



Factors associated with positive outcome of avulsion injuries in children

Faktori koji utiču na pozitivan ishod avulzija zuba kod dece

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Abstract

Introduction/Aim. Avulsions are severe dental injuries with high impact on patients' quality of life due to prolonged treatment and possible severe complications. The aim of the study was to analyze the epidemiological factors related to the occurrence, treatment and outcome of avulsions in Serbian children. **Methods.** This research included 2,194 patients aged 1–18 years with traumatic dental injuries. The history, demographic, clinical and radiographic data of the patients were observed from dental medical records. **Results.** A total of 266 avulsions were observed in 207 patients. The frequency of avulsions was 12% in primary dentition and 5% in permanent dentition. A statistically significant relationship between place, cause of avulsion and outcome was observed. Replantation of permanent teeth was performed in 46.7% with a mean time 6.9 h. Almost a half of permanently avulsed teeth (48.7%) were not retrieved from the accident site and 11.3% of replanted teeth were transported in adequate media. The observed incidence of complications was 31.9%. **Conclusions.** Replantation was not performed in more than a half of all eligible teeth due to either loss or inadequate/delayed transport, which emphasizes the need for preventive strategies and health education in population.

Key words:

tooth avulsion; child preschool; child; adolescent; risk factors; treatment outcome.

Apstrakt

Uvod/Cilj. Avulzije spadaju među najteže povrede zuba kod dece i utiču na njihov psihosocijalni razvoj zbog dugotrajne terapije i mogućih teških komplikacija. Cilj istraživanja bio je analiza epidemioloških faktora povezanih sa nastankom, terapijom i ishodom avulzija kod dece u Srbiji. **Metode.** Ovo istraživanje obuhvatilo je 2 194 ispitanika uzrasta 1–18 godina sa povredama zuba. Podaci su dobijeni iz kartona povreda i stomatoloških kartona, a obuhvatali su: anamnestičke podatke, demografske podatke, podatke iz kliničkog i radiološkog pregleda. **Rezultati.** Zabeleženo je ukupno 266 avulzija kod 207 ispitanika. Učestalost avulzija u mlečnoj denticiji iznosila je 12%, a u stalnoj 5%. Uočena je statistički značajna povezanost između mesta, uzroka povrede i ishoda avulzije. Replantacija stalnih zuba je izvršena kod 46,7% ispitanika sa prosečnim vremenom 6,9 h. Skoro polovina svih avulziranih stalnih zuba (48,7%) nije donešena sa mesta povrede, dok je svega 11,3% replantiranih zuba donešeno u adekvatnom medijumu. Učestalost komplikacija iznosila je 31,9%. **Zaključak.** Replantacija nije vršena kod više od polovine raspoloživih avulziranih zuba zbog neadekvatnog transporta ili zakasnelog dolaska kod stomatologa, što ukazuje na hitnu potrebu za izradom preventivnih strategija i zdravstveno-vaspitnim radom unutar populacije.

Ključne reči:

zub, avulzija; deca, predškolska; deca; adolescenti; faktori rizika; lečenje, ishod.

Introduction

Avulsions are severe dental injuries with a complete traumatic displacement of injured tooth from its socket. Impact leads to injury of pulp tissue in apical region, periodontal injury and accompanied injury of surrounding tissues such as supporting bone and cement¹. Contamination during

injury, extra-alveolar time, environment during transport, and initial treatment procedures influence outcome and frequency of posttraumatic complications after replantation^{2,3}.

The frequency of avulsions is estimated up to 13% of all primary dentition injuries⁴ and up to 3% in the permanent dentition¹. The choice of treatment procedures depends on the dentition and maturity of the affected teeth and factors

associated with injury. Long term clinical and radiographic follow-up, demanding treatment with uncertain outcome and possible severe complications including early tooth loss have a high impact on the quality of life of patients⁵.

Available epidemiological data regarding avulsion injuries in children of Eastern Europe are scarce and noncomprehensive. Most of the research was done in specific subpopulations such as schoolchildren, localized geographical sites or within limited age groups.

The aim of this multicenter study was to analyze the epidemiological factors determining the frequency, outcomes and associated factors regarding avulsions of primary and permanent teeth of children treated in the University Dental Clinics in Serbia.

Methods

The study was performed in all the four University Dental Clinics in Serbia. The study group consisted of children aged 1–18 years ($n = 2,194$) who presented due to dental trauma in the University Dental Clinics in Serbia during the period from January 1, 2003 to June 1, 2010. Retrospective data were collected through dental charts and dental medical records and included: demographics, data regarding etiology of dental trauma (mechanisms, causes and places of injuries), data from clinical examination (injured teeth according to Universal numbering system, number of injured teeth, type of injury, accompanied soft tissue injury and/or facial bone fracture, data concerning first dental treatment, follow-up and complications) and radiographic data (periapical radiographs).

The type of trauma was determined using the Andreasen classification¹.

Etiology of dental trauma was categorized according to current literature data^{1, 6, 7}. Mechanisms of dental injuries were classified into: falling, collision and other. Causes of dental trauma were classified as: accident, violence, sports, traffic, play and other. Places of dental trauma were categorized as: home, school/kindergarten, outdoor and other.

According to age and dentition patients were categorized into four groups: the group I (1–3 years), the group II (4–6 years), the group III (7–12 years) and the group IV or adolescents (13–19 years)⁸.

Treatment outcome was classified according to the International Association of Dental Traumatology (IADT) values as favorable outcome (absence of symptoms, pulp vitality and continuing in root development) and complications (pain, swelling, abnormal mobility, abnormal percussion sound/pain, radiographic and clinical signs of apical peri-

odontitis, infection related root resorption, arrested root development or tooth extraction due to trauma).

The differences in the means of variables between the groups were tested using both parametric and non-parametric tests depending on the distribution of the variables. Probability values of less than 0.05 were considered to be significant, and values are expressed as frequencies or means \pm SD unless otherwise stated. SPSS version 10.1 (SPSS, Chicago, IL) was used for analysis.

Results

A total of 2,194 patients with 4,030 injured teeth (3,077 in permanent, 953 in primary dentition) presented at the University Dental Clinics due to various dental injuries.

Avulsions occurred in 207 (62.3% of boys and 37.7% of girls) patients. The age of subjects at the time of avulsion ranged from 1 to 18 years (mean = 8.6 ± 4.5 years). Mean ages in male and female patients were 8.8 and 8.4 years, respectively. Nearly half of all the patients with avulsions were aged 7 to 12 years (47.9%; $n = 99$).

A total number of avulsed teeth was 266 (150 permanent teeth, 116 primary teeth). The observed frequency of avulsions was 12% of all dental injuries in primary dentition and 5% in permanent dentition.

The most frequent mechanisms of avulsions were falling (71.9%), and collision (26.1%). A statistically highly significant relationship ($\chi^2 = 10.8$; $p < 0.01$) between the age groups and mechanisms of injury was observed. Collisions were frequent in adolescents (50%) and less prevalent in small children (12.1%) in whom 87.9% of all avulsions occurred as a consequence of falling. Unfavorable outcome was the most frequent in avulsed permanent teeth as a result of unknown mechanism (66.7%), although a statistically significant difference could not be proven.

Tooth avulsion as a result of accidental injury was observed in 41.5% patients and 23.6% during play time. Sport injuries were recorded in 18.4%. Avulsions as a result of violence and traffic accidents were rare, 8% and 6%, respectively. As shown in Table 1, there was a highly significant relationship between the age groups and causes of injuries ($\chi^2 = 65.6$; $p < 0.001$). The most frequent cause of injury in preschoolers was accident. However, in adolescents and teenagers sport injuries and trauma due to violence were most common. Although rare, avulsions as a result of traffic accident most frequently had unfavorable outcome (92.9%). There was a significant relationship between avulsion outcome and causes of injury in permanent dentition ($\chi^2 = 12.268$; $p < 0.05$).

Table 1

Causes of avulsions in regard to age groups

Age groups (years)	Cause of injury (%)					
	Accidental	Sport	Violence	Traffic	Play	Other
1–3	81.8	–	3.0	–	15.2	–
4–6	48.4	3.2	–	–	48.4	–
7–12	36.4	21.2	3.0	7.1	28.3	4.0
13–18	18.2	36.4	27.3	11.4	2.3	4.5
Total	41.5	18.4	7.7	5.8	23.7	2.9

Regarding the place of injury (Table 2), avulsions most frequently occurred outdoor (56.5%) in all the age groups. A statistically highly significant relationship ($\chi^2 = 45.9$; $p < 0.001$) between the age groups and place of injury was observed, with injuries at home being most frequent in small children (75.8%) and less prevalent in adolescents (9%) in whom 75.0% of all avulsions occurred outdoor. A statistically highly significant relationship between place of injury and avulsion outcome was observed in permanent dentition ($\chi^2 = 22.5$; $p < 0.001$), with unfavorable outcome being most frequent after avulsions at unknown places (100%) and outdoor (69.5%).

presented avulsed permanent teeth and 48.7% were lost at the accident site or patients did not try to find avulsed tooth due to lack of knowledge. In 24.0% of avulsed permanent teeth precise transport media could not be determined. Favorable outcome was more frequent in adequately transported teeth that were replanted (70.7%) than in inadequately transported replanted teeth (66.7%), although a statistically significant difference could not be proven.

Of 150 avulsed permanent teeth in total, 46.7% were replanted. Only 24.6% of replanted teeth were transported in adequate media. The mean time to replantation was 6.9 ± 10.9 hours (ranging from 15 minutes to 48 hours).

Table 2

Place of avulsions in regard to the age groups

Age groups (years)	Place of injury (%)			
	Home	School/Kindergarten	Outdoor	Other
1-3	75.8	3.0	21.2	—
4-6	45.2	6.5	48.4	—
7-12	16.2	18.2	62.6	3.0
13-18	9.1	15.9	75.0	—
Total	28.5	13.5	56.5	1.4

Only one tooth was avulsed in 77.8% of patients, 16.4% of patients had two teeth avulsed, 5% had three teeth avulsed and the remaining 1% had four avulsed teeth. A statistically significant relationship between the number of injured teeth *per* patient and avulsion outcome was observed ($p < 0.05$), with unfavorable outcome being more frequent when traumatic event included more injured teeth besides the one with avulsion (63.0%). The upper incisors were the most frequently avulsed teeth both in primary and permanent dentition (85.9%).

In 70% of the patients avulsions were accompanied by the injury of the surrounding oral and/or facial tissues, while seven of these patients also had fractures of alveolar bone or tooth socket. The most frequent accompanied injury was laceration and contusion of oral mucosa which was observed in 25.6% of patients with avulsions. Concomitant crown fracture was observed in 3% of avulsed teeth.

Regarding presentation and mode of transport of 150 avulsed permanent teeth (Figure 1), adequate media (saline,

Only 5.7% of all replanted teeth were presented in emergency dental office within 20 minutes after the injury, while two thirds (67.1%) had extra-alveolar time of more than one hour (Figure 2). No statistically significant difference was found between the time to replantation and outcome.

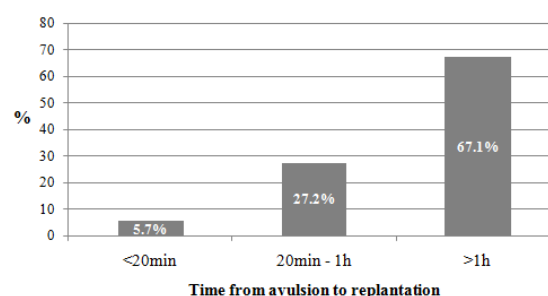


Fig 2. – Distribution of replantations according to the time from avulsion

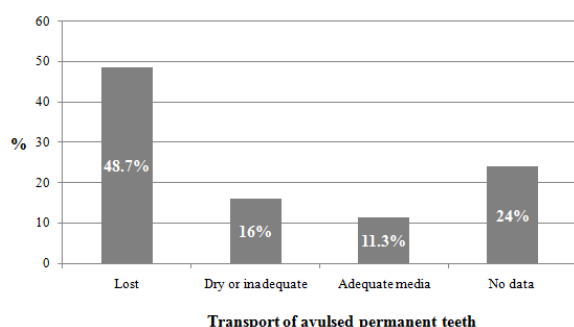


Fig. 1 – Distribution of avulsed permanent teeth according to transport.

saliva or cold milk) was used for transport of 11.3% of affected teeth. Inadequate transport media, such as a dry handkerchief or a pocket, was observed in 16.0% of the

A fibre-composite splint was used for immobilization in all 70 replanted teeth. Endodontic treatment including pulp extirpation and filling of the root canal within two weeks after replantation was performed in 92.9% of replanted teeth. Although 36 of all replanted teeth were immature, pulp extirpation and filling of the root canal was not performed only in 8.3% of these. Revascularization with continuity in root development was observed in two of them. The other one showed complication two months after replantation which presented with discoloration, negative pulp sensibility test, percussion tenderness and apical radiolucency, therefore endodontic therapy was necessary. During the follow-up period, no further complications were observed in any of these three teeth. In immature replanted teeth with preliminary endodontic treatment complications were observed in 13.9%. However, two of these teeth were extracted due to occurrence of severe complications.

During the follow-up period, complications were observed in 31.9% of all replanted permanent teeth. Half of all observed complications occurred during the first year after replantation and no complications were observed after five years. The mean time until occurrence of complication was 1.5 years (533 ± 516 days). The most common complication observed in both groups was external inflammatory root resorption (45.5%). Endodontic retreatment was possible in 45.5% replanted teeth with complication. Tooth extraction was observed in 54.5% replanted teeth after occurrence of complication.

Discussion

The results of the present study indicate that avulsions are rare injuries (5% in permanent teeth and 12% in primary teeth). The proposed explanation for avulsions being more prevalent in primary dentition is the fact that the structures of supporting tissues are more elastic in younger children^{9,10}. It has been reported that avulsions in permanent dentition are most common at the age of 7–14 which was also observed in our study^{11,12}.

The results of this multicenter study showed that boys were in twice higher risk of severe injuries such as avulsions than girls which could be explained by differences in gender psycho-social characteristics during childhood and adolescence: boys are more prone to risk behavior, play rough games and participate in contact, so-called man sports, which could be explained by higher level of catecholamine in boys^{10,13–15}.

The most common mechanism of avulsions observed in present study was falling which is in accordance with known epidemiological data^{16,17}. It was found that most of the injuries occurred accidentally, during leisure time at home which is in accordance with the results of the study conducted by Wood and Freer¹⁰. The results of the present study also show differences in cause or place of injury according to patients' age, which emphasizes need for age specific targeted prevention strategies¹⁸. Interestingly, Petrović et al.¹⁹ found that most of avulsions were a consequence of traffic accidents. In our study, avulsions due to violence and traffic accidents were very rare, which correlates with other epidemiological data from literature²⁰. This contrast in results might be explained by differences in methodology: in our study, category traffic accidents did not include falls from bicycle, skate or roller shoes. The real cause of injury was estimated through the underlying event, because it was concluded that children usually ride bicycle during leisure and play time. The results of the present study show that unfavorable outcome of avulsion most frequently occur as a result of injury of unknown origin (place and cause). Epidemiological data from the literature suggest that victims of violence tend to give vague and imprecise history about event. Recent epidemiological data show that the incidence of facial and intra-oral signs in physical abuse is high, therefore clinicians who treat paediatric dental injuries should be aware of violence as possible underlying cause of injury^{1,21,22}.

It has been observed that avulsions, both in permanent and primary teeth most commonly affect maxillary incisors.

The proposed explanation is the position of upper incisors and preventive effect of maxilla during occlusion²⁰. In our study avulsions were most frequently single tooth injuries, with two thirds of patients with concomitant facial trauma, which is in concordance with known literature data²³. Martin et al.²⁴ observed a significant relationship between the number of injured teeth, severity of injury and late presentation for after-hours treatment. The results of our study statistically significantly show more frequent unfavorable outcome when traumatic event include more injured teeth besides the one with avulsion.

According to current guidelines, replantation is not recommended as treatment of avulsed primary teeth due to potential damage to permanent successors²⁵. However, in permanent dentition prompt replantation is considered to be the treatment of choice for avulsions. Even delayed replantation, especially in immature teeth may be considered as a treatment option (although with poor prognosis), because this treatment allows maintenance of alveolar ridge contour space^{26–28}. In this study, replantation was carried out in only 69 of 151 affected permanent teeth. The authors from Beijing observed higher replantation rate – 85/120²⁰, and low replantation rates were observed in studies by Petrović et al.¹⁹ – 32/62, Tzigkounakis et al.²⁹ – 27/90 and Kinoshita et al.³⁰ – 10/32. Since almost half of all avulsed teeth in our study were not even brought to the emergency dental office, it is reasonable to conclude that the lack of knowledge regarding immediate management of avulsions in people present at the site of accident was the main reason for the low observed replantation rate. Since usually these people are parents, teachers and coaches, further efforts are necessary in order to educate public about emergency procedures in case of avulsion injuries.

Timely replantation of the avulsed teeth and extra-alveolar environment are the most important factors influencing healing and favorable outcome. According to current literature data, the time period of dry storage between injury and replantation should not exceed 20 minutes³¹. Barrett and Kenny³² analyzed the influence of extended extra-alveolar period of more than five minutes on the outcome of replantation. In this study only four of 69 replanted teeth had the extra-alveolar period of less than 20 minutes. Similarly, Diaz et al.³³ reported that only 3% of affected patients in their study were treated within 30 minutes and the most common form of storage was dry. Batstone et al.³⁴ showed that only 5% of their patients received emergency treatment within three hours, including patients with immediate treatment needs. Similar results in the present study confirm the necessity of developing educational and prevention strategies.

Surprisingly, our data show no statistically significant association between the time of replantation and the outcome. This may in part be explained by the fact that only 26.1% of replanted teeth transported in adequate media, but mainly because 94.2% of all replanted teeth were treated with prophylactic endodontic treatment, disregarding teeth maturity. The main reason for such high rate of endodontic treatment was the fact that most of replanted teeth in our study were transported in inadequate storage medium and/or with extended extra-alveolar time.

The results of our study show that 26.1% of the replanted permanent teeth were placed in adequate storage media during transport, which is higher percentage than in results showed by Petrovic et al.¹⁹ (6.25%). This result might be explained by multicentre character and larger sample size of the present study which included four University Dental Centers in different regions of Serbia. Recommended storage media for avulsed teeth transport are saline, milk or saliva²⁰. Tooth rescue box (tissue culture medium) is considered as physiologic medium for transport of avulsed tooth, but is rarely available at the site of accident^{1,28}. Saline, milk and Ringer are considered wet but non-physiologic storage media³. Although recent literature data show that saliva might be appropriate for short term storage, and it is the most available, important disadvantages are the presence of oral flora, salivary enzymes and accidental swallowing of the tooth³⁵.

Current guidelines recommend the use of wire-composite splint in immobilization of replanted teeth^{1,26}. In that way, physiologic functional tooth movements are allowed during the splinting period. Interestingly, the results of our study show exclusive use of fiber-composite splints probably due to the fact that they are better tolerated by patients.

Endodontic treatment within the two weeks after replantation was performed in 65 of 69 replanted permanent teeth in the present study. Thirty two of 35 immature replanted teeth were treated with prophylactic endodontic treatment. Literature data show that timely and appropriate endodontic treatment after replantation prevents occurrence of severe complications such as inflammatory root resorption³⁶. However, data from current dental trauma literature show that long term prognosis of endodontic treated immature teeth might be seriously threatened due to a possible occurrence of cervical fractures¹. The influence of dental treatment on the outcome of injury in replanted teeth could not be determined in this study due to a small number of

avulsed and replanted teeth not treated with prophylactic endodontic treatment.

The occurrence of complications after replantation of avulsed teeth reported in recent studies is up to 84.4%^{19,37}. In the present study recorded occurrence of complication was lower (20.3%) with inflammatory root resorption being the most common type of complication (12%). A low rate of observed complications found in our study might be explained by the fact that most of the replanted teeth were treated with prophylactic endodontic treatment within the two weeks after replantation and the observed survival rate correlates with reported rates in treatment of mature permanent teeth¹.

Conclusion

The results of this, the first multicenter study regarding avulsion injuries in Serbian children show that severe injuries with unfavorable outcome most frequently occur outdoor or after injuries of unknown origin (place, cause). Most of patients receive delayed treatment or not the best possible treatment due to late presentation or presentation without the avulsed tooth. This finding emphasizes the need for further efforts in health education of public about necessary actions when tooth injury occurs. Besides preventive measures, continuous education of dental professionals is necessary in order to update their knowledge about emergency management of avulsion injuries. Further longitudinal studies in the region are necessary to acquire precise information about factors related to tooth avulsions, treatment and outcome.

Acknowledgements

This study was supported by the Ministry of Education, Science and Technological Development, Government of the Republic of Serbia, project No 172026.

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Received on March 20, 2013.

Revised on June 11, 2013.

Accepted on July 13, 2013.

OnLine-First June, 2014.