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## A prospective cohort study of endodontic treatments of 1,369 root canals: results after 5 years

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**Objective.** The purpose of this prospective study was: 1) to follow-up a large number of endodontic treatments performed by a single operator, periodically checked over a 5-year period; and 2) to correlate outcome to a number of clinical variables.

**Study design.** This prospective study included all consecutive cases during the selected time period. All cases were followed regularly for a 5-year period. At the 5-year end point of the study, 470 patients with 816 treated teeth and with 1,369 treated root canals were available for evaluation.

**Results.** The overall rate of success among the 816 teeth/1,369 root canals available for evaluation was 88.6%/90.3%. The success rate for 435 teeth/793 root canals undergoing vital pulp therapy was 91.5%/93.1%. Teeth/root canals with necrotic pulp but without detectable periapical bone lesion were successfully treated in 89.5%/92.3%. If the pulp necrosis was complicated by apical periodontitis, the success rate fell to 82.7% for the teeth and 84.1% for the root canals ( $P = .037$ ). Teeth with periapical lesion  $<5$  mm had a success rate of 86.6%, and in cases where the lesion was  $\geq 5$  mm the rate of success was 78.2%.

**Conclusions.** More severe disease conditions negatively affects outcome. An optimal working length was identified. Excess of root canal filling material decreases success. Infected pulp space should be treated with an effective intracanal dressing. The quality of the coronal restoration or the placement of intracanal post retentions does not affect treatment outcome. (*Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2011;112:825-842)

Outcome of endodontic treatment has been the subject of many studies. Although some prognosis studies of endodontically treated teeth were conducted in the first half of the last century<sup>1-6</sup> the first comprehensive follow-up study was published by Strindberg in 1956.<sup>7</sup> In that study, performed on 775 endodontically treated roots—some radiographically followed for up to 10 years—he suggested a model for prospective clinical/radiologic cohort prognosis studies. A number of factors influencing the result of endodontic therapy were defined. Some of the most meaningful factors were the presence of resorbing apical periodontitis and the apical limit of the root canal filling.

That study model has since been used as a model for a number of outcome studies. Presently, it is widely accepted that one of the most important factors influencing the outcome of endodontic treatment is the preoperative status of the pulp space, including the presence or absence of a radiographically detectable periapical bone lesion.<sup>8-19</sup> It was generally observed that teeth, where the pulp was vital, had a higher rate of successful treatment than when the disease of the pulp tissue had progressed and resulted in an apical periodontitis. Some studies also reported findings where an increased radiographic size of the periapical lesion had a negative effect on the treatment outcome.<sup>10,12,15,18</sup> Other studies, however, do not support that concept.<sup>7,16</sup> Studies with longer observation periods have reported that the preoperative size of the lesions had little influence on the outcome of endodontic treatment, because larger periapical lesions tend to heal at a slower rate.<sup>7</sup> In later studies, the microbiologic status of the pulp space has been added to the list of important outcome factors.<sup>8-19</sup>

Although the results of many of these well designed and executed outcome studies provide consistent information to guide good patient care, there is still much disagreement on treatment protocols, often based on little or no documented evidence. Examples of such

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factors of disagreement are the effect of preoperative apical periodontitis and the need for comprehensive pulp space disinfection, including working area asepsis. Optimal working length is also intensively debated.

Since Strindberg's classical outcome study,<sup>7</sup> there has been no sufficiently powered randomized prospective comprehensive study published of endodontic treatment outcome based on contemporary treatment principles. There are a few, often cited, outcome studies focusing on the issue of single- or multivisit treatment of teeth with apical periodontitis.<sup>20-23</sup> Those studies are, however, underpowered and poorly randomized. Unfortunately, they are repeatedly used in systematic reviews and attempts to undertake meta-analysis,<sup>24,25</sup> resulting in spurious information.<sup>26</sup>

Lacking valid and relevant randomized controlled prospective clinical studies on endodontic treatment outcome, there is, however, substantial information to be gleaned from several prospective cohort studies published during the past 50 years.<sup>7,10,14,16,27-31</sup> The clinical work in many of those studies is, however, done by multiple operators or at trainee levels. The only cohort study executed by 1 single trained operator is now >55 years old.<sup>7</sup> Many instruments, materials, and treatment procedures have changed since the 1940s, and there is a need for additional information on a controlled large patient material.

The purpose of the present prospective study was: 1) to follow a large number of endodontic treatments performed by a single operator, periodically checked over a 5-year period; and 2) to correlate outcome to a number of clinical variables.

## MATERIALS AND METHODS

### Patient material

All patients received conventional therapeutic endodontic treatment by a general dentist with special interest in endodontics. The cases were consecutive during the selected time period. All treated cases were followed for postoperative development. For the study reported here, all patients that were followed regularly and had a 5-year follow-up visit were included. This group comprised a total of 780 patients who fulfilled the inclusion criteria. At the 5-year end point of the study, 470 patients with 816 treated teeth and with 1,369 treated root canals were available for evaluation. All treatment was provided by 1 operator (D.R.) using a standardized treatment protocol. Consent to treat was obtained from each of the patients in the study.

### Treatment procedures

All clinical signs and symptoms, such as spontaneous or provoked pain, swelling, presence of sinus tract,

and tenderness to percussion and palpation, were recorded. The periodontal condition of the tooth (mobility, gingival pocket depths) and the presence of carious lesions and/or previous restorations also were recorded. At least 1 diagnostic radiogram was exposed and a diagnosis established. The pulp diagnosis of "vital" or "necrotic" was made on the basis of the observation of continuous blood-filled pulp tissue in the root canal orifice(s), regardless of the clinical appearance of the tissue contained in the pulp chamber.

All endodontic treatments were performed using a strict aseptic technique. The tooth was first scaled with ultrasound and/or curettes, followed by plaque removal from the tooth/root surface with pumice and rubber cups. Restorations in connection with the access opening were removed. After rubber dam isolation, the treatment field (tooth, rubber dam, and clamp) was disinfected with 30% H<sub>2</sub>O<sub>2</sub> and 5% tincture of iodine.<sup>32</sup>

Working length was established at the apical constriction with the help of an electronic apex locator and confirmed with radiographs. An effort was made to machine an "apical box" to snugly hold a gutta-percha master cone of appropriate size. After an adequate preflaring of the coronal two-thirds of the root canal with Gates-Glidden burs and hand instruments (Hedström files), the apical third was instrumented by hand instruments (Hedström and Kerr files) using the "step-back" technique. Irrigation was frequently made using copious amounts of 1% sodium hypochlorite with a minimum-size needle (NaviTip; Ultradent, South Jordan, UT, USA). No other chemical treatment of the root canals was attempted.

The treatments were normally completed in 2 visits. However, in 38% of the teeth with vital pulp and in 18% of teeth with necrotic pulp and no apical periodontitis, the treatment was completed in 1 treatment sequence.

An intracanal antimicrobial dressing was placed in teeth undergoing multivisit treatment. Slurry of calcium hydroxide, applied with a Lentulo spiral, was used in most cases. In some cases, instead of the calcium hydroxide, a small amount of metacresylacetate (Cresatina; Ogna, Muggiò, Italy), applied on a cotton pellet, was deposited in the pulp chamber. In a few cases, iodoform (Pasta Iodoformica Radiopaca; Ogna) was applied.

The root canals were filled with laterally compacted gutta-percha and a sealer. Different sealers, such as AH26 (De Trey Frères, Zürich, Switzerland), Bioseal (Ogna), Pulp Canal Sealer (Sybron Dental, Orange, CA, USA), Tubliseal (Sybron Dental), Apexit (Ivoclar Vivadent, Schaan, Lichtenstein), Mynol (Hygienic, Akron, OH, USA), and Endomethasone (Septodont, Saint-Maur-des-Fossés, France), were used randomly.

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