Prognostic Factors Relating to the Outcome of Endodontic Microsurgery

Jeen-Nee Lui, BDS, MDS, MRD RCSEdin,[*] Ma-Ma Khin, BDS, MDS, MRD RCSEdin,[†] Gita Krishnaswamy, MS, MEng,[‡] and Nah-Nah Chen, BDS, MDS, MS[*]

Abstract

Introduction: The aim of this retrospective study was to evaluate the outcome of endodontic microsurgery and to examine prognostic factors related to healing. **Methods:** The clinical records of all patients who had undergone endodontic microsurgery from 1997–2003 at the National Dental Centre of Singapore were examined. Teeth with a recall period of 1–2 years were selected. All surgical procedures, except for flap raising and suturing, were performed under a surgical operating microscope. Root-end cavities prepared with ultrasonic tips were filled with Intermediate Restorative Material (Caulk, Milford, DE) or mineral trioxide aggregate. Teeth were evaluated for clinical signs and symptoms after surgery. Preoperative and postoperative radiographs were evaluated independently by 2 endodontists. **Results:** Of 243 root-end surgeries performed, 93 were eligible for the study. Outcomes were categorized as healed, healing, or persistent disease; 78.5% of teeth were assessed to be healed or healing, and 21.5% had persistent disease. The percentages of healed and healing teeth for anterior and posterior root-end surgeries were 76.5% and 80.4%, respectively, with no significant difference in the procedures ($P = .8$). Ordinal logistic regression showed a higher likelihood of healing in females compared with males ($P = .001$) and maxillary anterior teeth compared with mandibular anterior teeth ($P = .03$). Preoperative probing depths of $\leq$3 mm were significantly associated with healing ($P = .05$). **Conclusions:** The use of modern endodontic surgical techniques resulted in 78.5% healed and healing teeth with a recall period of 1–2 years. Prognostic factors affecting successful healing include sex, tooth type, and preoperative probing depths. *(J Endod 2014;40:1071–1076)*

Key Words

Endodontic microsurgery, outcome, prognostic factor, root-end surgery, surgical operating microscope

From the *Department of Restorative Dentistry, National Dental Centre of Singapore; †Dental Department, Khoo Teck Puat Hospital; and ‡Centre for Quantitative Medicine, Duke--NUS Graduate Medical School, Singapore.

Address requests for reprints to Dr Jeen-Nee Lui, 5 Second Hospital Avenue, Singapore 168938. E-mail address: lui.jeen.nee@ndcs.com.sg

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Endodontic surgery is performed to eradicate periapical pathology when conventional endodontic treatment or retreatment is considered not feasible or has resulted in failure. The literature on the success and failure of conventional endodontic surgery (1–4) reported success rates varying from 25%–90%. Such a disparity has been explained by differences in study design, sample size, selection criteria, period of recall, and healing criteria.

In the past, because of ease of access and better visibility, anterior teeth and premolars were more commonly treated with endodontic surgery compared with molars. This changed with the advent of the surgical operating microscope (SOM) in the early 1990s (5). The use of the SOM, ultrasonics, and microsurgical instruments now improve access to previously inaccessible areas of the mouth. The traditional use of amalgam as a root-end filling material for endodontic surgery has also been superseded with newer materials, such as Super EBA, Intermediate Restorative Material (IRM) (Caulk, Milford, DE), and mineral trioxide aggregate (MTA). When patients with amalgam root-end fillings and clinically healed lesions were recalled after 10 years, the percentage of healed lesions declined to 57.7% (4). The authors of this study could not determine if the unexpectedly high failure rate after 10 years was caused by the use of amalgam as a root-end filling material or the use of conventional surgical techniques. Both Super EBA and IRM were found to be superior to amalgam when used as a root-end filling material (3), whereas MTA was found to be as effective as IRM (6, 7).

Modern endodontic surgical techniques using the SOM, ultrasonic tips, and IRM or MTA as root-end filling materials reported success rates of 89% (8), which is a marked improvement compared with conventional endodontic surgery. Since the adoption of modern endodontic surgical techniques and materials in our institution from 1997, continued monitoring of surgical outcomes is important for quality assurance. The aim of this retrospective study was to determine the success rate of endodontic microsurgery performed over a 6-year period from 1997–2003. The association between healing and other variables was also evaluated.

Materials and Methods

Case Selection

Clinical records of all patients who had undergone an endodontic microsurgery over a 6-year period (January 1997–December 2003) at the National Dental Centre of Singapore were examined. All teeth had been assessed before surgery by endodontists for adequacy of previous root canal treatment and necessity for endodontic microsurgery. Anterior and posterior permanent teeth with a recall period after surgery of between 1 and 2 years were selected for this study. Teeth with previous root-end surgery, vertical root fractures, root resorption, and perforations were excluded.

Surgical Technique

Surgical procedures were performed using an SOM (Carl Zeiss, Oberkochen, Germany) with magnification of 10×–26.6×. Microsurgical techniques were used throughout the root-end surgeries, including osteotomies, root-end resections, root inspections, root-end preparations, and root-end fillings. Medium magnifications (10×–17×) were used for most procedures except for root inspections, which were performed under high magnification (20×–26.6×). Incisions, elevation of flaps, suturing, and suture removals were not performed under the microscope.

Triangular flaps with intrasulcular incisions were made, and osteotomies to remove bone overlying the root apices were performed using a small round bur mounted in a straight handpiece. Periapical granulation tissues were curetted and sent for biopsy. Roots were resected at 0- or near 0-degree bevels; the resected surface and external root surfaces were then examined to check for the extent of buccolingual boundaries of the root canal system and the presence of cracks, lateral canals, missed canals, and isthmuses. When detected intraoperatively, all cracks were removed by root resection. If the crack could not be removed completely without compromising retention of the tooth, the surgery was abandoned, and an extraction was indicated instead. If an isthmus was present between the root canals, the root-end preparation was expanded to include the isthmus.

Root-end preparations were performed with surgical ultrasonic tips in a piezoelectric ultrasonic unit (Satelac; Suprasson, Merignac, France). Micromirrors were used to examine root surfaces for adequacy of root-end preparations. Hemostasis of bony crypts was achieved by inserting pieces of dry gauze or cotton pellet into crypts and applying pressure for about 3 minutes. Occasionally, hemostatic agents such as ferric sulfate or Surgicel (Johnson & Johnson Medical, North Yorkshire, UK) were used, and care was taken to remove them completely before surgery completion. Root-end preparations were dried with paper points.

IRM or MTA (Dentsply, Tulsa, OK) was used as a root-end filling material mixed according to manufacturers' instructions and inserted with MTA carriers. Root-end preparations were filled and condensed, and excesses were carefully wiped off using moist cotton pellets. Bony crypts were examined and cleansed before flap replacement. If complete buccal bony dehiscence was present, a resorbable collagen membrane (BioMend; Zimmer Dental, Carlsbad, CA) was placed over the periapical bone defect and the exposed buccal root surface before flap replacement. Coronally, membranes were positioned at the cementoenamel junction, whereas apically and laterally, membranes overlapped defect margins by about 2 mm. No tacks or pins were used for membrane stabilization. If there was inadequate membrane stability, augmentation with inorganic bovine bone material (BioOss; Geistlich Biomaterials, Wolhusen, Switzerland) was performed before membrane placement; 4/0 black silk sutures were used to secure flaps.

Patients were usually seen for suture removal after 5 days. Periapical radiographs were taken on surgery completion and every 6 months subsequently. Teeth were evaluated for clinical signs and symptoms at each postsurgery visit, and the findings were recorded on a data collection form.

Radiographic Evaluation

Preoperative and postoperative radiographs were evaluated independently by 2 endodontists (MMK and NNC) in a blinded manner. The evaluators were precalibrated 1 week before the evaluations by performing assessments for 10% of the radiographs and discussing evaluations until an agreement was reached. When there was disagreement with the final evaluations, a third endodontist's evaluation was sought, and differences in interpretation were re-evaluated until an agreement was reached.

The roots of posterior teeth were evaluated as individual units if there was a clear and distinct separation between the roots. If an isthmus was present between roots and the root-end preparation expanded to include the isthmus, the tooth was assessed as a single unit.

Radiographic interpretation was assessed using criteria established by Rud et al (9) and classified into the following categories (Figs. 1–4):

1. *Complete healing:* Reformation of an intact lamina dura around the root
2. *Incomplete healing:* Rarefaction has either decreased in size or remained stationary. Bone structures may be present within the rarefaction. The rarefaction is irregular in shape and may be located asymmetrically around the root apex. An isolated rarefaction (scar tissue) may be present in the bone
3. *Uncertain healing:* Rarefaction has decreased in size. The rarefaction is circular in shape and is located symmetrically around the root apex
4. *Unsatisfactory healing:* Rarefaction has increased in size

Outcome Assessment

After clinical and radiographic evaluation, outcomes of the cases were grouped into the following 3 categories using criteria proposed by Friedman (10):

1. *Healed:* Absence of clinical signs and symptoms and radiographic classification of complete healing or incomplete healing (scar tissue)
2. *Healing:* Absence of clinical signs and symptoms and radiographic classification of uncertain healing
3. *Persistent disease:* The presence of clinical signs and symptoms and/or radiographic classification of unsatisfactory healing

Statistical Analysis

A univariate description with percentage frequencies was generated to characterize the study material. For statistical analysis of prognostic factors, the dependent variable was the healing outcome. Associations between outcome and key variables were examined by bivariate analyses using Fisher exact tests and interpreted at the significance level of 0.15 to identify factors to be included in multivariable analysis. The following variables were considered:

1. Demographics (ie, age, sex, and tooth type)
2. Preoperative variables (ie, type of coronal restoration, presence of post, probing depths $\leq$3 mm, mobility, sinus tract, swelling, percussion and palpation tenderness, and size of radiographic periapical lesion)
3. Intraoperative variables (ie, cortical bone fenestration, dehiscence, crack, isthmus, type of root-end filling material, and use of membranes)
4. Histology results

Stepwise multivariable ordinal logistic regression with the included variables was used to identify potential adjusted prognostic factors. The level of significance was set at 0.15 for entry into the regression model and 0.10 to stay in consideration of the relatively small sample size and type II error to allow variables near significance to enter the model. All statistical analyses were 2-tailed and performed with SAS software (version 9.2; SAS Institute, Chicago, IL).

Results

Of the 243 patients who had undergone an endodontic microsurgery during the study period, the following exclusions were made: teeth with vertical root fractures (1.2%), root resorption (1.2%), and perforations (1.6%); teeth with previous apical surgery (15%); and teeth not in the recall period after surgery of 1–2 years (43%).

Finally, 93 teeth (38%) were eligible for the study and subjected to further analysis. A univariate description of patient characteristics and preoperative, intraoperative, and postoperative evaluation factors for the 93 teeth is summarized in Table 1.

The percentage of teeth assessed as healed, healing, and with persistent disease were 71%, 7.5%, and 21.5%, respectively. The percentages of healed and healing teeth combined for anterior and posterior apical surgeries were 76.5% and 80.4%, respectively, with no significant association in outcomes and procedures detected using the Fisher exact test (P = .8) (Table 2).