

Radiographic analysis of traumatized primary teeth

Análise radiográfica da dentição decídua após traumatismo alveolodentário

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ABSTRACT

This study aimed to evaluate the frequency of radiographic findings in primary teeth, as well as their supporting tissues, following dental trauma, and the occurrence of sequelae according to the trauma type. One radiograph was taken soon after the trauma, and two follow-up radiographs, with approximately six-month intervals between each, were taken of 116 traumatized teeth from 65 patients at the Pelotas Dentistry School in Pelotas, Santa Catarina, Brazil. One hundred and ninety-five radiographs were analyzed to evaluate: tooth position, periodontal ligament space, root integrity, alveolar bone, and root canal aspects. Data were shown in the form of absolute and percentage frequencies. The Wilcoxon test ($p < 0.05$) was used to detect differences in the images. The widening of the periodontal ligament and pathological root resorption, although with different evolutions, represented the most frequent findings. In the first radiograph, 35.6% of the teeth were diagnosed as presenting a widening of the periodontal ligament, as compared to 15.1% in the final radiograph. Pathological root resorption varied from 9.6% in the first radiograph to 35.8% in the final exam. Whereas alveolar bone resorption prevailed in intrusion cases and root canal obliteration in concussion/subluxation cases, tooth displacement occurred most often in intrusion and lateral luxation/extrusion cases. Concussion, subluxation, and intrusion were the conditions which were most often associated with sequelae during this sample's period of analysis. Radiographic sequelae resulting from alveolodental trauma in the primary dentition tend to vary. Identifying radiographic findings and relating them to the type of trauma can aid the professional in defining the prognosis and a proper treatment plan.

Uniterms: Pediatric dentistry. Tooth. Deciduous. Injuries. Radiography.

INTRODUCTION

The epidemiologic relevance of dental trauma in primary teeth is well-known. Traumas include regular accidents involving children and often occur at an early age, showing an occurrence as high as 30%^{1,2} to 35%^{3,4}. The highest incidence can be observed in children between 1 and 3 years of age, which points out the interdependence of the motor development and trauma occurrence^{1,5}. In these cases, the upper incisors are the most commonly affected^{2,6,7}.

Alterations, such as pulp necrosis^{8,10}, fracture lines, dental mobility¹¹, ankylosis, early loss of the primary tooth¹⁰, bone and root resorption^{9,10,12,13}, dental discoloration, and pulp chamber obliteration¹⁰⁻¹², are likely to represent

dental trauma sequelae. Many of these conditions cannot be clinically viewed directly after the trauma. For this reason, a routine follow-up period is needed so as to detect and treat the traumas appropriately. Thus, radiographic assessment is essential, not only to diagnose, but also to deal with potential complications¹¹, given that radiographs are able to identify otherwise temporarily asymptomatic, but no less injurious, sequelae.

The knowledge of trauma types and radiographic sequelae most likely related to the trauma is important. In this light, the aim of this descriptive study was to evaluate the frequency of radiographic findings in primary teeth and their supporting tissues following dental trauma, as well as the occurrence of sequelae according to the trauma type.

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MATERIALS AND METHODS

The research protocol was submitted to by the Human Research Ethics Committee of the School of Dentistry, Federal University of Pelotas, and was approved under log #43/04. An Informed Consent Form was signed by the child's parent/guardian so that the child could participate in this study. Data were obtained at the Center for the Study and Treatment of Dental Traumas in Primary Dentition at the School of Dentistry, Federal University of Pelotas. The protocol consists of filing a dental trauma record, including anamnesis, a clinical and radiographic exam of the affected area, as well as photographic documentation of the injuries. Regular follow-up is performed until the permanent successor has erupted in order to detect possible alterations.

Files from 259 patients attended to from May 2002 to May 2008 were analyzed. Those who presented insufficient clinical data or poor radiographs, showed extensive caries lesions in the traumatized tooth, or abandoned treatment sessions were excluded. Sixty-five patients with 116 traumatized teeth were included in the study. A total of 195 periapical or occlusal radiographs were taken upon first examination of each patient, from six months to one year following the trauma.

Dental trauma was classified according to Andreasen & Andreasen's classification¹⁴ and divided into 5 groups: ADT 1 – concussion/subluxation; ADT 2 – lateral luxation/extrusion; ADT 3 – intrusion; ADT 4 – enamel and dentin crack/fracture with or without pulp exposure; ADT 5 – crown-root and root fracture.

Radiographic analysis was performed in a dark room in an X-ray viewing box with the aid of a 2X magnifying lens. The radiographs were arranged in chronological order to detect sequelae in the affected teeth and their evolution. An average of 30 radiographs was evaluated each day. Data were logged in a specific medical record.

The evaluation was carried out separately by two previously trained examiners (SAXM and EFZB), one of whom was a radiology specialist. The

diagnoses of the two examiners were compared, and, in case of disagreement, a decision was reached by consensus.

The examiners received a dental record which included the child's age at the time of the trauma and the affected tooth. The following pre-established criteria were used:

- a) Position of the tooth: NORMAL or DISPLACED;
- b) Periodontal ligament space: NORMAL or THICKENED;
- c) Root integrity: NORMAL, with FRACTURE or with PATHOLOGICAL RESORPTION;
- d) Bone tissue adjacent to affected tooth: NORMAL or with RESORPTION;
- e) Root Canal Lumen: NORMAL or OBLITERATED.

Displacement was diagnosed in comparison with the homologous tooth. When two teeth, consecutive dental elements on a same arch, were displaced by dental trauma, they were diagnosed as displaced in relation to their neighboring teeth's incisal edge or cusp.

Results were shown as simple and percentage frequencies. The Wilcoxon test ($p < 0.05$) was used to detect differences on each traumatized tooth by comparing the final radiograph to the first. Statistical analysis was carried out using the Stata 9.1 software (2005).

RESULTS

Of the 116 evaluated teeth, 9 teeth were lost during follow-up due to early exfoliation or extraction: six of which belonged to the lateral/ extrusive luxation group, two to the intrusion group, and one to the crown-root/root fracture group.

Table 1 shows the distribution of sequelae found in the three radiographic examinations. The most frequent alterations found were the widening of the periodontal ligament space, which decreased in follow-up radiographs, and pathological root resorption, which increased during follow-up.

Table 1 - Distribution of teeth with radiographic sequelae identified during the first exam and subsequent visits

| Radiographic sequelae | INITIAL | | 6MONTH | | 1 YEAR | |
|------------------------------|------------|------|-----------|------|-----------|------|
| | n | % | n | % | n | % |
| Tooth displacement | 35 | 30.2 | 18 | 16.4 | 6 | 6.6 |
| Widening of PL* | 41 | 35.6 | 19 | 17.3 | 16 | 15.1 |
| Root fracture | 7 | 6.1 | 3 | 2.7 | - | - |
| Pathological root resorption | 11 | 9.6 | 27 | 24.6 | 38 | 35.8 |
| Bone resorption | 8 | 7 | 12 | 10.9 | 10 | 9.4 |
| Root canal obliteration | 7 | 6.1 | 15 | 14 | 15 | 14 |
| Total | 109 | | 94 | | 85 | |

PL: periodontal ligament

Table 2 presents sequelae development according to the trauma type. Assessing the position of the teeth, realignment occurred in the lateral/extrusive luxation ($Z=-3.16$; $p<0.001$) and in the intrusion groups ($Z=-3.00$; $p<0.001$). Periodontal ligament space thickening showed a significant decrease in concussion/subluxation ($Z=-2.13$; $p<0.001$) and in lateral/extrusive luxation cases ($Z=-3.16$; $p=0.02$). A significant increase in

root resorption in concussion/subluxation ($Z=-2.67$; $p<0.001$), intrusive luxation ($Z=-2.53$; $p=0.01$), and enamel and dentin crack/fracture ($Z=-2.44$; $p=0.01$) groups could be observed. Alveolar bone resorption occurring during the follow-up radiographic exams prevailed in intrusion cases. Obliteration of the root canal increased significantly in concussion/subluxation cases ($Z=-2.64$; $p<0.001$).

Table 2 - Sequelae distribution and development according to trauma type

| RADIOGRAPHIC SEQUELAE | ADT 1 n = 49 | | | ADT 2 n = 21 | | | ADT 3 n = 18 | | | ADT 4 n = 17 | | | ADT 5 n = 11 | | |
|-------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | Exam | | | Exam | | | Exam | | | Exam | | | Exam | | |
| | 1 st | 2 nd | 3 rd | 1 st | 2 nd | 3 rd | 1 st | 2 nd | 3 rd | 1 st | 2 nd | 3 rd | 1 st | 2 nd | 3 rd |
| Tooth displacement | - | - | - | 15* | 4 | - | 17* | 13 | 6 | 2 | 1 | 1 | 1 | - | - |
| Widening of PL | 13* | 7 | 5 | 14* | - | - | 7 | 6 | 5 | 4 | 5 | 5 | 3 | 1 | 1 |
| Root fracture | 1 | 1 | - | 1 | - | - | - | - | - | - | 1 | - | 5* | 1 | - |
| Root resorption | 5* | 8 | 14 | 2 | 5 | 3 | 1* | 9 | 9 | 2* | 3 | 8 | 1 | 2 | 4 |
| Bone resorption | 3 | 2 | 2 | - | 1 | - | 4 | 7 | 6 | - | 2 | 2 | 1 | - | - |
| Root canal obliteration | 4* | 11 | 11 | 2 | 2 | 2 | 1 | 2 | 2 | - | - | - | - | - | - |
| Total | 26 | 29 | 32 | 34 | 12 | 5 | 30 | 37 | 28 | 8 | 12 | 16 | 11 | 4 | 5 |

*Statistically significant difference in the 3rd as compared to the 1st radiograph - Wilcoxon test ($p<0.05$)

PL: periodontal ligament; ADT 1: concussion/subluxation; ADT 2: lateral luxation/extrusion; ADT 3: intrusion; ADT 4: enamel and dentin crack/fracture with or without pulp exposure; TAD 5: crown-root and root fracture.

DISCUSSION

Periodic radiographic evaluations associated with anamnesis and clinical examinations are crucial in cases of traumatized teeth. Their relevance must be made clear to parents/guardians by the professional so as to define the most appropriate moment to intervene, mainly because of the potential for late sequelae development.

Radiographs in primary dentitions are many times difficult to obtain due to the patient's young age or because of his unwillingness to cooperate. According to the International Association of Dental Trauma, depending on the child's ability to cope with the procedure and the type of injury suspected, several angles are recommended: a 90° horizontal angle, an occlusal view, and an extra-oral lateral view¹⁵. In this study, the occlusal technique by means of a size 2 film was preferred, as it is a simple procedure in which the film is easily fitted to the young child's mouth and because it allows the dentist to assess tooth or root fractures, tooth displacement, and/or the widening of the periodontal ligament space¹¹.

The difficulty of radiographic interpretation in primary teeth is also indisputable due to the overlapping of the permanent tooth follicle¹⁰.

According to Tyndall¹⁶, the professional must differentiate between artifact occurrence and anatomic accidents.

Upon evaluating the position of the tooth, in the lateral/extrusive and intrusion groups, statistical analysis showed a significant decrease in displacement between the first and third radiographs (Table 2). However, in the intrusion group, cases of displacement still occurred in the final radiograph. Borun & Andreasen¹⁰ also found a similar result upon evaluating primary incisors, which moved in a labial direction and presented a favorable prognosis, and found that 20% to 22% of the teeth do not totally re-erupt or re-erupt without perfect alignment. According to studies by Kenwood & Seow¹⁷, displaced teeth tend to develop necrosis over time, which reinforces the need for follow-up. In more severe displacement cases, compromising of the supporting structure may lead to early dental loss. Likewise, dental losses following lateral and/or extrusive luxation and intrusive luxation during follow-up, commonly caused by a premature exfoliation due to accelerated root resorption or the need for exodontics due to infection, could also be observed.

The widening of the periodontal ligament

was observed in the concussion/subluxation group, although this is not a common characteristic finding of these trauma types¹⁵ (Table 2). This alteration may have been caused by periodontal fiber edema, which decreased during follow-up. Cases in which thickening persisted may well be compatible with pulp necrosis^{8,14}. However, as the evaluations were solely based on radiographic aspects, the periodontal ligament condition may have been overestimated.

The decrease in root fractures in this study does not necessarily mean root healing had occurred (Table 2). Since most fractures occurred in teeth with crown-root or root fractures, either the extraction of the tooth or the removal of the coronal fragment was recommended, in turn maintaining the apical fragment to be resorbed¹⁵. According to a study by Kenwood & Seow¹⁷, out of eleven teeth with root fracture, 90% were normal upon first assessment whereas during in follow-up periods two teeth presented pulp necrosis. Both studies emphasize the importance of long-term follow-up.

An increase in pathological root resorption cases during follow-up could be observed in all cases except for the lateral/extrusive luxation group. Andreassen¹⁸ found a significant relationship between lateral luxation and intrusion and root resorption. Borum & Andreassen¹⁰ also found root resorption in intrusion and lateral luxation cases.

Pathological root resorption cases were detected in the first radiograph when taken soon after the trauma (Table 2). A history of previous traumas likely explains this finding. According to Holan & Fuks¹⁹, many primary tooth injuries are not perceived by parents, and radiographic signs of a previous injury were not supported by their personal accounts. In addition, Mortelliti & Needleman²⁰ found that, out of 233 children with a record of vicious oral habits, traumas, and overjet, 14% presented radiographs which showed evidence of atypical root resorption. Moreover, when these risk factors were added, the total resorption values increased.

Obliteration of the root canal increase proved only to be statistically significant ($p < 0.001$) in concussion/subluxation cases. Fried *et al.*¹¹ reported that pulp calcification after subluxation increased in occurrence and severity over time. In contrast to this study, Kenwood's & Seow¹⁷ and Ravn²¹ findings revealed pulp obliteration cases following crown fractures. In the present study, luxation revealed atresia signs during follow-up. Holan & Ram²² found pulp canal obliteration to be a common sequelae following intrusion of primary teeth and emphasized that the average age of children who had experienced some form of trauma was 3 years of age, at which time the apex may be open,

favoring revascularization of the pulp and apposition of calcified deposits. Obliteration was observed both in diagnosis and follow-up radiographs. The same situation occurred in a study by Cardoso & Rocha²³. It is important to mention that pulp obliteration is not an exclusive result of alveolodental trauma. It may occur by accelerating the physiological process, causing hard tissue apposition along the root canal walls.

The fact that sequelae, such as bone resorption, dental displacement, and pathological root resorption, are closely associated with intrusion shows the severity of this injury. Because it is strongly associated with secondary damage in permanent teeth²⁴, the need for long term follow-up is emphasized.

It is evident, though, that a relation between radiographic findings and the clinical and symptomatological condition of the patient must be researched¹⁶. Often, the data from an image suggest a normal alteration which is not compatible with the clinical exam. In such cases, it is recommended to remain on alert, explaining the situation to parents/guardians in search of signs which can aid in identifying the proper diagnosis.

All planned interventions for a young patient must necessarily take the future into account as part of a permanent healthcare program. Likewise, the treatment of dental trauma must fit this postulate. Thus, radiographic examinations are essential in this context.

CONCLUSION

Radiographic follow-up and the establishment of a connection between the type of alveolodental trauma and radiographic sequelae in primary dentitions can aid the dentist in defining the prognosis and the most appropriate treatment in an attempt to maintain the integrity of the deciduous tooth, the supporting tissues, and the permanent successor.

RESUMO

Este estudo visa identificar as sequelas radiográficas em dentes decíduos e seus tecidos de suporte, após traumatismo alveolodentário. Foram realizadas tomadas radiográficas logo após o traumatismo alveolodentário e duas radiografias subsequentes, executadas com intervalo de cerca de seis meses, em 116 dentes pertencentes a 65 pacientes, na Faculdade de Odontologia da Universidade Federal de Pelotas, Brasil. Nas cento e noventa e cinco radiografias foram analisadas a posição do dente, o espaço do ligamento periodontal, a integridade radicular, o osso alveolar e a luz do canal radicular. Os dados foram apresentados como frequências

simples e percentuais, sendo que o teste de Wilcoxon ($p < 0,05$) foi utilizado para detectar diferenças entre as imagens radiográficas. A alteração do espaço do ligamento periodontal e a reabsorção radicular patológica foram os achados mais frequentes, apesar de apresentarem diferentes evoluções. O espessamento do espaço do ligamento periodontal, o qual foi diagnosticado em 35,6% das radiografias iniciais, foi visualizado em 15,1% das radiografias finais. A reabsorção radicular patológica variou de 9,6%, das tomadas radiográficas iniciais, para 35,8% das finais. Enquanto a reabsorção óssea alveolar predominou nos casos de intrusão, e a obliteração do conduto radicular nos casos de concussão e subluxação; a alteração da posição dentária ocorreu com maior frequência nas intrusões e luxações laterais/extrusões. Concussão, subluxação e intrusão foram os tipos de traumatismos alveolodentários mais frequentemente associados às sequelas durante o período de análise da amostra. A apresentação das sequelas radiográficas, decorrentes do traumatismo alveolodentário na dentição decídua, é diversificada. Identificar a correlação dos achados radiográficos com o tipo de traumatismo auxilia o profissional a estabelecer o prognóstico e plano de tratamento de acordo com cada tipo de trauma.

Descritores: Odontopediatria. Dente. Decíduo. Traumatismos. Radiografia.

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