

# Outcome of Endodontic Surgery: A Meta-analysis of the Literature—Part 3: Comparison of Endodontic Microsurgical Techniques with 2 Different Root-end Filling Materials

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## Abstract

**Introduction:** The aim of the present study was to investigate the influence of root-end preparation and filling material on endodontic surgery outcome. A systematic review and meta-analysis was conducted to determine the outcome of resin-based endodontic surgery (RES, the use of high-magnification preparation of a shallow and concave root-end cavity and bonded resin-based root-end filling material) versus endodontic microsurgery (EMS, the use of high-magnification ultrasonic root-end preparation and root-end filling with SuperEBA [Keystone Industries, Gibbstown, NJ], IRM [Dentsply Sirona, York, PA], mineral trioxide aggregate [MTA], or other calcium silicate cements).

**Methods:** An exhaustive literature search was conducted to identify prognostic studies on the outcome of root-end surgery. Human studies conducted from 1966 to the end of December 2016 in 5 different languages (ie, English, French, German, Italian, and Spanish) were searched in 4 electronic databases (ie, Medline, Embase, PubMed, and Cochrane Library). Relevant review articles on the subject were scrutinized for cross-references. In addition, 5 dental and medical journals (*Journal of Endodontics*; *International Endodontic Journal*; *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics*; *Journal of Oral and Maxillofacial Surgery*; and *International Journal of Oral and Maxillofacial Surgery*) were hand checked dating back to 1975. All abstracts were screened by 3 independent reviewers (H.B., M.K., and F.S.). Strict inclusion-exclusion criteria were defined to identify relevant articles. Raw data were extracted from the full-text review of these selected articles independently by each of the 3 reviewers. In case of disagreement, an agreement was reached by discussion, and qualifying articles were assigned to

group RES. For EMS, the same search strategy was performed for the time frame October 2009 to December 2016, whereas up to October 2009 the data were obtained from a previous systematic review with identical criteria and search strategy. Weighted pooled success rates and a relative risk assessment between RES and EMS were calculated. To make a comparison between groups, a random effects model was used. **Results:** Sixty-eight articles were eligible for full-text review. Of these, per strict inclusion exclusion criteria, 14 studies qualified, 3 for RES ( $n = 862$ ) and 11 for EMS ( $n = 915$ ). Weighted pooled success rates for RES were 82.20% (95% confidence interval [CI], 0.7965–0.8476) and 94.42% for EMS (95% CI, 0.9295–0.9590). This difference was statistically significant ( $P < .0005$ ). **Conclusions:** The probability for success for EMS proved to be significantly greater than the probability for success for RES, providing best available evidence on the influence of cavity preparation with ultrasonic tips and/or SuperEBA (Keystone Industries, Gibbstown, NJ), IRM (Dentsply Sirona, York, PA), MTA, or silicate cements as root-end filling material instead of a shallow cavity preparation and placement of a resin-based material. Additional large-scale randomized clinical trials are needed to assess other predictors of outcome. (*J Endod* 2018; ■:1–9)

## Key Words

Apicoectomy, calcium silicate cements, endodontic microsurgery, IRM, meta-analysis, mineral trioxide aggregate, outcome, resin, Retroplast, root-end filling, root-end surgery, success, SuperEBA, systematic review

Endodontic root-end surgery is a procedure indicated for the treatment of nonhealing apical periodontitis after nonsurgical retreatment or, in certain situations, primary endodontic therapy (1). The procedure can address both intracanal and extraradicular infections that

may have contributed to the negative outcome of the previous treatment. Over the course of time, there have been remarkable variations in the execution of endodontic

## Significance

Endodontic microsurgery with the use of high-magnification ultrasonic root-end preparation and root-end filling with SuperEBA, IRM, or MTA (silicate cements) has a higher probability of success than resin-based endodontic surgery with the use of high-magnification preparation of a shallow concave root-end cavity filled with bonded resin-based materials.

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## Review Article

surgery. *Apicoectomy* was the classic term applied to the procedure, which may or may not have included the preparation and filling of the root-end cavity. *Root-end surgery* is the current terminology used in the American Association of Endodontics *Glossary of Endodontic Terms* that addresses endodontic surgery using contemporary techniques, involving root-end preparation and root-end filling, or other methods of retrograde sealing of the apically resected root surface.

Various studies have described the outcome of endodontic surgery irrespective of the techniques used (2–4). However, when cumulative success rates were calculated depending on the surgical technique, variations in outcomes become obvious. For the modern technique, Tsesis et al (2009/2013) (3, 5) published 2 meta-analyses on the outcome of endodontic surgery that used IRM, mineral trioxide aggregate (MTA), or SuperEBA as root-end filling materials; ultrasonic root-end preparation; and dental microscopes, endoscopes, or loupes for visualization and magnification. The cumulative success rates were 91.9% (3) and 89.0% (5), respectively. In a 2-part investigation, Setzer et al (6, 7) strictly defined endodontic microsurgery (EMS) as a microsurgical approach to endodontic surgery using ultrasonic root-end preparation; root-end filling with IRM, SuperEBA, or MTA (calcium silicate cements); and the application of high-power magnification >10× with a dental operating microscope or an endoscope. The first study compared EMS with traditional root-end surgery (TRS) using conventional burs for root-end preparation and amalgam root-end fillings without the application of magnification devices (7). The second meta-analysis (6) compared EMS with contemporary root-end surgery (CRS), which is identical to EMS, however, without the use of high-power magnification, relying only on loupes or no magnification. Weighted pooled success rates from 9 studies for EMS were calculated to be 93.5% (95% confidence interval [CI], 0.8889–0.9816;  $n = 699$  teeth), 88% for CRS from 7 studies (95% CI, 0.8455–0.9164,  $n = 610$ ), and 59% for TRS from 12 studies (95% CI, 0.55–0.6308,  $n = 925$ ) from 12 studies. The differences between EMS and TRS as well as between EMS and CRS were statistically significant. Relative risk ratio analyses showed that the probability of success for EMS was 1.58 times the probability of success for TRS and 1.07 times the probability of success for CRS, the latter providing the best available evidence for the improvement of outcome in endodontic surgery using high-power magnification over loupes or the naked eye.

Another method of the bonded resin-based endodontic surgery (RES) to seal the root end after root resection was first described in the literature by Rud et al (1991) (8) and more recently by von Arx et al (2010) (9). Briefly, while using a microscope or endoscope for the technical steps of the surgical procedure, the procedure differs significantly from EMS by using a round bur to create a concave cavity over the entire resected root surface instead of an ultrasonically prepared axial root-end cavity within the root canal, and after etching with EDTA, a bonded resin material (eg, Retroplast [Retroplast Trading, Rorvig, Denmark] or Geristore [Den-Mat, Santa Maria, CA]) is placed in a domelike fashion over the entire resected root surface instead of IRM, SuperEBA, or calcium silicate cements. Although this technique has been repeatedly described in the context of modern endodontic surgery, so far no cumulative success rate or relative risk assessment in comparison with other techniques has been described in the literature.

The primary aim of this systematic review and meta-analysis was to assess the cumulative success rate of contemporary RES and to test the hypothesis that there was no significant difference in the outcome in comparison with EMS. Considering several recent publications, the secondary aim of this investigation was to provide an update on the expected outcome of EMS.

## Materials and Methods

In order to control the methodologic quality and reporting bias, the AMSTAR (A MeaSurement Tool to Assess Systematic Reviews) tool was reviewed (10) and the Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) Protocols checklist (11) addressed. A provision for an a priori design was formulated to reduce publication bias and create a transparent search process. Using the PICO (Population, Intervention, Comparison, Outcome) format, the following research question was formulated: Teeth that have undergone a root-end surgery and root-end filling procedure (population) by EMS (intervention) compared with RES (comparison) have what expected probability of success according to longitudinal studies with strictly defined inclusion and exclusion criteria (outcome)?

## Identification of Studies

The materials and methods for this investigation are detailed in part 1 and 2 of this publication for EMS (6, 7). To reiterate briefly, 4 electronic databases were searched for surgical prognosis-related studies. The terms [(apicoectomy OR apicectomy OR root-end filling OR root-end surgery OR retro-grade filling OR retro-grade surgery OR periapical surgery OR periradicular surgery OR surgical endodontic treatment OR apical microsurgery) AND (success OR treatment outcome)] was applied for the EMS group, and the terms [(endodontics) AND (retroplast)] was applied for RES to search the Medline, Embase, PubMed, and Cochrane Library databases. Studies were limited to human subjects and publication in any of the 5 languages (English, French, German, Italian, and Spanish). The previous identical search for EMS for the time frame 1966 to the second week of October 2009 was performed and combined with a new search starting the second week of October 2009 to the end of December 2016. The electronic database search for RES covered the time frame from 1966 to the end of December 2016. Five relevant scientific journals (*Journal of Endodontics*; *International Endodontic Journal*; *Oral Surgery*, *Oral Medicine*, *Oral Pathology*, *Oral Radiology*, and *Endodontics*; *Journal of Oral and Maxillofacial Surgery*; and *International Journal of Oral and Maxillofacial Surgery*) were hand searched back to 1975. Three independent reviewers (H.B., M.K., and F.S.) screened the identified titles and abstracts for inclusion or exclusion from the study. In situations of disagreement or uncertainty about the relevance of the article, a consensus was reached by discussion. Full articles were obtained for titles wherein the abstract did not provide adequate information to help make a decision. The references of all these articles were searched for cross-references, and the additional abstracts were subjected to the same reviewing process. Three experts in the field were contacted to reveal possible gray literature in the form of ongoing studies or consensus reports by major endodontic societies.

## Inclusion and Exclusion Criteria

The selection of studies was based on the following inclusion criteria, which were modified from and defined in part 2 of the meta-analysis (6):

1. Clinical study on root-end surgery
2. Sample size given
3. A minimum follow-up period of 1 year
4. Success and failure were evaluated using Rud et al's (12) or Molven et al's (13) radiographic parameters and clinical assessment. Radiographically, success was defined as either complete or incomplete healing (scar tissue formation) and clinically by the absence of pain, swelling, percussion sensitivity, or sinus tracts.

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