# Radiographic Evaluation of Teeth Treated Endodontically with Resilon Root Filling

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## Abstract

The purpose of this study was to evaluate clinical outcomes with the use of Resilon™ root filling in private endodontic practice. This study compared immediate post-operative (IPO) radiographs with at least one year post-treatment, follow up (F) radiographs from 70 randomly selected private practice primary endodontic cases, treated according to a non-standardized protocol but root-filled with Resilon.™ Two methods of quantification were used: the Periapical Index (PAI); and the Clinical Impression of Healing (CIH). PAI results determined 84.3% of teeth healed or were healing overall while in the CIH 90.9% demonstrated progressive healing. The findings of this study support the contention that, regardless of treatment protocol, healing rates for Resilon™ filled teeth in private practice were within the range of success rates for studies using preselected teeth and uniform treatment techniques mostly in University settings with gutta percha root filling.

## Introduction

The field of endodontics focuses on the prevention and/or elimination of apical periodontitis, and treatment consists of at least two phases: microbial control and root filling. Success in preventing or eliminating apical periodontitis is dependent on many factors. These include 1. preoperative factors (e.g., primary endodontics or retreatment, presence of apical periodontitis, patient systemic health) 2. intra-operative factors (e.g., size of instrumentation, positive or negative culture at filling, length or density of fill, presence of procedural errors) and 3. post operative factors (e.g., presence or quality of coronal restoration).

Many studies have been performed over the years evaluating the relative importance of pre-, intra-, or post-operative factors in the outcome of endodontically treated teeth. In all of these studies gutta-percha and some type of sealer have been used to fill the root canal. However when the ability of gutta-percha to seal the canal is evaluated, it is quite apparent that it fails in this primary function. However as evidenced by the outcome studies root canal treatment can be highly successful if a gutta-percha technique has been used. This fact may lead one to believe that, in fact, although in-vitro and in-vivo studies show gutta-percha does not predictably seal the root canal, it does work in vivo. However studies by Ray and Trope, 1995 and others have demonstrated that it is the coronal seal above the gutta-percha filling that is critical for the prevention of coronal leakage and re-infection of the root canal. Thus if the coronal seal is inadequate or breaks down over time the canal filled with gutta-percha is susceptible to re-infection. Clearly it would be advantageous to create a coronal barrier from the root orifice to the apex.

A new, bonded endodontic root filling material, Resilon,™ has been developed as an alternative to conventional gutta percha. Gutta percha contains 35% gp rubber and 65% filler material. With Resilon™ the 35% (gutta-percha) rubber material has been replaced by 35% synthetic polyester with 65% fillers. Because of the resin based core material Resilon™ is able to bond to the adhesive sealer which in turn will bond to cleaned dentinal surfaces thus forming a "monoblock." Results from research on the Resilon™ system thus far has been published in vitro and in dogs indicating a superior seal to coronal leakage when compared to gutta percha techniques. The purpose of study is to report on clinical outcomes from its use in private endodontic practice. This study compared immediate post-operative (IPO) radiographs with short-term (1 year) post-treatment, follow up (F) radiographs from private practice endodontic cases treated with the Resilon™ system root filling.

## Materials & Methods

The study was approved the the Institutional Review Board of the University of North Carolina. The office managers of 20 private practices were approached (with prior permission of the practicing endodontist) to provide at least 5 primary endodontic cases root filled with Resilon™ that had at least one year follow-up. The office managers were paid for their efforts and were instructed to randomly pick the cases without input from the practitioner. Doctors and office managers enrolled in the study signed agreements that case selection would be without the Doctor's input and that patients and Doctors would remain confidential. Participating Doctors were from the continental US and Western Europe. The study accepted radiographs of teeth with and without apical periodontitis but did not collect diagnostic information or patient related variables. There was no standardization regarding endodontic treatment protocol or technique among the practitioners. Although no bite registration was required in order to reproduce angulation at follow up examination, radiographic guidelines required: similar projection angles between IPO and F films, films that demonstrated the entire apex and lesion, and 1 year or more follow up.

The healing rate of teeth was determined radiographically by measuring the periapical status. Immediate post operative (IPO) and follow up (F) radiographs of each tooth were read and assessed using two evaluation approaches based on healing of the most periapically involved root (in a multirooted tooth): the Periapical Index (PAI) (Orstavik, 1986), a scoring index based on histologic analysis by Brynoff, 1967 and the Clinical Impression of Healing (CIH). These approaches varied in three ways. First, the PAI required evaluator reliability be established through a calibration process prior to rating experimental radiographs (in this study the evaluator received a training calibration kappa of 0.81). The Clinical approach did not require calibration; rather observers were provided information on the evaluation process and the types of ratings to be assigned. Secondly the PAI observer was blinded to the phase of endodontic treatment and restoration status and viewed randomly ordered, individual radiographs. Conversely, three Clinical observers viewed IPO-F pairs with a known restoration status. Thirdly, the scoring system for the PAI was based on a

five point scale. Diagrammatic and radiographic guideline were provided (Figure 1) as well as written descriptors for each value on the PAI scale where a value of 1 represented teeth with a normal apical periodontium and 5 represented teeth with a radiolucency and radiating expansions of bony structural changes. The CIH required one of three ratings: healed, healing, or not healed/healing. A single examiner (DC) received, compiled, and prepared experimental radiographs (JPEG format) from participating practices then subsequently entered ratings for each training and experimental tooth into Microsoft Excel or PowerPoint for analysis.

Figure 1 Periapical Index diagrammatic and radiographic illustration of scoring

Outcomes were determined as favorable or unfavorable healing in both the PAI and CIH.

## Periapical Index

| | | |
|---|---|---|
| Favorable | healed | 3, 4, 5 at IPO $\Rightarrow$ 1-2 at Follow up |
| | | *or* 1-2 at IPO $\Rightarrow$ 1-2 at Follow up |
| | healing | 3, 4, 5 at IPO improves but isn't 1-2 at Follow up |
| Unfavorable | not healed/healing | 5-3 at IPO stays 5-3 at F |
| | | *or* 1-2 at IPO $\Rightarrow$ 3, 4, 5 at Follow up |

## Clinical Impression of Healing

| | | |
|---|---|---|
| Favorable | healed | complete disappearance of radiolucency |
| | | restoration of lamina dura |
| | healing | lucency apparent but smaller |
| Unfavorable | not healed/healing | lucency the same or larger |

## Results

Four office managers failed to deliver cases in a timely manner and so were excluded from the study. An additional practice had a disproportionate non–healing rate by the PAI scoring system (75%), contributing 45% of all study teeth with healing deemed "unfavorable." All data assigned to this outlier was excluded from analysis due to possible bias of the sample. Thus 70 teeth from 15 practitioners were used for statistical analysis.

*The PAI results* (Tables 1 & 2)

Results from four PAI categories were dichotomized into favorable and unfavorable healing. **Favorable healing was found in 83.4% of teeth**: 47 of 51 teeth started healthy (PAI 1,2) and stayed healthy (1,2); 12 of 19 teeth started diseased and ended healthy (PAI 3, 4, 5 to 1, 2); 3 of 19 started diseased (PAI 3, 4, 5) and showed improvement buy did not reach the healthy category (PAI 1,2); 4 of 19 teeth started diseased (3,4,5) but stayed diseased over the course of the year.

Table 1

Number and percent of teeth by change in PAI category of radiographic disease (N=70)

| | Start (IPO) | 1 year (F) | Total |
|---|---|---|---|
| No radiographic disease | 51 | 47 healed | 92% |
| | | 4 became diseased | 8% |
| Radiographic disease | 19 | 12 healed | 63% |
| | | 3 healing | 16% |
| | | 4 no change | 21% |

Table 2

Number and percent of teeth by change in PAI category of disease (N=70)

| Nature of Change | Number | Percent | Total |
|---|---|---|---|
| Stayed Absent (from 1-2 to 1-2) | 47 | 67.2 | 84.3% favorable |
| Disease to Absence (from 5-3 to 2-1) | 12 | 17.1 | |
| Stayed Disease (from 5-3 to 5-3) | 7 | 10 | 15.7% unfavorable |
| Absence to Disease (from 1-2 to 3-5) | 4 | 5.7 | |
| Total | 70 | 100 | |

*The CIH results*

Results from the CIH analysis were dichotomized into favorable (healed or healing teeth) and unfavorable healing (not healed/healing). Chi square analysis demonstrated no significant difference between the PAI evaluation and any of the 3 CIH observations although the relationship between PAI and CIH reader C did approach significance (p=0.056) (Table 3). There was an average of 90.9% favorable healing (range: 87.1% to 91.5% Table 3). The CIH classification did not permit analysis of a starting condition of the teeth; teeth in the process of "healing" were subsumed under the category of favorable healing.

Table 3
Significance of differences among the percentage of healing rates assigned in four independent observations (N=70)

| Observer | Favorable healing (%) | Chi square and probability | | | |
|---|---|---|---|---|---|
| | | PAI | CIH A | CIH B | CIH C |
| PAI | 84.3 | | 1.66 P=0.197 | 0.23 P=0.630 | 3.63 P=0.056 |
| Clinical Impression of Healing (CIH) reader A | 91.4 | | | 0.67 P=0.414 | 0.43 P=0.513 |
| Clinical Impression of Healing (CIH) reader B | 87.1 | | | | 2.10 P=0.146 |
| Clinical Impression of Healing (CIH) reader C | 94.3 | | | | |

## Discussion

- The current study is a unique evaluation of randomly selected material (70 teeth) from private practitioners. The study analyzes results of various endodontic and restorative treatment protocols from private practice endodontists and general practitioners with a single consistent feature: Resilon™ root filling.
- Although the PAI score was lower than CIH, there was no statistical difference between them (Table 3) and the pattern is consistent with other PAI-based studies (Trope et al 1999, Friedman et al 2003).
- Outcomes were similar to carefully controlled University studies. Seven major gutta percha-based outcome studies form the basis of comparison for the current study (Table 4). Unlike the Resilon™ study, each study from the endodontic literature had carefully defined treatment protocols, made clear distinctions in outcomes based on pre-operative diagnoses, accounted for numerous independent variables that impacted outcome.

Table 4
Endodontic literature based comparison of favorable healing rates

| Study | with lucency | without lucency | overall | time to follow up | type of study |
|---|---|---|---|---|---|
| Resilon PAI | 63% | 92% | 84.3% | 1 year | PAI |
| Resion CIH | na | na | 90.9% | 1 year | subjective |
| Strindberg, 1956 | 74% to 93% | ? | ? | 4-10 years | academician |
| Seltzer, et al, 1963 | 76% | 93% | 84% | 6 months | private practice |
| Kerekes & Tronstad, 1979 | 85% | 94% | 91% | 3-5 year | University |
| Bystrom, et al, 1987 | 85% | na | na | 2-5 years | academician |
| Sjogren, et al, 1990 | 86% | 96% | 91% | 8-10 years | University |
| Chugal, et al, 2001 | 63% | 88% | na | 4 years | University |
| Friedman, et al, 2003 | 74% | 92% | 81% | 4-6 years | PAI |

Only 1 study included teeth treated by private practitioners (Seltzer et al 1963) while 3 were by academicians (Strindberg 1956; Bystrom et al 1987, Sjogren et al 1997). As well, two studies report treatment by dental students (Kerekes & Tronstad 1979, Sjogren et al 1990); 2 studies report treatment by endodontic residents (Chugal et al 2001; Friedman et al 2003). One study (Bystrom et al 1987) based their findings on single rooted teeth only. Follow up times varied from 6 months (Seltzer et al 1963) to 17 years (Molven & Halse 1988). Two studies reported the use of radiographic series to determine end points rather than using single IPO and F films (Bystrom et al 1987; Molven & Halse 1988). All report following Strindberg or modified Strindberg criteria of success except one (Seltzer et al 1963) but criteria for calibration are oblique with the exception of a few studies (Molven & Halse 1988 and Sjogren et al 1990, Friedman et al 2003).

- In contrast to carefully controlled studies from the literature, the expectation in approaching the current study should be of a single consistent feature: Resilon™ root filling. Given the random selection of the material and a mosaic of endodontic and restorative treatment protocols from the private practice endodontists and general practitioners, results suggest that Resilon™ may provide additional resistance to coronal leakage (Table 5).

Table 5

Significance of coronal restoration (from Ray and Trope 1995)

If endodontics is good:

100% good restoration = 91% endodontic success*
75% good restoration = 79% endodontic success
50% good restoration = 67% endodontic success
25% good restoration = 56% endodontic success

**Success signifies lack of apical periodontitis*

## Conclusion

Irrespective of treatment technique or microbial control protocol, outcomes for randomly selected Resilon™ filled teeth from15 private practitioners were similar to those reported in University-based gutta percha studies.

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