Scientific Article

Pulp Canal Obliteration Following Trauma to Primary Incisors: A 9-year Clinical Study

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Abstract: *Purpose:* The purpose of this study was to determine the occurrence of pulp canal obliteration (PCO) in traumatized primary maxillary central incisors and its association with secondary pulp necrosis, type of trauma, and further incidence of trauma. **Methods:** A retrospective descriptive study on 112 traumatized teeth was carried out (9-year follow-up) using the clinical and radiographic data from 82 patient charts at the Traumatized Patient Care Program of the Universidade Federal de Santa Catarina. **Results:** A total of approximately 54% of the teeth exhibited PCO; in approximately 58% of these cases, obliteration was diagnosed within 12 months following the trauma. An association between PCO and crown discoloration was confirmed (P<.001). PCO was not significantly associated with patient gender, age, type of trauma, or recurrence of trauma. There were no cases of secondary pulp necrosis. **Conclusions:** The findings of the present study reveal that the occurrence of PCO in traumatized primary teeth was high, while the type and recurrence of trauma were not risk factors for the development of PCO. Moreover, there was no association between PCO and secondary pulp necrosis. (Pediatr Dent 2011;33:399-402) Received February 22, 2010 | Last Revision May 14, 2010 | Accepted May 17, 2010

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Studies on dental trauma in the primary dentition report a prevalence ranging from approximately 1% to 36%.¹⁻⁵ A number of histopathological reactions may occur due to trauma to a primary tooth, such as pulp canal obliteration, pathological root resorption, and pulp necrosis.^{6.7} Obliteration is a response of live pulp to dental trauma, which can trigger hard tissue deposition within the pulp chamber and root canal space.^{7.8}

With the aging of teeth, there is a physiological deposition of tissue on the walls of the pulp cavity, which is a normal defensive response to stimuli during the vital cycle of teeth. In dental trauma, this response may be accelerated considerably and lead to pulp canal obliteration.⁹⁻¹² Obliteration may be the result of damage to the neurovascular supply, with ischemia followed by necrosis or revascularization. When successful, the latter can induce the formation of osteodentin, bone, or dentin tissue on the canal walls, leading to pulp canal obliteration.¹³

Pulp canal obliteration is usually found in a radiographic image after the disappearance of the root canal space.^{6,8,14} Meanwhile, it is common to observe clinically a mainly yellowish color alteration in the crown of the affected teeth, the prevalence of which may be as high as approximately 68%.^{6,8,9,12,15} Pulp necrosis also may occur, even in a tooth with root canal obliteration.^{8,9,16} This is one of the reasons for the recommendation of periodic clinical and radiographic follow-up.^{6,15}

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The aim of the present study was to determine the occurrence of pulp canal obliteration (PCO) in traumatized primary teeth and its association with secondary pulp necrosis as well as type and recurrence of trauma.

Methods

A retrospective, descriptive study (1-9-year follow-up) was carried out using data from the charts of patients treated at the Traumatized Patient Care Program of the Federal University of Santa Catarina, Santa Catarina, Brazil. The study received approval from the Ethics Committee of the Federal University of Santa Catarina.

The inclusion criteria were treatment at the Traumatized Patient Care Program between August 1998 and August 2007 and having at least 1 traumatized primary maxillary central incisor. The exclusion criteria were: incomplete data on the chart; less than a 12-month follow-up among cases in which no PCO was diagnosed; and dental trauma with an indication of endodontic treatment or extraction due to the impossibility of diagnosing PCO.

Data and radiographs from 220 files were analyzed following the chronological order of the appointments. All radiographs were evaluated by a single independent examiner in a darkened room using an X ray illuminator and a magnifying glass. Based on the eligibility criteria, 82 patients were included, with a total sample of 112 traumatized primary maxillary central incisors.

In accordance with the protocol for the care of traumatized patients at the Federal University of Santa Catarina, follow-up is carried out with periodic appointments, at which clinical

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and radiographic examinations are performed. These evaluations are carried out at 15, 30, and 90 days as well as 5, 8, and 12 months post-trauma. After 1 year, follow-up is performed every 6 months until the complete eruption of the permanent successor.¹⁷

The following aspects were investigated as factors associated with the development of PCO: gender; age at the time of trauma; type of trauma; and new incidence of trauma. Crown discoloration, time elapsed between trauma and diagnosis of PCO, presence of any new incident of trauma (before or after obliteration), and the occurrence of secondary pulp necrosis (diagnosed by the presence of fistula and periapical abscess) were also determined and classified as independent variables.

For the data collection, previously established diagnostic criteria cited in the literature were used.^{6,8,13} An 18-monthold cutoff point for patient age at the time of trauma was established (≤ 18 vs >18-months-old). Eighteen months is the mean age at which the apex closure of the primary maxillary incisors is observed radiographically, when they are then considered mature teeth.¹⁸ According to the literature, a tooth is immature when its root is less than three quarters its complete length or when root formation is complete but the foramen remains wide.¹⁹

Trauma was dichotomized as mild (crown fracture without pulp exposure, concussion, and subluxation) or severe (lateral luxation, intrusion, extrusion, and crown-root fracture without pulp exposure).^{9,12} For teeth having suffered further incidents of trauma, the reference was the most severe injury.

Table 1. OBSERVATIONS AND SIMPLE FREQUENCIES OF VARIABLES IN TRAUMATIZED PRIMARY MAXILLARY CENTRAL INCISORS (N=112)				
Variables	No. of valid % observations			
Gender				
Male	62	55		
Female	50	45		
Age (mos)				
. ≤18	24	21		
>18	88	79		
Type of trauma				
Mild	97	87		
Severe	15	13		
New incidence of trauma				
No	82	73		
Yes	30	27		
Color alteration				
No	67	60		
Yes	44	40		
Pulp canal obliteration				
No	52	46		
Yes	60	54		
1				

Among teeth that developed obliteration, the most severe type of trauma before its establishment was considered. The incidence of new trauma was classified as absent (1 episode of trauma) or present (>1 episode of trauma to the same tooth). When present, crown discoloration was classified as yellowish or grayish.

Time elapsed between the episode of trauma and the development of PCO was dichotomized as equal to or less than 12 months and more than 12 months. The presence of at least 1 of the following indicators was considered to determine if a tooth with PCO was necrotic: abscess and/or fistula; inflammatory root resorption; and/or periapical lesion.

After the description of the variables, Fisher's exact test was performed using the Stata 9.0 statistical package (StataCorp LP, College Station, Texas). Associations with a *P*-value \leq .05 were considered statistically significant. Intraexaminer calibration (κ =1) was carried out by the principal examiner, who was also considered the gold standard, as she had accompanied all patients in the sample during their treatment and follow-up.

Results

Among the 112 traumatized primary maxillary central incisors, 60 (~54%) exhibited PCO and 52 (~46%) did not develop this condition (Table 1). Forty-four teeth (~39%) exhibited discolorations; 29 (~26%) were yellowish; and 15 (~13%) were grayish.

The analysis of the time elapsed between trauma and the development of PCO revealed that 35 (~58%) of the 60

Table 2. ASSOCIATION BETWEEN PULP CANAL OBLITERATION IN TRAUMATIZED PRIMARY MAXILLARY CENTRAL INCISORS AND INDEPENDENT VARIABLES				
	Presence of pulp canal obliteration			
Variables	N*	%*	<i>P</i> -value†	
Gender			>.34	
Male	36	58		
Female	24	48		
Age (mos)			<.11	
≤18	9	38		
>18	51	58		
Type of trauma			<.41	
Mild	50	52		
Severe	10	67		
New incidence of trau	ma		>.83	
No	43	52		
Yes	17	57		
Color alteration			<.001	
No	27	40		
Yes	33	75		

* Simple and relative frequencies based on valid observations. † Fisher's exact test. teeth with PCO developed this condition within 12 months following injury, and 25 (-42%) developed it more than 12 months following trauma, with a range of 1 to 48 months. Mean and median time elapsed between trauma and the diagnosis of PCO was 14 and 11 months, respectively.

PCO was not significantly associated with gender, age, type of trauma, or further incidents of trauma (Table 2). Among the teeth with PCO that suffered a further incident of trauma (17/60=-28%), calcification occurred prior to the new episode of trauma in 13 teeth (-77%).

The association between PCO and crown discoloration was significant (P<.001); among the 60 teeth with PCO, 33 (55%) exhibited an alteration in crown color (Table 2). The crown became shades of yellow in 24 teeth (~73%) and shades of gray in 9 teeth (~27%). In a further analysis of this same sample, among the 44 teeth with discoloration, approximately 83% of those with a yellowish coloration (24 of 29) and 60% of those with a grayish coloration (9 of 15) developed PCO. There were no cases of secondary pulp necrosis.

Discussion

The occurrence of PCO in primary and permanent teeth that suffered trauma ranges from 3% to approximately 48%.^{6,7,9,12,15,20,21} In the present study, the occurrence of PCO was greater than that reported by Borum and Andreasen,⁶ who found 36% of teeth with this condition in a sample of 395 primary maxillary incisors. Robertson et al.,²² histologically evaluated 123 primary incisors extracted following trauma and found 21% with PCO. The higher occurrence of pulp calcification in the present study may be explained by the fact that Robertson et al.¹³ only evaluated teeth that were extracted due to signs of pulp necrosis.^{6,9}

With respect to the time elapsed between the trauma and diagnosis of PCO, the present study's findings are similar to that described by Andreasen et al.,⁹ who also determined the mean time elapsed prior to the diagnosis of PCO, but in permanent teeth. In primary teeth, Borum and Andreasen⁶ report that PCO was diagnosed an average of 1 year following trauma when observed over a period of 0.3 to 5 years. In contrast, Fried et al.¹⁴ reported that the occurrence of obliteration in permanent teeth increased over time, with most cases diagnosed more than 3 years following the trauma.

There was no association between PCO and patient age, although there were a greater number of teeth with PCO among patients over 18 months of age. Contrasting results are reported in studies involving primary and permanent teeth.^{6,8,9,21,23} Borum and Andreasen⁶ report a higher frequency of PCO among children from 2- to 3-years-old at the time of trauma, and the authors relate the development of this condition to the closed root apex. In teeth with an open apex, there is a greater possibility of maintaining pulp vitality or revascularization of the neurovascular supply compared to mature teeth, due to the intense cell activity capable of promoting the defense and regeneration of affected tissues.¹⁹

PCO was not associated with the type of trauma in the present study. Some authors, however, report an association of PCO with severe trauma.⁶⁹,Gondim and Moreira Neto⁷ found

no PCO in any of 22 primary teeth that had suffered severe trauma (intrusion) and been followed for 36 months, which agrees with the findings of the present study. Jacobsen and Sangnes⁸ report a higher number of primary teeth with PCO among cases of mild trauma. According to Cleen,¹² mild trauma, such as concussion and subluxation, often causes slight, transitory damage to the periodontal ligament, with no major consequences. In some of these cases, however, injury to the pulp may lead to PCO.

Additional incidents of trauma were also not associated with PCO. In a comparison of complications triggered by 1 or more episodes of trauma in permanent teeth, however, Pissiotis et al.²⁴ found a higher frequency of PCO in teeth that suffered more than 1 incident of trauma. According to these authors, repeated incidents may compromise the pulp and periodontal ligament, thereby increasing the risk of PCO. According to Jacobsen and Sangnes,⁸ most patients have a history of more than 1 episode of dental trauma.⁸ However, when the trauma is mild and does not cause any apparent complication, it is often not reported during the patient history, which may have occurred with the patients in the present study. Thus, the absence of data on the recurrence of trauma may be considered one of the present study's limitations.

The occurrence of a color change to yellow seems to be frequently associated with PCO.^{6,8,12,15,25,26} This supposedly occurs as a consequence of the greater amount of mineralized tissue in the dental structure in such cases. In primary teeth, Jacobsen and Sangnes report this alteration in 100% of the teeth with PCO evaluated.8 The authors also report that, soon after trauma, some teeth exhibited a grayish color, which became yellowish after 2 months of follow-up. A similar result is reported by Borum and Andreasen,⁶ who examined 120 teeth with yellowish tone, among which 97 (~82%) had obliterated pulp canals. Moreover, among the 184 teeth they observed with no discoloration following dental trauma, 32 (-18%) had PCO. The authors also concluded that, among the 70 teeth with a grayish color, only 6 (~9%) had PCO, and there was no significant association between PCO and this type of discoloration.

Pulp necrosis was not found in any of the 60 teeth with PCO, which is similar to the finding described by Borum and Andreasen.⁶ Although the authors relate this result to the exclusion of teeth with new episodes of trauma, such teeth were included in the present study. Other authors report a frequency of necrosis ranging from 1% to 26% in teeth with PCO.^{8,9,23,25} Using an electron microscope to examine 123 primary teeth extracted following dental trauma, Robertson et al. found the formation of 3 types of calcified tissues within the pulp cavity, although none was associated with the presence of necrotic cells.¹⁴

The findings of the present study can help guide clinical decisions regarding diagnosis (considering discoloration) and choice of treatment in cases of primary teeth having suffered dental trauma and consequent development of PCO. Periodic clinical and radiographic follow-up is the best option, as the risk of necrosis exists, even though no cases were reported here. Follow-up is of fundamental importance to the early diagnosis and treatment of any condition that may develop as a result of dental trauma.^{5,6,8,20,24} Examination soon after an episode of trauma and follow-up of the affected tooth as well as neighboring teeth could prevent or reduce the establishment of complications.

Conclusions

Based on this study's results, the following conclusions can be made:

- 1. There was a high incidence of pulp canal obliteration (~54%) in the present study, with most cases diagnosed within the first year following the trauma.
- 2. The type and recurrence of trauma were not risk factors for the development of pulp canal obliteration.
- 3. There were no cases of secondary pulp necrosis among the obliterated teeth.

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