

# Analysis of 261 avulsed permanent teeth of patients treated in a dental urgency service

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## ABSTRACT

**Objective:** The aim of this study was to evaluate the epidemiological aspects and clinical factors associated with avulsion of permanent teeth. **Materials and Methods:** The sample consisted of 261 avulsed teeth of 170 patients seen in the Dental School of the Federal University of Goiás, Brazil, from 2000 to 2008. **Result:** The highest incidence was found among boys (71.18%) aged 6-15 years (61.18%). The main etiologic factors were falls (51.76%) and traffic accidents (29.41%). Most cases occurred in autumn (March to June; 31.18%) and winter (June to September; 27.65%). Most avulsed teeth were the maxillary central incisor (62.45%), followed by the maxillary lateral incisor (21.46%). A high proportion (67.23%) of injured teeth had a completely formed root apex. Replantation was used to treat 119 teeth (45.59%) in 86 patients. Most replantations were delayed (89.08%). Thirty-eight teeth (31.93%) were stored in dry media. Periodontal healing was found in 41 teeth (34.45%), inflammatory root resorption, in 44 (36.97%) and replacement root resorption, in 22 (18.49%). The most frequent treatments for replanted teeth were endodontic treatment and temporary filling of the root canal with calcium hydroxide (58.92%) and endodontic treatment and definitive root canal filling (26.89%). **Conclusion:** The epidemiological and clinical aspects of tooth avulsion in this study were similar to those reported in other studies. The number of replantation was low, the number of teeth stored in non-physiological conditions was high, and replantation was often delayed.

**KEY WORDS:** Dental trauma, oral epidemiology, tooth avulsion, tooth replantation

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## Introduction

Traumatic dental injuries (TDI) in young people are a serious public health problem. Several studies have reported that TDI prevalence has increased in the past few decades, which poses a significant threat to the dental health of children and adolescents.<sup>[1,2]</sup>

Tooth avulsion, one of the most serious types of TDI, is defined as the complete displacement of a tooth out of its socket.<sup>[1]</sup> The prevalence of avulsed teeth in permanent dentition ranges

from 0.5% to 18.3%.<sup>[1,3]</sup> Male patients, younger than 14 years, experience it more often,<sup>[1]</sup> and the tooth most commonly affected is the maxillary central incisor.<sup>[4-7]</sup>

After tooth avulsion, there may be extensive damage to pulp and periodontal tissues, which may result in posttraumatic complications.<sup>[5,8,9]</sup> Tooth avulsion and its complications may lead to the development of sequelae to permanent teeth and loss of the injured tooth<sup>[9]</sup> or may affect the growth of the alveolar ridge and the eruption and position of adjacent teeth.<sup>[10]</sup>

The prognosis of avulsed teeth depends on the proper measures taken at the place of accident, and studies<sup>[11,12]</sup> have suggested the need to develop educational campaigns and produce knowledge about prevention and emergency management of avulsed teeth. However, an effective educational program about tooth avulsion should be preceded by an investigation on the occurrence of this injury in the community.

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■ Guedes, *et al.*: Tooth avulsion in a dental urgency service

Information about the characteristics of tooth avulsion in different geographical regions of Brazil is limited.<sup>[13]</sup> This study investigated the epidemiological and clinical aspects associated with avulsion of permanent teeth of patients treated in a dental urgency service.

## Methodology

This is a retrospective study of patients attending to the Dental Urgency Service of the Dental School of the Federal University of Goiás, Goiânia, Brazil, from October 2000 to December 2008. Data about the patients were collected [Figure 1] from charts and radiographs using computer readable data collection sheets by two graduate students. Cases with incomplete documentation were excluded. All teeth were followed-up for a minimum of 1-year.

The root apices were classified, according to radiographs, as open if their root canal was divergent or parallel, and as closed if the canal walls were convergent.<sup>[14]</sup> Extra-oral time was the total time of the tooth outside the socket. Teeth replanted 5 min after injury were classified as delayed replantation.<sup>[8]</sup>

Posttraumatic complications were recorded according to the analysis of all follow-up radiographs. Root replacement resorption (RRR) was defined as radiographic loss of root substance and concurrent bone replacement, such that there was loss of periodontal ligament space and no associated radiolucency; inflammatory root resorption (IRR) was diagnosed in case of loss of root substance according to radiographs and concurrent loss of bone substance and associated radiolucency;<sup>[4]</sup> internal inflammatory root resorption (IIRR) was recorded when a radiolucent, round and symmetrical widening of the root canal space was observed on follow-up radiographs<sup>[15]</sup> and pulp canal obliteration (PCO) was diagnosed with the apparent loss of the pulp space on radiographs.<sup>[16]</sup>

This study was approved by the local Research Ethics Committee (Process #055/2005).

Data were analyzed using the IBM SPSS for Windows 21.0 (IBM Corporation, Somers, NY, USA), including frequency distribution and cross-tabulation. Comparative statistical analysis was performed using Chi-square test, and the level of statistical significance was set at 5%.

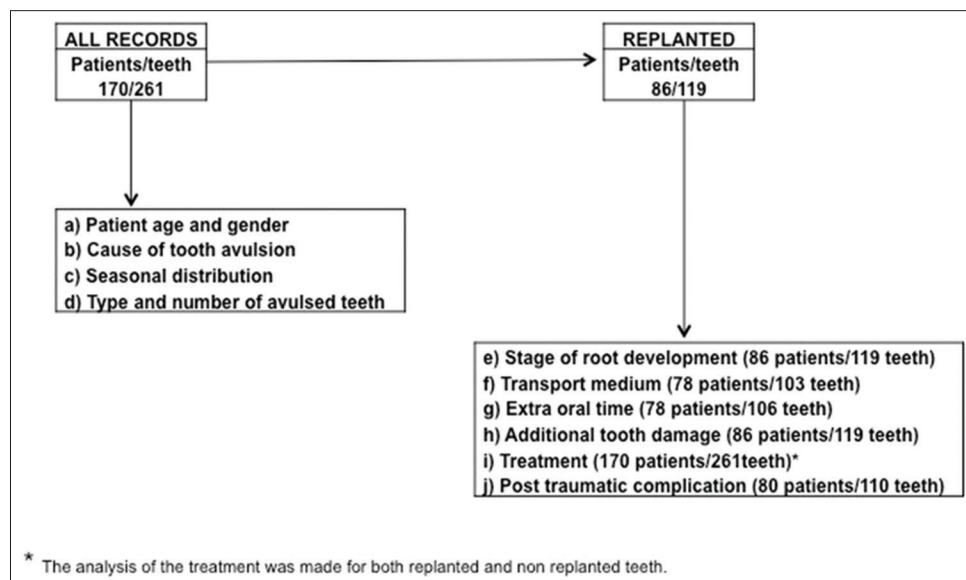
## Results

This study involved dental records' of 280 patients. A total of 110 patients were excluded from the study because incomplete documentation ( $n = 60$ ) and presenting a follow-up period <1-year ( $n = 50$ ). The final sample consisted of 170 patients (121 male, 71.18%; male-to-female ratio = 2.4:1), aged 6–43 years (mean = 15.9 years). From 261 avulsed teeth, just 119 (45.59%) were replanted. The highest avulsion frequencies were in the groups of patients aged 6–10 and 11–15 years (30.59% each) [Table 1].

One hundred fifty-nine participants (93.53%) had avulsion because of nonintentional reasons. Falls (51.76%) and traffic accidents (29.41%) were the main causes of tooth avulsion. The Chi-square test showed a statistically significant difference between etiological factor and age ( $P < 0.05$ ). Falls were the most common cause in patients younger than 15 years (41.18%). As age increased, traffic accidents were the main etiological factor of tooth avulsion (16.47%) [Table 1].

The season when most cases occurred was autumn (31.18%), followed by winter (27.65%), spring (23.53%) and summer (17.65%).

There were 261 avulsed permanent teeth. A total of 226 (86.59%) avulsed teeth were in the maxillary arch. Most avulsed teeth were maxillary central incisors (62.45%), followed by maxillary



**Figure 1:** Data collected from patient charts and radiographs

**Table 1: Distribution of the etiological factors of the tooth avulsion according to age and gender**

	Fall (%)	Traffic accidents (%)	Sports injuries (%)	Violence (%)	Collision (%)	Others (%)	Total (%)
Age (n=170)							
6-10	39 (22.94)	7 (4.12)	1 (0.59)	0 (0.00)	2 (1.18)	3 (1.76)	52 (30.59)
11-15	31 (18.24)	15 (8.82)	2 (1.18)	3 (1.76)	0 (0.00)	1 (0.59)	52 (30.59)
16-20	9 (5.29)	10 (5.88)	1 (0.59)	5 (2.94)	1 (0.59)	1 (0.59)	27 (15.88)
21-25	6 (3.53)	7 (4.12)	0 (0.00)	1 (0.59)	0 (0.00)	3 (1.76)	17 (10.00)
26-30	2 (1.18)	7 (4.12)	0 (0.00)	1 (0.59)	1 (0.59)	1 (0.59)	12 (7.07)
>30	1 (0.59)	4 (2.35)	0 (0.00)	1 (0.59)	1 (0.59)	3 (1.76)	10 (5.88)
Gender (n=170)							
Male	63 (37.06)	35 (20.59)	4 (2.35)	9 (5.29)	5 (2.94)	5 (2.94)	121 (71.17)
Female	25 (14.71)	15 (8.82)	0 (0.00)	2 (1.18)	0 (0.00)	7 (4.12)	49 (28.83)

lateral incisors (21.46%), mandibular central incisors (5.75%), mandibular lateral incisors (5.36%), maxillary canines (2.68%), mandibular canines (1.92%) and mandibular premolars (0.38%). A total of 111 participants (65.29%) had one tooth avulsed, 38 (22.35%), 2 teeth, and 21 (12.35%), three or more teeth.

### Stage of root development

The percentage of replanted teeth with complete root formation and closed apex was 67.23% (n = 80 teeth), whereas 32.77% (n = 39 teeth) had open apices.

### Storage media

Thirty-eight teeth (31.93%) were stored in dry media, 20 (16.81%) in saline, 20 (16.81%) in milk, 15 (12.61%) in water, 5 (4.20%) in alcohol, 4 teeth (3.36%) in the patient's oral cavity and 1 tooth (0.84%) was stored in ice. Information about the transport medium could not be determined in 16 (13.45%) of the 119 replanted teeth.

### Extra oral time

No tooth was replanted <5 min after avulsion. Replantation was delayed for 106 replanted teeth (89.08%): 42 (35.29%) were replanted 60 min after injury, 26 (21.85%), 1–2 h and 38 (31.93%), more than 2 h after the accident. Information about extra-oral time was not available for 13 teeth (10.92%).

### Additional tooth damage

Other TDI associated with tooth avulsion were found in 31 replanted teeth (26.05%). The most common type of injury was uncomplicated crown fracture (70.97%), followed by complicated crown fracture (16.13%), fracture of the alveolar process (9.68%) and complicated crown-root fracture (3.23%). Only 4 teeth (3.36%) had repeated TDI.

### Treatment

Treatments were subdivided into treatment for replanted teeth and treatment for nonreplanted teeth. Most replanted teeth received endodontic treatment and root canal filling with calcium hydroxide (58.82%) followed by endodontic treatment and root canal filling (26.89%), extraction (3.36%),

prosthodontic rehabilitation (3.36%), endodontic treatment and root canal filling associated with orthodontic movement (1.68%), space maintainer (0.84%) and prosthodontic rehabilitation associated with orthodontic movement (0.84%). For the nonreplanted teeth, the most frequent treatment was analysis of history and clinical exam (82.39%) followed by prosthodontic rehabilitation (15.49%), space maintainer (0.70%), orthodontic movement (0.70%) and tooth transplantation associated with endodontic treatment and the filling of the root canal with calcium hydroxide (0.70%).

### Posttraumatic complications

All teeth were followed-up for 1–8 years. Follow-up radiographs revealed that 44 (36.97%) had IRR, 41 (34.45%), periodontal healing (PH), 22 (18.49%), RRR, 2 (1.68%), PCO, and 1 (0.84%), IIRR. Information about posttraumatic complication was not available for 9 teeth (7.56%).

Fifty-two teeth were followed-up for 1–2 years and had the following results: PH (24 teeth; 46.15%); RRR (9 teeth; 17.31%), IRR (18 teeth; 34.62%) and PCO (1 tooth; 1.92%). Eleven teeth were followed-up for 2–3 years and had the following results: PH (1 tooth; 9.09%); RRR (5 teeth; 45.45%), IRR (3 teeth; 27.27%), PCO (1 tooth; 9.09%), and IIRR (1 tooth; 9.09%). Totally, 32 were followed-up for more than 3 years and had the following results: PH (8 teeth; 24.24%); RRR (8 teeth; 24.24%) and IRR (16 teeth; 51.52%) [Table 2].

The correlation between follow-up time and posttraumatic complications were not analyzed for 15 teeth (15.78%) because 14 patients moved from town and missed their scheduled appointment or simply dropped out of treatment.

### Discussion

Clinical factors and epidemiological outcomes of TDI should be known because of their important implications, such as root resorption and pulp changes. Epidemiologically, our results are in agreement with previously reported data about tooth avulsion.<sup>[6,7,13,17]</sup> The data collected confirmed that male patients had significantly more tooth avulsion than female patients (2.4:1). However, recent studies have shown a reduction or even a reversal in this gender disparity.<sup>[4,14,18]</sup> In general and in comparison to women, men engage in more vigorous physical activities, such as physical contact sports, usually without

**Table 2: Distribution of posttraumatic complications in function of follow-up period**

Follow-up period (years)	PH (%)	Posttraumatic complications				Total
		RRR	IRR	PCO	IIRR	
1-2	24 (46.15)	9 (17.31)	18 (34.62)	1 (1.92)	0 (0.00)	52 (100)
2-3	1 (9.09)	5 (45.45)	3 (27.27)	1 (9.09)	1 (9.09)	11 (100)
>3	8 (24.24)	8 (24.24)	16 (51.52)	0 (0.00)	0 (0.00)	32 (100)

RRR: Root replacement resorption, IRR: Inflammatory root resorption, PCO: Pulp canal obliteration, IIRR: Internal inflammatory root resorption

wearing adequate protection, and in aggressive activities, such as fights.<sup>[1,2]</sup>

Tooth avulsion is more frequent in patients aged 7–14 years.<sup>[11]</sup> In this study, the age of patients that had tooth avulsion ranged from 6 to 43 years. The highest prevalence was found in the 6–10 and 11–15 years age groups, which together made up about 61% of the sample. Previous studies found higher prevalence in different age groups.<sup>[7,13]</sup>

The most frequent causes of tooth avulsion were nonintentional, such as falls (51.76%) and traffic accidents (29.41%). Etiological factors varied according to age group. Most tooth avulsions due to falls were found in the 6–10 and 11–15 years groups. As age increased, traffic accidents became the main etiological agent. The place where the study was conducted and the age group should be taken into account when analyzing injury etiology.<sup>[7,17]</sup>

Maxillary central incisors were the teeth most often affected, as previously reported.<sup>[4,7]</sup> The vulnerable position of this teeth, which may often be protracted and have inadequate lip coverage, may explain this result.<sup>[2]</sup>

One hundred and eleven patients (65.29%) had only one tooth avulsed. Some individuals had 3, 4 or even 6 avulsed teeth. Previous studies confirmed that most injuries involve multiple teeth.<sup>[8]</sup> The number of avulsed teeth seems to vary according to etiology. Therefore, traumatic injuries due to traffic accidents may result in a greater number of avulsed teeth. Additional damage may be associated with avulsion, such as dental hard tissue injury. In 31 replanted teeth (26.05%), there was additional crown damage, of which 70.97% were uncomplicated crown fractures. Donaldson and Kinirons<sup>[5]</sup> detected an increased risk of earlier root resorption onset for teeth with an additional coronal damage at the time of replantation.

The analysis of the stage of root development revealed that 39/119 replanted teeth (32.77%) had incomplete root formation. This prevalence is similar to those found by Gonda *et al.*<sup>[18]</sup> (31.03%), Barrett and Kenny<sup>[9]</sup> (38.46%) and Stewart *et al.*<sup>[14]</sup> (28.78%), higher than the one recorded by Andreasen *et al.*<sup>[8]</sup> (15.07%) and lower than the one found by Petrovic *et al.*<sup>[17]</sup> (48.38%). Schatz *et al.*<sup>[19]</sup> conducted a clinical and radiological study and found that most avulsed teeth had fully developed roots with an open apex. However, the outcomes of the studies that used different age groups should

be compared carefully because some variation between dental age and biological age may be expected.

The treatment of choice for avulsed teeth should be the replantation, even when the prognosis is unclear. Our study found a low replantation rate (45.59%), which is in agreement with the rate reported by Kinoshita *et al.*<sup>[20]</sup> (43.75%), Tzigkounakis *et al.*<sup>[6]</sup> (30%) and Petrovic *et al.*<sup>[17]</sup> (48.38%). Panzarini *et al.*<sup>[13]</sup> and Zhang and Gong<sup>[7]</sup> found higher replantation rates: 70.13% and 70.83%, respectively. The main reasons for no replantation are the fact that people at the accident site had insufficient knowledge about how to manage an avulsed tooth or reacted inappropriately, the teeth were not found, the patient sought dental treatment long after avulsion or the patient was hospitalized to treat more serious injuries.<sup>[6,7,13]</sup>

One of the most critical factors to preserve the periodontal ligament of avulsed teeth is the type of transport medium.<sup>[15]</sup> Pohl *et al.*<sup>[21]</sup> evaluated the healing results of 28 avulsed and replanted permanent teeth. The periodontal ligament of six avulsed teeth stored in a cell culture medium for 1–53 h was described as not compromised. A total of 16 teeth were stored in nonphysiological conditions temporarily, and their periodontal ligament was compromised. Other 6 teeth were stored in nonphysiological conditions for longer times, and the condition of the periodontal ligament was defined as hopeless. Chappuis and von Arx<sup>[22]</sup> conducted a 1-year follow-up study of 45 avulsed permanent teeth and found a higher occurrence of replacement resorption in teeth kept for extended times in dry storage. Replacement resorption ranged from 9.5% in teeth kept in dry storage for a short time (<15 min) to 100% in teeth kept in dry storage for over 60 min.

Many patients in the present study did not keep the avulsed tooth under physiological conditions, and 38/119 replanted teeth were kept in dry storage before replantation. A possible explanation for this finding is that the patients in the study did not know how to store the avulsed tooth.

Avulsed teeth are usually replanted between 1 and more than 5 h after avulsion.<sup>[6,7,13,18]</sup> Boyd *et al.*<sup>[4]</sup> found that total extra-oral time was the best predictor of IRR. In our study, 89.08% of the teeth received delayed replantation.

Complications after replantation of avulsed teeth are common, at a reported prevalence of 57–83%.<sup>[19,23]</sup> The overall prevalence of complications was lower (57.98%) in our study than in those conducted by Schatz *et al.*<sup>[19]</sup> (83.3%) and Petrovic *et al.*<sup>[17]</sup> (84.4%). IRR was the most common type (36.97%). Several factors might have contributed to this unfavorable outcome, such as the significant proportion of avulsed teeth stored in a nonphysiological medium and the long extra-alveolar storage time. Information about the time interval between the replantations and pulp extirpation was not available. Thus, one possible explanation for a high rate of IRR was the delay at the pulp removal.<sup>[4,5,14,17]</sup>

According to published guidelines for the management of tooth avulsion,<sup>[24]</sup> the clinical decision to perform endodontic

treatment should be based on the stage of root development and the extra-alveolar time. For the replanted teeth in our study, the most common management strategies were endodontic treatment and temporary filling of the root canal with calcium hydroxide and endodontic treatment and definitive root canal filling (85.71%). For the nonreplanted teeth, the most frequent treatment was analysis of history and clinical exam (82.39%), the present study was based on the verification of clinical records of patients treated at a Public Dental Urgency Service. Patients were referred to other departments so that restorative treatments were performed.

The lack of epidemiological data about permanent tooth avulsion in the several geographical regions of Brazil has motivated this study. This retrospective study was conducted to describe tooth avulsion in Goiânia, a city in Midwestern Brazil. In addition, oral health initiatives should be based on prevalence data and clinical factors to implement adequate policies. This study data suggest the establishment of accurate prevention policies to promote guidelines for the proper management of tooth avulsion. Epidemiological surveys support decisions about public health, and preventive campaigns have lower costs than the treatment of TDI.

The most serious problems detected in this study were the low number of replanted teeth, the use of inappropriate storage medium to transport avulsed teeth and the prolonged extra-oral time.

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