Analysis of Root Canal Treated Primary Incisor After Trauma: Two Year Outcomes

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Background: *The low number of clinical studies of traumatized teeth submitted to root canal treatment is completely out of proportion to the seriousness that dental trauma imposes on children in early years. Aim. This study evaluates the outcomes of root canal treatment (RCT) in traumatized primary incisors and identifies the predisposing factors associated with therapy success.* ***Methods:*** *This is a retrospective study conducted with all dental records of 704 patients who had one or more teeth with traumatic injuries. Patients with irreversible pulp changes in primary teeth leading to RCT with a 24 month follow-up met the inclusion criteria.* ***Results:*** *Twenty-five maxillary incisors of 17 children were evaluated. The children's age at the time of therapy ranged from 24 to 72 months (mean 47.3). Pulp necrosis was the most common disorder (84.0%) and pre-operative periapical lesions were observed in 52.0%. Coronal discoloration was found in 48.0%. The roots were filled with ZOE paste (68.0%) or Guedes-Pinto paste (32.0%). Overall RCT success rate was 68.0%. The absence of pre-operative periapical lesions (p = 0.02) and pathological root resorption (p = 0.02) presented positive association with therapy success. Success was not associated to filling paste (p = 0.49), filling extent (p = 0.44), of discoloration (p = 0.39) nor the patients' age (p = 0.59).* ***Conclusions:*** *RCT was considered successful in 68.0% of the cases at the 24 month follow-up. Failure of RCT in traumatized primary incisors was associated with pre-operatory periapical lesions and pathological root resorption. The filling paste, the filling extent and the patient's age were unrelated with therapy success.*

Keywords: *pulpectomy, trauma, primary teeth, deciduous teeth.*
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INTRODUCTION

Children are commonly affected by traumatic dental injuries, especially in their early years. Epidemiological studies show that approximately 30% of all children under the age of seven have sustained injuries to one or more of their primary incisors.[1] As regards etiology, the factor observed most frequently are falls.[2]

Due to the resiliency of the alveolar bone surrounding the primary teeth, the majority of injuries are tooth luxations.[3] The maxillary central incisors are the most commonly injured teeth[3] and pulp necrosis has been found to be the most common post-traumatic complication.[4,5]

The difficulty in managing behavior in preschool children and the risk of damage to the permanent tooth germ have determined that extraction has generally been the treatment of choice for traumatized primary teeth.[6] On the other hand, preserving traumatized primary incisors by root canal treatment (RCT) offers significant advantages over premature extraction of such teeth, in order to avoid speech problems, premature or ectopic eruption of the permanent successor or damage to the child's self image.[7]

There are diverging opinions concerning the treatment of traumatized primary teeth. Primosch *et al* [8] indicated that incisors submitted to RCT following a dental trauma failed at a significantly higher rate compared with teeth treated for dental caries. According to Rocha and Cardoso, the RCT of traumatized teeth should be initiated at an early stage and must be coincident with radiographic signs of resorption.[9] In addition, the success rate of treating teeth affected by a sequelae deriving from traumas such as periapical lesions,

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pathological resorption and dark coronal discolorations has been little researched.[10-12]

Because of the importance of RCT in maintaining teeth with pulp changes until their usual exfoliation time, many studies[7, 8, 13-17] have been carried out to evaluate RCT due to caries. However, few clinical studies[7-9,18] have evaluated traumatized primary teeth submitted to RCT and the scientific publications in this area are scarce.[19]

The aim of this study was to evaluate the outcomes of RCT in traumatized primary incisors and identifies the predisposing factors associated with therapy success.

MATERIALS AND METHOD

A review of all dental records of patients who attended the Dental Traumatology Surveillance Center (DTSC) from 2005 to 2009 was carried out. A total of 704 dental records of children from 0 to 12 years old that had one or more primary teeth with traumatic injuries were evaluated. Patients who were healthy and had at least one traumatized primary tooth indicated for RCT were candidates for inclusion if any of the following criteria were fulfilled: (1) irreversible pulpitis or pulp necrosis, (2) history of spontaneous pain, gingival swelling or sinus tract/purulence, (3) continuous bleeding after amputation of coronal pulp, (4) physiologic or pathologic external root resorption involving only a third of its length and (5) radiolucent periapical area without permanent tooth bud involvement.[20] Only anterior primary teeth with a completed RCT and a minimum 24 month follow-up were included. This study was approved by the local Ethics Committee (064/05).

Data collected from the children's records

The following data were collected from the dental records: patients' age (months) at time of trauma, children's age (months) at the time of therapy, interval (months) between trauma and therapy, gender, type of injury, presence of periapical lesion and pathological root resorption, presence of coronal discoloration, type of filling paste, filling extent, reoccurrence and treatment outcome (success or failure) determined by clinical and radiographic findings.

The traumatic injuries (concussion, subluxation, and lateral and intrusive luxations and crown fracture) were classified according to the Dental Traumatology Guideline[21] and were collected from dental records. To identify pathological root resorption, the radiography of the non traumatized contralateral/adjacent tooth was observed. The immediate postoperative radiograph was evaluated for filling extent: underfilled (more than 2 mm short of the radiographic apex), ideal (at the radiographic apex or up to 2 mm short of the apex), and overfilled (extravasation through the radiographic apex). Incomplete dental records were excluded.

All RCT procedures were performed by pediatric dentists from Department of Pediatric Dentistry and Orthodontics, previously trained by professors in a standardized treatment protocol. RCT was indicated only for traumatized teeth presenting: crown fracture with pulp exposition associated to either periapical lesions, submucosal abscess (associated or not with fistula) or pathological root resorption[22] limited to the apical third of the root.[17] Traumatized teeth submitted to RCT should not be severely displaced. Cases of dental intrusion was submitted to RCT only when the tooth re-erupts within three months after the trauma.[21] The RCT procedure was performed on primary teeth with roots at least two-thirds intact and with adequate tooth structure remaining for an appropriate restoration. All therapy procedures were performed under local anesthesia and rubber-dam isolation. Treatments were performed without general anesthesia or other pharmacological adjunct for behavior management. If necessary, physical restraint was carried out with caregivers permissions. Chemomechanical preparation was carried out using Kerr files and irrigation with 2.5% sodium hypochlorite and saline solution. The roots were filled with ZOE paste (SS White, Rio de Janeiro, Brazil) or iodoform-based paste, known as Guedes-Pinto paste (GPP)[23]; composed of Rifocort® (Medley, São Paulo, Brazil), camphorated paramonochlorophenol (Biodinâmica, Paraná, Brazil) and iodoform (Biodinâmica, Paraná, Brazil) using a lentulo spiral in a slow-speed handpiece. All teeth were restored with composite resin. The patients were asked to return 2 weeks post-therapy, after 1 month and at 6-month intervals as part of a routine recall appointment up to 24 months.

Clinical and radiographic evaluation

Three calibrated evaluators examined the preoperative and post-treatment radiographs and added the information to dental records with a consensus on the treatment outcome. The criteria for success were: (a) pretreatment clinical signs and symptoms resolved within 2 weeks; (b) infectious process resolved radiographically within 6 months, as evidenced by bone deposition in the pretreatment radiolucent areas and (c) no increase of pathologic root resorption. Teeth were extracted if, during the follow-up period, they had not fulfilled all previous mentioned criteria or if any evidence of permanent tooth bud deflection from the normal eruption path[24] was detected.

Results were demonstrated by absolute and relative frequencies. Fisher's exact test and Chi-square test were used for statistical analyses with a 95% significant level (*p-value* ≤ 0.05).

RESULTS

Twenty-six dental records, from children aged from 24–72 months old, with traumatized maxillary primary incisors submitted to RCT were analyzed. Nine records were excluded due to the non attendance of follow-up visits after RCT. A total of 17 dental records, from children with 25 traumatized maxillary primary incisors with a 24 month follow-up were selected.

Table 1 shows the data of the 25 cases included. The mean age of the children at the time of therapy was 47.36 months (±10.6) and the mean time between dental trauma and intervention was 10.12 months (±7.9). Among the 25 teeth analyzed, 22 were central incisors and 3 were lateral incisors. Subluxation was the most frequent type of trauma

(68.0%). Pulp necrosis was the most common disorder (84.0%) and pre-operative periapical lesions were observed in 52.0% of the cases. In 48.0% of the cases, root resorption was observed in the pre-RCT radiographs. Pre-operative periapical infection was observed in 52.0% of the cases. Coronal discoloration was found in 48.0%. The ZOE paste was the filler paste in 68.0% (n = 17) of the cases and GPP paste was used in 32.0% (n = 8). The reoccurrence of trauma was observed in 20.0% of the cases. In general, failed RCT occurred in the first 12 months (6 cases at the first six month evaluation and 1 case at the 12 month evaluation). Only 1 case failed after 12 months. All failed cases (n = 8) were extracted. RCT was considered successful in 68.0% of the cases at the 24 month follow-up. Comparison between success and type of trauma, pulp diagnoses, periapical infection, pathological resorption, age of patient at time of therapy, root canal filling paste and filling extent are shown in Table 2. Success was statistically associated with the absence of periapical infection before treatment ($p = 0.02$) and pathological resorption ($p = 0.02$). The root canal filling paste was not associated with treatment success ($p = 0.49$). Figure 1 illustrates two successful RCT treatments (cases 6 and 7) with ZOE paste and Figure 2 represents two failed treatments (cases 4 and 5) with the same paste.

DISCUSSION

The majority of treatment failures presented pathological root resorption and periapical infection. Studies with traumatized primary teeth have described a failure range between 35.3 to 42.0%,[8,18] similar to our results. We suggest

Table 1. Description of the studied cases, traumatized teeth and RCT data.

RCT	Gender	Traumatized tooth	Age (months) at the time of trauma	Age (months) at the time of therapy	Type of trauma	Periapical lesion*	Pathological resorption*	Coronal discoloration*	Root canal filling paste	Filling extent	Treatment outcome
1	F	51	28	34	subluxation	-	-	+	ZOE	under	success
2	F	52	28	35	subluxation	-	-	-	ZOE	over	success
3	F	61	28	35	subluxation	-	-	+	ZOE	ideal	success
4	M	51	48	58	lateral luxation	+	+	-	ZOE	ideal	failure
5	M	61	48	58	lateral luxation	+	+	-	ZOE	ideal	failure
6	F	51	24	38	subluxation	-	-	-	ZOE	ideal	success
7	F	61	24	40	subluxation	-	-	-	ZOE	ideal	success
8	F	61	45	57	subluxation	-	-	+	ZOE	ideal	success
9	F	61	42	48	crown fracture	+	-	+	ZOE	ideal	failure
10	M	62	24	45	crown fracture	+	+	+	GPP	ideal	success
11	M	51	33	58	subluxation	+	+	-	ZOE	ideal	failure
12	M	61	33	58	subluxation	+	+	-	ZOE	ideal	failure
13	F	61	22	30	intrusion	+	+	+	GPP	under	failure
14	F	51	36	63	subluxation	+	+	-	GPP	ideal	success
15	M	51	33	48	crown fracture	-	-	-	GPP	ideal	success
16	F	62	44	45	subluxation	-	-	-	ZOE	over	success
17	F	61	44	46	subluxation	+	+	+	ZOE	ideal	success
18	F	51	44	47	subluxation	+	+	-	GPP	under	success
19	M	51	47	55	subluxation	-	+	+	GPP	under	failure
20	M	51	51	52	subluxation	+	+	+	GPP	over	success
21	F	51	38	40	crown fracture	+	+	+	GPP	ideal	success
22	F	51	68	69	subluxation	-	-	+	ZOE	ideal	success
23	F	51	36	48	crown facture	+	+	-	ZOE	ideal	failure
24	M	61	36	48	crown facture	-	-	-	ZOE	ideal	success
25	F	61	27	29	crown fracture	-	-	+	ZOE	under	success

*Note: (+) indicate presence and (–) absence; * indicates pre-operative data.*

Table 2. Comparison of success with type of trauma, pulp diagnoses, periapical infection, pathological resorption, coronal discoloration, children's age at the time of therapy, filling extent and root canal filling paste.

	Success (n=17)	Failure (n=8)	Total (n=25)	*p-value*
Type of trauma				
Subluxation	12	3	15	0.09**
Lateral luxation	0	2	2	
Crown fracture	5	2	7	
Intrusion	0	1		
Pulp diagnoses				
Pulp necrosis	13	8	21	0.18*
Irreversible pulpitis	4	0	4	
Pre-operative periapical infection				
Present	6	7	13	**0.02***
Absent	11	1	12	
Pre-operative pathological resorption				
Present	6	7	13	**0.02***
Absent	11	1	12	
Coronal discoloration				
Present	9	3	12	0.39
Absent	8	5	13	
Children's age at the time of therapy				
36 months or less	4	1	5	0.59*
37 months or more	13	7	20	
Filling extent				
underfilled	4	2	6	0.44**
ideal	10	6	16	
overfilled	3	0	3	
Root canal filling paste				
ZOE paste	11	6	17	0.49*
GPP paste	6	2	8	

*Note: *Fisher's exact test and **Chi-square test. Bold form indicates statistical significance.*

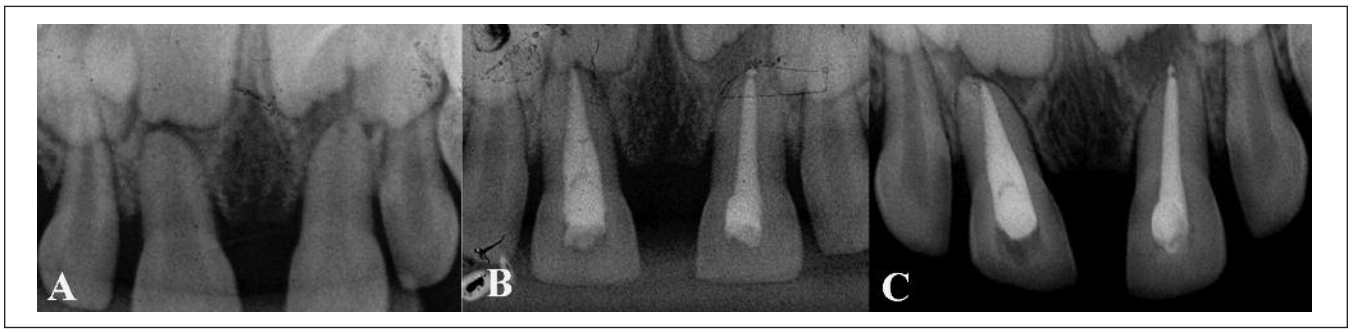

Figure 1. RCT number 6 (teeth 51) and 7 (teeth 61) presenting successful treatment; A – Pre-operative image of subluxation of the primary maxillary central incisors; B – Six-month follow-up; C – Twenty four-month follow-up without pathological alterations.

Figure 2. RCT number 4 (teeth 51) and 5 (teeth 61) presenting failed treatment; A – Pre-operative image of lateral luxation of the primary maxillary central incisors with periapical lesion; B – Three-month follow-up with maintenance of the pretreatment periapical lesion; C – Six-month follow-up with persistence of the periapical lesions and consequently the extraction of both teeth was indicated.

that the low failure rate in this work occurred due to rigorous inclusion criteria and an effective protocol of RCT. Our results emphasize the importance of periodic evaluation of traumatized primary teeth to diagnose any radiographic or clinical findings of infection and prevent damage to their permanent successors.

It seems reasonable that RCT has a higher success rate when performed in symptomless teeth with no root resorption and/or periapical infection.[24] Coll and Sadrian[13] demonstrated that the success rate of RCT was related significantly to the amount of preoperative resorption. Although the authors[13] correlated failure of pulp therapy to the presence of periapical lesions of decayed teeth, periapical lesions due to traumatic injuries was not evaluated. Considering dental trauma studies, our study corroborated with previous findings concerning the relationship between the presence of preoperative periapical lesions in traumatized teeth or root resorption and pulp therapy failure.[9, 18]

According to a descriptive study[25] with teeth affected by caries, the main factor associated with RCT failure in primary teeth was the technical limitations associated with morphological irregularities created by external and inflammatory resorption. Regarding trauma, Rocha and Cardoso[18] previously reported that the majority of RCT failures occurs in the 7–12 months following treatment and teeth affected by more than one trauma presented a greater failure rate. Our results demonstrated similar findings because seven cases failed in the first 12 months and the recurrence of traumatic injury was observed in 20.0% of cases. An intrusion case, with pre-operative periapical lesion and pathological resorption was filled with GPP and failed after the 12-month evaluation. Contradicting the results of Rocha and Cardoso,[18] we not found statistical difference when associated recurrence of traumatic injury and RCT outcome.

Concussion and subluxation, in spite of being considered mild traumas, are associated with a lower chance of successful endodontic treatment.[15] In these cases, parents usually go for professional help after the sequelae has reached a severe clinical stage, resulting in pulp therapy failure.[15] In our study, the majority of the trauma cases was classified as subluxation and crown fracture. Some cases presented a long interval between dental trauma and professional intervention, however, we did not observe a relationship between this interval and therapy outcome. In addition, previous studies[8,18] related that the age at the time of treatment was not associated with the success of the outcome. Our findings confirm this argument, although cases of failure tended to occur in children that are 36 months old or more when compared to the children that had successful treatment.

In the present study, the root canal filling paste varied. Zinc-oxide eugenol paste has traditionally been the choice as a primary root filling material. However, concerns have been expressed regarding the slow resorption of zinc-oxide eugenol by the body and the differential rate of resorption between this material and the root.[26] When ZOE is forced beyond the apex, due to its hardness there is a risk of deflecting the erupting succedaneous teeth[14] and also particles of ZOE paste may migrate from the gingival vestibular area during permanent dentition eruption.[27] Newer preparations of filling material with iodoform pastes, such as GPP, Vitapex and Sealapex, have been developed in order to minimize the slow resorption of other pastes. Iodoform paste has presented excellent clinical and radiographic results and it can be reabsorbed when extruded from canals.[28,29] Two systematic reviews concluded that there is no difference regarding RCT outcomes between those materials and ZOE, and also there was no agreement with regard to the filling materials' resorption.[30,31]

The low number of studies published concerning traumatized primary teeth is completely out of proportion to the seriousness that dental trauma imposes on children.[19] The pulp diagnosis remains a challenge for clinicians. Dark-gray discoloration of primary incisors could be interpreted as an early sign of pulp degeneration that might deteriorate into necrosis.[10] Also, accelerated root resorption is found in discolored teeth.[12] On the other hand, traumatized dark discolored primary incisors can remain asymptomatic till natural exfoliation.[24] In the current study, it was not found statistical association between coronal discoloration and pulp therapy outcome. For this reason, in agreement with previous reports[6,24] we believe that dark discoloration following trauma is not a predictor for pulpal necrosis and we recommend follow-up with intervention only when signs and/or symptoms of infection appear or pulp necrosis is diagnosed.

Nevertheless, our retrospective study has limitations. An important contributing factor was the socioeconomic status of the families attending Federal University in Brazil. For them, bringing in a child for periodic assessment is costly. In spite of having a small sample size, we believe that the rigorous inclusion criteria minimized the bias in our study. Our study presented a long term evaluation of RCT after trauma and tends to fill a lack of clinical studies in this research area.

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