Prognostic Factors for Clinical Outcomes in Autotransplantation of Teeth with Complete Root Formation: Survival Analysis for up to 12 Years

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Abstract

Introduction: Tooth autotransplantation is a treatment option that has the potential to restore masticatory function and esthetics to edentulous spaces resulting from extracted teeth. The purpose of this study was to investigate the prognostic factors and clinical outcomes for autotransplanted teeth with complete root formation. **Methods:** Patients who had received tooth autotransplantation in the Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea, from July 2001 to August 2010 were electronically searched, and a total of 105 cases of autotransplanted teeth met the inclusion criteria. Tooth survival, inflammatory root resorption (IRR), ankylosis, and related prognostic factors were assessed by using the survival analysis that was based on clinical and radiographic examination. **Results:** The cumulative tooth survival rate was 68.2% at 12 years after the tooth autotransplantation. According to the Cox proportional hazard regression analysis, patient age, donor position, and extraoral time were significantly associated with tooth survival ($P < .05$). Donor extraction type was significantly associated with IRR ($P < .05$), and transplantation timing and initial stability were significantly associated with ankylosis ($P < .05$) **Conclusions:** Patients less than 45 years of age, maxillary donor teeth, and an extraoral time of less than 15 minutes were associated with significantly higher tooth survival. Surgical extraction of the donor tooth was associated with a significantly higher incidence of IRR. Immediate transplantation after the extraction of the recipient site's tooth and low initial stability were associated with a significantly lower incidence of ankylosis *(J Endod 2016;42:198–205)*

Key Words

Autotransplantation, computer-aided rapid prototyping model, extraoral time, periodontal ligament, survival analysis

Tooth autotransplantation is a treatment option that has the potential to restore masticatory function and esthetics to edentulous spaces resulting from extracted teeth by repositioning the patient's own teeth to another recipient site in the same patient (1, 2). By using the patient's own teeth, tooth autotransplantation exhibits a number of advantages compared with other treatment options (ie, dental implants or fixed partial prostheses), such as greater resistance to occlusal loading, maintenance of the periodontal ligament (PDL) and surrounding bone, and potential for better esthetics (1, 3, 4).

After its first reported clinical application in 1950 (2), the success rate of tooth autotransplantation has gradually increased because of advances in diagnostic and surgical techniques, such as computer-aided rapid prototyping (CARP) models. By applying preoperatively fabricated CARP models, the extraoral time is significantly reduced, and the suitability between the donor tooth and the recipient site is improved (5). Consequently, recent clinical studies report high success rates with tooth autotransplantation (6, 7).

However, it should be noted that most studies have focused on autotransplantation using teeth with incomplete root formation (7–9), which restricts the application of tooth autotransplantation to patients in their early 20s and younger (10). Therefore, to expand the potential therapeutic applicability of tooth autotransplantion, teeth with complete root formation could be considered for use as donor teeth. However, in the field of autotransplantation of teeth with complete root formation, there is currently a lack of clinical evidence regarding its clinical outcome and prognostic factors. One problem is that most studies use a relatively short follow-up period (ranging from 16.4–35.6 months on average) (7, 11, 12), which reduces the ability to assess the long-term predictability. When considering that the cumulative survival of tooth autotransplantation changes over time (11, 12), a longer follow-up period is required to properly assess the influence of related prognostic factors.

In addition, most studies analyzed the prognostic factors related only to tooth survival, but other clinical outcomes, such as inflammatory root resorption (IRR) and ankylosis, were not thoroughly analyzed (11–13) even though they are major

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complications in tooth autotransplantation (14). Therefore, prognostic factors related to IRR and ankylosis should also be assessed.

The purpose of this study was to investigate the prognostic factors and clinical outcomes for autotransplanted teeth with complete root formation. To accomplish this goal, 105 cases of autotransplanted teeth were evaluated for up to 12 years, and clinical outcomes, including tooth survival, IRR, ankyloses, and other related prognostic factors, were assessed based on survival analysis.

Materials and Methods

Subject Materials

Patients who had received tooth autotransplantation in the Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea, from July 2001 to August 2010, as performed by a single operator (E.K.), were electronically searched for potential inclusion, and their eligibility for this retrospective study was further assessed based on the following inclusion and exclusion criteria.

Inclusion criteria were as follows: patients without severe systemic disease (American Society of Anesthesiologists classification 1 or 2) and permanent teeth with complete root formation (root development stage 5 and 6 by Moorrees et al [15]) as the donor teeth.

Exclusion criteria were the following: patients with severe systemic disease (American Society of Anesthesiologists classification 3 or more); primary teeth or permanent teeth with incomplete root formation (root development stage 14 [15]); and incomplete documentation on the pre-, intra-, and postoperative records.

Consequently, 105 teeth in 96 patients met the inclusion criteria, and their surgery record sheets and electronic and manual charts were reviewed.

Preoperative Preparation

On the first visit, the patient's medical history was reviewed, including underlying systemic disease such as chronic hypertension, diabetes mellitus, tuberculosis, and hepatitis B. A thorough dental history was recorded, and clinical examination of the donor tooth and recipient site was performed. This included mobility and percussion tests, periodontal probing, and pulp sensibility tests. Computed tomographic imaging (Highspeed Advantage and Denta Scan program; GE Medical Systems, Milwaukee, WI) was acquired on the donor tooth and the recipient site. Crown and root length and the cervical dimension of the donor tooth were measured and compared with the residual bone height and width of the recipient site, and anatomic relationships with the inferior alveolar nerve and maxillary sinus were also determined preoperatively. Written informed consent was obtained from each patient at this stage. In most cases, nonsurgical root canal treatment (RCT) of the donor tooth was completed preoperatively to reduce the extraoral time of the tooth, but in several cases in which the donor tooth was impacted and surgically extracted, RCT was performed extraorally during the surgery or conducted within 2 weeks after the surgery.

Surgery Simulation with CARP Model

Computed tomographic data (Digital Imaging and Communication in Medicine format) were 3-dimensionally reconstructed using a visualization program (V-works; Cybermed, Seoul, Korea), and actual-size CARP models of the donor tooth and the recipient site were fabricated using a rapid prototyping machine. Using these CARP models, model surgery was conducted preoperatively to confirm the suitability of the donor tooth in the recipient site and the postoperative interocclusal relationship.

Surgical Procedure

Amoxicillin 500 mg and ibuprofen 400 mg were prescribed 1 hour before the surgery. After local anesthetic injection, the recipient site's tooth was extracted with a mucoperiosteal flap elevation around the tooth. To reduce bone trauma, the tooth was sectioned with a #170 tapered fissure bur and then luxated passively with forceps. After the extraction, recipient bone preparation was conducted with a round implant bur (Center Punch Bur #3 mm; Degussa, Dusseldorf, Germany) under copious saline irrigation. After confirming the suitability of the model tooth in the recipient site, the donor tooth was extracted. To minimize trauma during the extraction, a #15 blade was initially introduced into the PDL space and tapped with a mallet. Then, the tooth was engaged and passively luxated with the forceps beak placed above the cementoenamel junction. The use of elevators was minimized to prevent any damage to the cementum and the PDL. When the donor tooth was impacted and surgically extracted, the same luxation protocol was used after the flap elevation and ostectomy around the donor tooth. The extracted donor tooth immediately received root-end resection, ultrasonic root-end preparation, and root-end filling under the operating microscope (OPMI PICO; Carl Zeiss, Göttingen, Germany) and was then transferred to the recipient site. ProRoot MTA (Dentsply, Tulsa, OK), Super EBA (Bosworth, Skokie, IL), or IRM (Caulk Dentsply, Milford, DE) was used as a root-end filling material. During the entire extraoral procedure, the donor tooth was handled by only engaging the crown portion by forceps, and the root surface was not touched manually. The tooth was frequently immersed in either saline or Hank's balanced salt solution (HBSS) to keep the root surface hydrated and to replenish nutrients for the cells of the PDL. In most cases, a simple periodontal pack was sufficient to stabilize the donor tooth, and a resin-wire splint was applied in several cases in which the donor tooth showed low stability. Amoxicillin 250 mg and ibuprofen 400 mg 3 times a day were prescribed for 1 week with 0.1% chlorhexidine rinse (Hexamedin; Bukwang Pharmaceutical, Ansan, Korea). The periodontal pack was removed 1 week postoperatively, and the resin-wire splint was maintained for 2 weeks.

Outcome Assessment

Patients were usually followed up at 1, 3, and 6 months and then every 6 months after the surgery. Subjective symptoms were recorded, and clinical and radiographic examinations were conducted, including mobility and percussion tests, periodontal probing, and bite tests. Periapical radiographs were acquired and evaluated by 2 blinded independent examiners. Based on these examinations, the following 3 types of outcomes were assessed: tooth survival, IRR, and ankylosis. The "event" in each outcome was defined as follows:

1. *Tooth survival:* Any signs and/or symptoms that severely impede normal masticatory function of the autotransplanted tooth, such as excessive mobility (horizontal movement exceeds 2 mm or any vertical movement) because of periodontal bone loss or IRR and persistent pain on mastication, were considered as treatment failure, and the tooth was planned for extraction. Radiographic findings that were not associated with the impairment of normal masticatory function, such as mild to moderate periodontal bone loss, limited root resorption, and ankylosis, were not considered as treatment failure (Fig. 1*A–C*). The date of the event corresponds to the date when treatment failure was diagnosed.
2. *IRR:* Progressive root resorption accompanying an adjacent radiolucency in the bone on a periapical radiograph was considered to represent IRR (16) (Fig. 1*D–F*). The date of the event corresponds to the date when IRR was diagnosed.