# Retention and Healing Outcomes after Intentional Replantation

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## Abstract

**Introduction:** Intentional replantation is an alternative to tooth extraction and prosthetic replacement when conventional endodontic treatment modalities are unfeasible or contraindicated. This study assessed tooth retention and healing after intentional replantation and explored predictors of these outcomes. **Methods:** Data of intentional replantation procedures performed between March 2000 and December 2010 were collected prospectively, excluding teeth with preoperative periodontal and root defects. A cohort of 159 teeth was followed up for 0.5–12 years. Retention and healed status without complications (periapical radiolucency, external root resorption, ankylosis, signs/symptoms, probing ≥6 mm) was recorded and analyzed with Kaplan-Meier survival analysis and Cox proportional hazard regression model ($P < .05$). **Results:** Complications leading to extraction occurred in 8 of 159 teeth (5%). Kaplan-Meier survival function suggested 93% cumulative 12-year retention. Cumulative healed rates declined from 91% at 6 months to 77% at 3 years. The healed rate was significantly lower for maxillary teeth without preoperative periapical radiolucency, replanted in more than 15 minutes, and root-end filled with ProRoot MTA. Cox regression identified extraoral time ≤15 minutes as predictor of complication-free healing ($P < .04$; hazard ratio, 2.767; 95% confidence interval, 1.053–7.272). **Conclusions:** This prospective cohort study of contemporary intentional replantation suggested a cumulative 12-year retention rate of 93% and healed rate of 77% after 3 years. Healing occurred 1.7 times more frequently in teeth replanted within 15 minutes. Although most complications occurred within 1 year after replantation, follow-up should extend for at least 3 years to capture late complications. *(J Endod 2016;42:909–915)*

## Key Words

Extraoral time, healing outcome, intentional replantation, survival rate

Cross-sectional studies of populations in many countries have reported high prevalence values of post-treatment (persistent, recurrent, and emerged) apical periodontitis (AP) associated with root-filled teeth (1). The principal management options for post-treatment AP include extraction of the tooth with or without replacement, orthograde retreatment, and apical microsurgery (2). Selecting treatment from among such contrasting options can be challenging for clinicians and patients alike (3, 4). Clinical decision-making is routinely based on analysis of benefits, risks and costs associated with each treatment option, and expressed patient preferences (3, 4). When specific analysis or patient's preference suggests that retention of a tooth by conventional orthograde retreatment or apical microsurgery is unfeasible, the patient is left with the option of tooth extraction and possibly its prosthetic replacement. In these situations, intentional replantation of the affected tooth may be considered as an alternative (5, 6), with the primary outcome goal being survival of the tooth (6, 7) and complete healing being the secondary goal.

Although intentional replantation has been enthusiastically endorsed as simple and predictable (8, 9), the frequent occurrence of external root resorption has been highlighted as its main risk (7, 10, 11). Understanding of post-replantation complications has been critically advanced by systematic research on root resorption in traumatically avulsed and replanted teeth, which is focused on survival of the periodontal ligament and cementum along the root surface (12–14), prevention of infection (15), trauma associated with extraction, extraoral manipulation and replantation, extraoral time and conditions, and type and duration of splinting (15, 16). This extensive research has led to the development of improved treatment protocols aimed at reducing complication rates after tooth replantation (17). Indeed, contemporary intentional replantation studies where the current treatment protocols were applied have reported external root resorption rates ranging from 0% to 14% of teeth (18–22) and persistent infection rates in the range of 9% (19). Despite these improved outcomes, awareness and use of intentional replantation are not widespread (6), possibly because of shortage of recent outcome reports to match the large numbers of reports on nonsurgical endodontic treatment and apical microsurgery (23). Thus, the objective of this study was to augment the

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0099-2399/$ - see front matter



http://dx.doi.org/10.1016/j.joen.2016.03.006

current evidence base for contemporary intentional replantation by assessing its outcome with regard to retention and healing of the teeth and to explore potential outcome predictors.

## Materials and Methods

### Subjects

The Institutional Review Board of Yonsei University Health System approved the study protocol. All patients treated by intentional replantation between March 2000 and December 2010 were entered into the clinical database of the Department of Conservative Dentistry at the College of Dentistry, Yonsei University, Seoul, Korea. Included were teeth with post-treatment AP where orthograde retreatment and apical surgery were considered unfeasible or were declined by the patient. Teeth with divergent roots or with broken down coronal tooth structure were excluded because of fracture risk during extraction. To focus the study primarily on teeth presenting with endodontic disease, we excluded teeth with preoperative periodontal defects ≥6 mm (24), root perforation, root resorption, developmental groove, or subcrestal root caries. At the time of treatment, informed consent was obtained from each subject after the nature of the procedure and risks had been explained. A total of 196 teeth in 196 subjects were screened and included in this study.

### Intervention

Teeth were anesthetized with 2% lidocaine with 1:80,000 epinephrine. They were extracted with extraction forceps as carefully as possible to not damage the root surface, and the patients were instructed to bite on wet gauze while the teeth were being worked on extraorally. Once a tooth was extracted, it was subjected to treatment procedures in accordance with contemporary interventions of apical microsurgery (25, 26) and tooth replantation (17). Any granulation tissue attached to the root was carefully removed with tissue forceps, and the tooth was placed under an operating microscope (OPMI PICO; Carl Zeiss, Göttingen, Germany) for the remainder of its preparation. The root surface was carefully inspected for perforation or microcracks. The coronal two thirds of the root surface was covered with saline-soaked gauze, and the apical 3 mm of the root was resected perpendicular to the long axis with a high-speed diamond bur under copious water spray. The resected surface was stained with methylene blue dye and inspected at ×20 magnification.

A 3-mm-deep root-end cavity was prepared along the long axis of the root. In thick roots, cavities were drilled with high-speed diamond burs (Komet 858 010; Komet, Rock Hill, SC) or slow-speed 1/2 round burs (Komet RA 1/2; Komet). In thin roots, isthmi, fins, and cavities were prepared with ultrasonic tips (KiS; Obtura Spartan, Algonquin, IL) mounted in a piezoelectric ultrasonic unit (Spartan MTS; Obtura Spartan). After root-end cavity preparation, the resected root surface was again inspected at ×20 magnification, and the cavity was air-dried and filled with 1 of the following materials: Intermediate Restorative Material (IRM) (Caulk Dentsply, Milford, DE) (27, 28), Super EBA (29) or ProRoot MTA (Dentsply–Tulsa Dental Specialties, Tulsa, OK) (30, 31).

The socket was rinsed with sterile saline solution, and the tooth was replanted without forcing. When the tooth was stable, no splint was applied, and the patient was instructed to bite on gauze. Unstable teeth were splinted semi-rigidly with 1-mm-thick fishing line (Haekwang, Bucheon, Korea) secured to teeth with flowable resin (Metafil Flo; Sun Medical, Shiga, Japan). Total extraoral time was recorded for 95 of the treated teeth. The average was 12.5 minutes (range, 4–25 minutes).

### Outcome Assessment

Data for each subject were recorded in dedicated Excel (Microsoft Corp, Redmond, WA) spreadsheets and forms. Preoperative data were related to the subject (sex, age), tooth (jaw, type), and endodontic condition (periapical radiolucency, sinus tract, root filling adequacy). Intraoperative data were related to the treatment procedure (root-end filling material, extraoral time).

Subjects were scheduled for post-treatment follow-up examinations at 1, 3, 6, and 12 months and annually thereafter. Subjects who did not show at scheduled examinations were contacted by phone and rescheduled. No specific incentives were offered to subjects for attending. Any extracted teeth were recorded, and the retained teeth were subjected to clinical examination (subjective discomfort, sinus tract, swelling, tenderness to percussion or palpation, percussion sound, mobility, periodontal probing) and periapical radiographic examination (radiolucency size, evidence of external root resorption, continuity of the periodontal ligament space). Subjects were informed about the findings at each follow-up session.

Outcome in all retained teeth was assessed by combined clinical and radiographic criteria. Teeth were considered healed (Fig. 1) when they had no periapical radiolucency, no evidence of external root resorption or ankylosis (indicated by percussion sound and blurring of the periodontal ligament space in periapical radiographs), no signs/symptoms, and probing depth <6 mm (24). Occurrence of any of the above was recorded as a complication (Fig. 2). Two examiners (S.J.L., S.Y.C.) evaluated the radiographs independently by using standardized evaluation criteria for periapical healing, ankyloses, and periodontal involvement (32). Interexaminer reliability was determined with Cohen kappa statistics in accordance with Landis and Koch (33).

### Analysis

All subjects with at least 6 months of follow-up were included in the analysis. Kaplan-Meier survival curves were plotted to chart retained teeth during the duration of the follow-up period, as well as healed teeth free of complications (periapical radiolucency, external root resorption, ankylosis, signs/symptoms, probing ≥6 mm). Bivariate associations between complications and clinical variables were explored with the log-rank test, followed by multivariate analysis with the Cox proportional hazard model. All statistical analyses were performed with SPSS v21.0 software (IBM Corp, Somers, NY) and interpreted at the 5% level.

## Results

Interexaminer agreement regarding preoperative periapical lesions, root-filling adequacy, postoperative periapical lesions, and external root resorption ranged from $\kappa$ = 0.94 to 0.97, suggesting very good agreement (33).

Of 196 enrolled subjects, 37 subjects were lost to follow-up within 6 months before the first juncture used for analysis. The attending sample of 159 of 196 teeth and subjects (81% recall) is characterized in regard to preoperative and intraoperative variables in Table 1. The majority of subjects were female and younger than 40 years of age. The majority of teeth were molars (126 second molars, 20 first molars, and 13 others) with periapical radiolucency, adequate root filling, and without sinus tract. They were mostly root-end filled with IRM and replanted within 15 minutes.

Follow-up periods ranged from 6 months to 12 years (average, 3.2 years), with the majority of teeth examined in 2 or more time intervals generating longitudinal data. Of the 196 treated teeth, 159 (81%) were examined at 6 months, 132 (67.3%) at 1 year, 94 (48.0%) at 2 years, 53 (27.0%) at 3 years, and 24 (12.2%) at 4 years or longer