

Age and Timing of Pulp Extirpation as Major Factors Associated with Inflammatory Root Resorption in Replanted Permanent Teeth

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Abstract

Introduction: External root resorption (ERR) is a serious complication after replantation, and its progressive inflammatory and replacement forms are significant causes of tooth loss. This retrospective study aimed to evaluate the factors related to the occurrence of inflammatory ERR (IERR) and replacement ERR (RERR) shortly after permanent tooth replantation in patients treated at the Dental Trauma Clinic at the School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil. **Methods:** Case records and radiographs of 165 patients were evaluated for the presence, type, and extension of ERR and its association with age and factors related to the management and acute treatment of the avulsed tooth by using the logistic regression model. **Results:** The patient's age at the moment of trauma had a marked effect on the ERR prevalence and extension. The patients older than 16 years at the moment of trauma had less chance of developing IERR and RERR (77% and 87%, respectively) before the pulp extirpation, regardless of the extension of the resorption. The patients older than 11 years of age at the moment of trauma showed the lowest indices of IERR ($P = .02$). Each day that elapsed between the replantation and the pulp extirpation increased the risk of developing IERR and RERR by 1.2% and 1.1%, respectively, and also raised the risk of severe IERR by 0.5% per day. **Conclusions:** The risk of mature teeth developing severe IERR before the onset of endodontic therapy was directly affected by the timing of the pulpectomy and was inversely proportional to age. Systemic antibiotic therapy use had no effect on the occurrence and severity of IERR in mature teeth. The occurrence of RERR before the onset of endodontic treatment stimulates further investigations of

the early human host response to trauma and subsequent infection. (*J Endod* 2014;40:366–371)

Key Words

External inflammatory root resorption, external replacement root resorption, tooth avulsion, tooth replantation, traumatic injuries

After replantation, external root resorption (ERR) is a possible serious outcome that commonly results in tooth loss. In advanced stages of the inflammatory and replacement progressive forms of ERR, the weakened root walls become unable to endure even functional forces, thereby leading to the exfoliation of the tooth or to cervical root fracture (1). Replacement ERR (RERR) is related to the absence of vital periodontal ligament (PL) cells in the root surface, which results in tooth fusion to the alveolar bone. The damaged PL is repopulated by the adjacent bone marrow cells, followed by gradual replacement of the tooth structure by bone, a progressive condition that may lead to tooth loss because there is no effective treatment (1–4). Inflammatory ERR (IERR) is characterized by areas of erosion on the cementum and dentin, with numerous Howship lacunae, odontoclasts, and regions of inflammatory infiltration in the adjacent periodontal tissue (1, 4–6). The onset of IERR results from mechanical damage to the PL and to the root surface at the time of injury and the presence of necrotic and infected pulp. Immediately after replantation, healing events are initiated to repair the damaged areas. This process exposes dentinal tubules and allows for the passage of bacteria and their toxic products from the root canal to the lateral PL intensifying the resorption that advances toward the root canal (7–9).

Many clinical studies concerning the fate of replanted teeth have examined the prevalence of ERR and their determinants (10–23). There is clinical evidence that younger patients and earlier stages of root development are associated with a greater risk for ERR (10–12) and its faster progression (13). Furthermore, several factors related to the immediate care and treatment of the avulsed tooth may affect the outcome of replantation. The lack of a sustaining metabolic medium during the extra-alveolar period seems to be crucial for triggering ERR and its progression (10, 13–22). The presence of visible contamination (18, 20) and additional crown fracture have been associated with ERR after replantation (20). In terms of the treatment-related factors,

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delaying pulp extirpation after the replantation (21–24), using systemic antibiotic therapy (SAT) (25), and splinting type and time have also been associated with ERR (18, 26). Only a few of the aforementioned studies have approached the specific determinants of the 2 types of ERR separately soon after replantation (17, 19, 20). Because the disease processes and clinical features of IERR and RERR are so diverse, it is reasonable to surmise that various risk factors may act at different times after replantation and influence the specific patterns of ERR. Therefore, the aim of the present study was to evaluate the role of age and other factors related to the management and acute treatment on the occurrence of IERR and RERR shortly after replantation of avulsed permanent mature teeth in patients treated at the Dental Trauma Clinic, School of Dentistry, Federal University of Minas Gerais, Belo Horizonte, Brazil.

Materials and Methods

Study Population and Teeth

Case records and radiographs of replanted teeth from patients who were admitted to the Dental Trauma Clinic at the School of Dentistry of Federal University of Minas Gerais from 1994–2011 were analyzed to collect retrospective data regarding the patient's age at the time of trauma, root development stage, extra-alveolar period and storage condition of the avulsed teeth, splinting period and type, pulpectomy timing, and SAT use. The patients received acute treatment at the Emergency Dental Service of Municipal Hospital Odilon Behrens and were referred to the Dental Trauma Clinic at the School of Dentistry of Federal University of Minas Gerais to proceed with treatment. The time elapsed between the trauma and the acute treatment ranged from 4 hours to 3 days. The replantation was performed according to the protocol adopted by the Dental Trauma Clinic at the School of Dentistry of Federal University of Minas Gerais since 1994, which was based upon information from the literature (27). The avulsed teeth were held by the crown and rinsed with a physiological salt solution. Saline irrigation was used to remove the intra-alveolar clot. No root surface treatment was performed. After the correct repositioning was radiographically verified, the tooth was splinted with a double-ligature wire (0.08 inches), slightly twisted and fixed with composite resin. Only teeth with closed apices were included in this study. Teeth with additional traumatic injuries and those with extensive restoration, endodontic treatment, or radiographic signs of root resorption before the injury were excluded. Patients with history of previous trauma were not included. Study approval was obtained from the Human Ethics Committee of the Federal University of Minas Gerais (COEP-UFGM - 003.0.203.000-11).

Radiographic Assessment of Root Resorption

Periapical radiographs, which were taken immediately after replantation and at the time of pulpectomy, were independently examined by 2 authors (J.V.B. and M.I.S.C.). Each radiograph was labeled with a number to ensure that the analyses were performed blindly. Radiographic standardization was based on established criteria (28). Occlusal and periapical radiographs were taken immediately after replantation and at the onset of the endodontic therapy. The occlusal radiographs were performed by using the bisecting angle technique with large film (Kodak Ultra-speed, size 4; Eastman Kodak Company, Rochester, NY) and directing the central beam between the 2 central incisors. The periapical radiographs were taken by using the paralleling technique with small film (Kodak Ultra-speed DF 58, size 2; Eastman Kodak Company) and film holders with a fixed object-focus distance of 33 cm (Cone; Maquira Dental Products, Maringá, PR, Brazil). The orientation of the central beam was directed between the 2 central incisors, between the right or left lateral and the central

incisors or canines, depending on the traumatized teeth. All radiographs were taken at 70 kVp, 8 mA (Spectro 70X Eletronico Dabi Atlante S/A; Medical & Dental Industry, Ribeirão Preto, SP, Brazil). Data regarding the presence and amount of ERR were assessed by using the root resorption index developed by Andersson et al (13). The structures in the resorption cavities were classified as either inflammatory resorption (bowl-shaped radiolucencies in the resorption area) or as replacement resorption (bone structures in the resorption area and periodontal space loss) (11).

Statistical Procedures

The statistical analysis was performed by using SPSS 17 software (SPSS Inc, Chicago IL). A logistic regression model was used to test the association between the patient's age, extra-alveolar period and storage, SAT use, and the pulpectomy and splinting timing in relation to ERR at the onset of endodontic therapy. Variables that presented *P* values < .25 in the univariate analysis were tested in the multivariate model (29). The level of significance was set at *P* < .05.

Results

Patients and Teeth

The sample consisted of 165 patients, 122 male (74.5%) and 43 female (25.5%), with 205 teeth replanted after avulsion. Patient's age at the time of injury ranged from 7.9–33.1 years (mean, 12.7 ± 3.8 years). Considering the potential interdependence in cases in which more than 1 tooth was replanted in the same patient, 1 tooth was randomly selected from each patient to avoid any possible bias (30). The tooth group distribution was as follows: 139 maxillary central incisors (84.2%), 17 maxillary lateral incisors (10.3%), 3 mandibular incisors (1.8%), and 9 canines (3.6%).

Extra-alveolar Conditions

The median extra-alveolar period of the avulsed teeth was 120 minutes and ranged from 5 minutes–3 days. The sample distribution according to the extra-alveolar period and storage condition is shown in Table 1. The teeth that were kept dry for more than 20 minutes before storage in a wet medium were classified within the dry environment group. This criterion was based on previous results showing that a combination of dry and wet storage resulted in a significantly lower healing rate among teeth kept dry for 20 minutes or more before storage in a wet medium (15).

Factors Related to Acute Treatment

Splinting times ranged from 7 days to 24.6 months, with a median time of 49 days. Time elapsed from replantation until pulp extirpation ranged from 6 hours to 39.6 months, with a median time of 2.2 months. Systemic therapy with amoxicillin was prescribed in 32.8% of the cases.

Root Resorption Activity

Radiographic signs of ERR were found in 77.6% of the cases, and 37 teeth (22.4%) showed no ERR. Regarding the ERR type, 64.3% of the teeth showed IERR, and 13.3% showed RERR. The ERR indices ranged from 0–12 and were grouped into 2 categories, low (≤ 4) and severe (> 4), which represented 73.3% and 26.7% of the cases, respectively. The kappa scores indicated excellent intraexaminer agreement for both examiners (0.85% and 0.82%) and fair to good interexaminer agreement (0.75%).

The patient's age, extra-alveolar period and storage, SAT use, and pulpectomy and splinting timing were individually tested in relation to the presence and type of ERR in the whole sample (IERR + ERSS).

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