

Outcome of Endodontic Surgery: A Meta-analysis of the Literature—Part 1: Comparison of Traditional Root-end Surgery and Endodontic Microsurgery

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Abstract

Introduction: The aim of this study was to investigate the outcome of root-end surgery. The specific outcome of traditional root-end surgery (TRS) versus endodontic microsurgery (EMS) and the probability of success for comparison of the 2 techniques were determined by means of meta-analysis and systematic review of the literature. **Methods:** An intensive search of the literature was conducted to identify longitudinal studies evaluating the outcome of root-end surgery. Three electronic databases (Medline, Embase, and PubMed) were searched to identify human studies from 1966 to October 2009 in 5 different languages (English, French, German, Italian, and Spanish). Relevant articles and review papers were searched for cross-references. Five pertinent journals (*Journal of Endodontics*, *International Endodontic Journal*, *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics*, *Journal of Oral and Maxillofacial Surgery*, *International Journal of Oral and Maxillofacial Surgery*) were individually searched back to 1975. Three independent reviewers (S.S., M.K., and F.S.) assessed the abstracts of all articles that were found according to predefined inclusion and exclusion criteria. Relevant articles were acquired in full-text form, and raw data were extracted independently by each reviewer. Qualifying papers were assigned to group TRS or group EMS. Weighted pooled success rates and relative risk assessment between TRS and EMS were calculated. A comparison between the groups was made by using a random effects model. **Results:** Ninety-eight articles were identified and obtained for final analysis. In total, 21 studies qualified (12 for TRS [n = 925] and 9 for EMS [n = 699]) according to the inclusion and exclusion criteria. Weighted pooled success rates calculated from extracted raw data showed 59% positive outcome for TRS (95% confidence interval, 0.55–0.6308) and 94% for EMS (95% confidence interval, 0.8889–0.9816). This difference was statistically significant ($P < .0005$). The relative risk ratio

showed that the probability of success for EMS was 1.58 times the probability of success for TRS. **Conclusions:** The use of microsurgical techniques is superior in achieving predictably high success rates for root-end surgery when compared with traditional techniques (*J Endod* 2010;36:1757–1765)

Key Words

Amalgam, apicoectomy, endodontic microsurgery, IRM, meta-analysis, MTA, outcome, root-end surgery, success, SuperEBA, systematic review

Endodontic surgery is a dental procedure to treat apical periodontitis in cases that did not heal after nonsurgical retreatment or, in certain instances, primary root canal therapy (1). This might include situations with persistent or refractory intracanal infection after iatrogenic changes to the original canal anatomy (2) or microorganism in proximity of the constriction (3) and the apical foramen (4). Other reasons might be found in extraradicular infection, such as bacterial plaque on the apical root surface (5) or bacteria within the lesion itself (6–9).

Few dental techniques have been substantially transformed as has endodontic surgery. Various techniques were suggested to make the procedure easier to execute, safer for the patient, and more predictable (10). For many years, the state of the art was the traditional approach with surgical burs and amalgam for root-end filling (11–13). Modern techniques incorporate the use of ultrasonic tips and more biocompatible filling materials such as intermediate restorative material (IRM), SuperEBA, and mineral trioxide aggregate (MTA) (14). Endodontic microsurgery (EMS) is the most recent step in the evolution of periradicular surgery, applying not only modern ultrasonic preparation and filling materials but also incorporating microsurgical instruments, high-power magnification and illumination (15).

Although many studies have been published that advocate the use of modern approaches, the traditional techniques are still widely used in the oral surgery and maxillofacial surgery community, and the success rates of modern techniques are debated (16, 17). In 2008, a survey from the Netherlands reported the use of amalgam by oral surgeons as a root-end filling material at 35%, second only to IRM (18). MTA was only used in 2.6%, although it was recommended as the most biocompatible root-end filling material available to date (15, 19). Several reviews and meta-analyses were published on the outcome of endodontic surgery, but they failed to identify cumulative success rates for different techniques (10, 14, 20). One recent meta-analysis addressed the outcome of endodontic surgery with ultrasonic root-end preparation and modern filling materials, but it did not clearly distinguish between

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TABLE 1. Studies Included in the Meta-analysis

Study	Group	Language	Sample size	Follow-up (months)	Magnification	Root-end preparation
Finne et al, 1977 (89)	TRS	English	116	36	None	Bur
Hirsch et al, 1979 (99)	TRS	English	77	6–12	None	Bur
Malmström et al, 1982 (97)	TRS	English	78	6–12	None	Bur
Mikkonen et al, 1983 (87)	TRS	English	12	12–24	None	Bur
Forssell et al, 1988 (96)	TRS	English	44	12–48	None	Bur
Dorn and Gartner, 1990 (49)	TRS	English	294	6–120	None	Bur
Rapp et al, 1991 (45)	TRS	English	120	6	None	Bur
Zetterqvist et al, 1991 (47)	TRS	English	52	12	None	Bur
Pantschev et al, 1994 (61)	TRS	English	52	36	None	Bur
Jesslen et al, 1995 (42)	TRS	English	41	60	None	Bur
August, 1996 (40)	TRS	English	16	120–276	None	Bur
Schwartz-Arad et al, 2003 (58)	TRS	English	23	6–45	None	Bur
Rubinstein and Kim, 1999 (85)	EMS	English	94	14	Microscope	Ultrasonic
Von Arx et al, 2003 (35)	EMS	German	54	12	Endoscope	Ultrasonic
Chong et al, 2003 (36)	EMS	English	108	24	Microscope	Ultrasonic
Taschieri et al, 2005 (34)	EMS	English	28	12	Endoscope	Ultrasonic
Filippi et al, 2006 (31)	EMS	German	103	12	Endoscope	Ultrasonic
Taschieri et al, 2006 (32)	EMS	English	39	12	Endoscope	Ultrasonic
Taschieri et al, 2008 (26)	EMS	English	100	24	Endoscope /Microscope	Ultrasonic
Kim et al, 2008 (28)	EMS	English	148	12–60	Microscope	Ultrasonic
Christiansen et al, 2009 (70)	EMS	English	25	12	Microscope	Ultrasonic

studies that apply high-power magnification for the surgical procedure and those that did not (14).

To date, no study has established cumulative success rates for either the traditional or contemporary non-microsurgical or truly microsurgical techniques. To make an informed decision for clinical care, the highest evidence for any kind of treatment is desirable (21). If microsurgical endodontic surgery techniques do provide a better prognosis than traditional or non-microsurgical approaches, then the differences in outcome, as well as the probability for success, by comparing these techniques must be demonstrated to facilitate that decision for the better of the patient. Randomized controlled trials are seen as the gold standard but are either not available to support all medical or dental interventions (22) or might be deemed unethical because of current knowledge. Therefore, the best available evidence has to substitute in these situations (22). The aim of this systematic review was to provide the best available evidence in the absence of high level studies. A meticulous meta-analysis of the literature was undertaken for 5 languages to incorporate a large quantity of available information by raw data extraction and subsequent statistical analysis. The results of this investigation will be presented in 2 parts. The aims of the first part of this paper are to present and compare weighted pooled success rates and relative risk ratios for traditional root-end surgery (TRS) and EMS and to discuss the impact of these findings on the different specialties in the dental community. Part two will compare contemporary non-microsurgical techniques and EMS, the influence of the tooth type on the probability of success, and discuss this outcome in relation to the impact of microscopic dentistry in general and for the specialty of endodontics.

Materials and Methods

Before the literature search, a research question was defined according to the paradigm of evidence-based dentistry, following the Population, Intervention, Comparison, Outcome (PICO) format: “Teeth that have undergone a root-end surgery and root-end filling procedure (Population) by endodontic microsurgery (EMS) (Intervention) compared to traditional root-end surgery (TRS) (Comparison) have what expected probability of success according to longitudinal studies with strictly defined inclusion and exclusion criteria (Outcome)?”

Identification of Studies

Three electronic databases were searched for topic-related studies, regardless of the publication type. The term [(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 to search the Medline, Embase, and PubMed databases. Limits were studies on human subjects and publication in any of the 5 languages (English, French, German, Italian, and Spanish). The electronic database search covered the time frame from 1966 to the second week of October 2009. For the articles resulting from PubMed, the related articles search was conducted as well. 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*, *International Journal of Oral and Maxillofacial Surgery*) were hand-searched back to 1975. All resulting titles and abstracts were individually screened by 3 independent reviewers (S.S., M.K., and F.S.) for relevance of the topic: if they were definitely to be excluded, included, or a conclusion was not possible from the title or even the abstract. In situations where no agreement was reached by independent abstract review, a final agreement was reached by discussion until a consensus was reached. Full articles were obtained by electronic or traditional search methods for all review articles, relevant titles, and all articles where no conclusion was possible from reading the abstract. The references of all these articles were searched for cross-references that had not been found before, and the additional abstracts were subjected to the same reviewing process. Three experts in the field were contacted to reveal possible gray literature in form of ongoing studies or consensus reports by the major endodontic societies.

Inclusion and Exclusion Criteria

The selection of studies was based on the following inclusion criteria:

1. Clinical study on root-end surgery.
2. Sample size given.

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