because of the occurrence of complications (Table 1). Mildly and moderately intruded teeth re-erupted more frequently compared with severely intruded teeth ($P < 0.05$, chi-squared test).

There were 25 diagnosed complications in primary teeth as a result of intrusive injury. Of these, nine were mildly intruded which was significantly lower occurrence of complications compared with 12 moderately intruded, and four teeth with severe intrusion ($P < 0.05$, chi-squared test with Yates correction). Crown discoloration occurred in 10 intruded teeth, pulp necrosis was diagnosed in nine cases and pathologic root resorption was found in five injured teeth. Fifteen complications occurred in children aged 2 years (Table 2).

Twelve injured teeth were extracted because of the occurrence of the complication (Table 3). One intruded tooth was extracted during the first visit because intrusion was associated with a significant lateral dislocation and mobility with massive bone loss. During the follow-up period, three teeth with pathologic external lateral root resorption and eight teeth with pulp necrosis were indicated for extraction. Remaining teeth with complications were without clinical signs of pulp pathology (sensitivity, pain or swelling) and were left to await spontaneous root resorption and exfoliation.

During the observation period, 13 permanent successors of injured primary teeth erupted. Of these, three teeth occurred with discolorations and structure anomalies. These were the successors of two intruded primary mandibular incisors (central and lateral) and one

Table 1. Time to the total re-eruption

Intrusion	0–2 months	2–4 months	4–6 months	6–8 months	8–12 months	No. total re-eruption	Not analyzed	Total
Mild (*n*)	47	8	3	0	0	6	6	70
Moderate (*n*)	1	8	10	1	1	2	1	24
Severe (*n*)	0	1	4	0	1	2	0	8
Total (*n*)	48	17	17	1	2	10	7	102

Table 2. Complications of intrusive injuries in primary teeth

Age	1			2			3			4			5			6		
Extent of intrusion (mm)	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4
Color change	–	–	–	3	4	1	–	–	–	–	–	–	1	1	–	–	–	–
Pulp necrosis	1	–	–	2	2	1	–	2	–	–	1	–	–	–	–	–	–	–
Pathologic root resorption	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Premature tooth loss	2	–	–	2	3	1	1	1	–	–	1	1	–	–	–	–	–	–
Canal obliteration	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gingival retraction	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Permanent displacement	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Disturbances in physiological root resorption	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 3. Outcomes of intrusive injuries in primary teeth

Age	1			2			3			4			5			6		
Extent of intrusion (mm)	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4	<2	2–4	>4
Spontaneous re-eruption without complication	18	3	2	18	7	2	14	–	–	2	2	–	1	–	–	1	–	–
Complication with extraction	2	–	–	2	3	1	1	1	–	–	1	1	–	–	–	–	–	–
Complication without extraction	–	–	–	3	4	2	–	1	–	–	–	–	2	1	–	–	–	–
Not analyzed	2	–	–	–	1	–	1	–	–	1	–	–	1	–	–	–	–	–

Fig. 4. Permanent successors of intruded primary teeth (left central and lateral mandibular incisors) – discoloration and structure anomalies.

maxillary incisor that exfoliated without complications. The central mandibular incisor was the most affected and the treatment of choice was extraction (Fig. 4). Other two teeth are in the observation period still present in the mouth.

Discussion

Advantage of retrospective studies is the ability to analyze data obtained from the sample large enough that may be representative of the population of interest. Also, these analyzes may suggest effects of specific interventions and thus have the potential for quality improvement initiatives. Altogether, it makes retrospective studies valuable for the development of treatment guidelines and preventive programmes.

In the present study, the majority of children sustaining intrusion injuries were 2 years old and younger, the period when children are learning to walk, which is in agreement with similar investigations (11–13). At this age, children have predilection to dental trauma because of still developing coordination of movements and only few defensive reflexes. In addition, preventive care is very difficult. Thus, the most common mechanism of injury was fall which is in agreement with results of other studies (14–16). In relation to gender, there were more injured boys in all age groups, as most of other studies reflect (4, 15–17).

Our finding that most of children suffered trauma to one tooth is in contrast to Wright et al. (18) whose study showed that more than 64% of children experienced trauma to more than one tooth. However, the majority of observations concerned a single injured tooth (13, 19, 20). Most of the intrusions in the present study involved maxillary central incisors. This is hardly surprising because of the position of these teeth in the dental arch and is in agreement with the study conducted by other researchers (13).

It is well known that for the long-term success, the management or treatment of traumatized teeth should be carried out as soon as possible (5). In the present investigation, only 24.3% of parents whose children suffered the trauma came to our department within 12 h after the injury. Considering the fact that most of children were 2 years old and that intrusive injuries were accompanied by crying, soft tissue injuries, presence of blood and dental dislocation, it is surprising that parents did not seek professional care more promptly (21). Some authors who did not find parent's reaction as gratifying have expressed the need to develop educational programs that would stimulate parents to seek immediate treatment after the dental trauma (6, 22, 23). However, our observation is that the late consultation of intruded primary teeth did not give consequences that could have been avoided.

As the traumas are often consequences of falls and/or occur during children's play, these are difficult to prevent. Sometimes, the first experience of dentistry for a child may be due to the dental trauma (24). The trauma itself is not only a physical trauma for the child, but also a psychological trauma for the child and the family (21, 25). The clinician must be able to comfort the child and parents in the emergency situation. In the present study, the majority of the patients were treated only by monitoring. Nowadays, this opinion has been practically accepted unanimously in the literature (26–29). This can be explained by the fact that complications in traumatized primary teeth are related more to the extent of the initial injury than to the type of treatment instituted. Moreover, it is important not to induce fear and anxiety from the measures taken in the acute phase. Besides the psychological challenge, the treatment of trauma in primary dentition is often different from treatment of permanent teeth. The proximity of the root of the intruded tooth to the permanent germ has to be taken into account and the highest priority has to be given to the normal development of the permanent tooth. Thus, follow-up examinations should be carried out to prevent complications and developmental disturbances of the permanent successors (7).

According to the IADT guidelines (9), follow-up procedures for intrusions should be as following: clinical examinations after 1 week, 3–4 weeks (includes radiographic examination), 6–8 weeks, 6 months (includes radiographic examination), 1 year (includes radiographic examination) and once a year until tooth exfoliation. Protocol at our department differed only in the third examination which was after 3–4 months instead of 6–8 weeks. In addition, radiographic examinations were not as frequent as in the IADT guidelines. Depending on the angle of the projection, wanted results may be overlooked after the first radiogram and additional radiographic examinations are required. The real purpose of additional radiographs is questionable: real usefulness or just scientific curiosity? Thus, in the present study, radiographic examination had been performed at the follow-up controls only if trauma of permanent germ was suspected or clinical signs of complications in primary teeth were observed and data obtained from radiographs could influence further treatment.

As to the process of spontaneous re-eruption, findings in literature are scarce. Our finding that re-eruption rate was over 60% of observed teeth differs from Gondim and Moreira Neto (7) who found less than 30% of the teeth spontaneously re-erupted completely without any consequences. However, the percentage of total re-eruptions accompanied by complications was almost the same as in the present study. There were authors who advocated tooth extraction in cases of severe or complete crown intrusion (30, 31). Results from the present study do not show connection between the extent of intrusion and occurrence of complication. We support the recommendation that re-eruption should be waited for, even in situation of total crown intrusion (32, 33).

In the present study, complications were found in 25 of 102 intruded primary teeth. Color change appeared as the most common complication. Tooth discoloration is a frequent post-traumatic complication (34, 35) and is, in many instances, the only clinical evidence of trauma to the tooth (36). Clinical studies showed that in most cases there were no radiographic or clinical signs of infection of discolored primary teeth (34, 37). As majority of these teeth exfoliate at the expected time, there is usually no need for the treatment, but the adequate follow-up schedule should be provided to detect possible additional symptoms.

The majority of the complications in primary teeth occurred in children who were 2-years old at the moment of trauma. Considering the fact that at this age the development of primary teeth is finished and root resorption did not begin, this result is not surprising. However, analyzing all injuries in this study, most of the intruded teeth spontaneously re-erupted without any consequences, and less than a half teeth with diagnosed complications were indicated for extraction.

Although the number of evaluated permanent teeth was small compared with the sample total, complications that occurred in permanent successors were consequences of affected developing germs. This finding is in line with previous reports from the literature (38–40). The direction of the impact, as well as the direction of apex of intruded primary tooth which was obviously pointed towards the permanent germ can account for that. Further clinical evaluation with larger number of permanent successors of intruded primary teeth is needed to confirm these results.

Conclusion

Based on the results of the present study, it can be concluded:

1. Most of the intrusions occurred in children who were 2-years old and younger. Boys were slightly more prone to the tooth injuries than girls.
2. The most common mechanism of injury was fall.
3. Regarding the extent of the injury, the majority of primary teeth appeared mildly intruded.
4. Spontaneous re-eruption occurred in the majority of intruded primary teeth. In comparison with moderate and severe intrusions, mildly intruded teeth took less time to re-erupt.
5. Crown discoloration was the most frequent complication of primary teeth intrusion. Complications occurred less often in mildly intruded teeth than in moderate and severe intrusions.

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