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An assessment of the plastic Thermafil obturation technique Part 1 Radiographic evaluation of adaptation and placement

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Summary

Adaptation and placement of alpha-phase gutta-percha delivered with a plastic core-carrier, Thermafil, was compared to the lateral condensation of gutta-percha in a specific tooth model. Fifty-one mandibular molar roots with separate canals, patent canal orifices and curvatures greater than 15 degrees were cleaned and shaped with K-files and 2.5% sodium hypochlorite to a size 30 at the apex, and flared with Hedstrom files to create a continuously tapering funnel preparation. Canals were randomly obturated with Sealapex root canal sealer and either alpha-phase gutta-percha on a plastic Thermafil carrier, or standard beta-phase gutta-percha with lateral condensation. Roots were radiographed from the proximal and evaluated by three examiners, based on established criteria for overall material adaptation, apical adaptation, and filling material extrusion. Thermafil provided a statistically significant better overall canal obturation ($P<0.001$), while, in the apical third, both techniques were not significantly different ($P>0.05$). When the apical orifice was patent there was a significant propensity for the extrusion of filling materials beyond the apex ($P<0.001$) with the Thermafil technique.

Keywords: **extrusion, heated gutta-percha, radiographic evaluation, obturation, Thermafil.**

Introduction

Techniques which claim to provide three-dimensional obturation of the root canal system are dependent of proper cleaning and shaping prior to filling. Likewise, because all canal systems present with a multitude of irregularities, obturation techniques and materials must be capable of being adapted to the root canal walls, thereby providing complete obturation of the prepared space. Clinically, the determination of that obturation and adaptation is manifest exclusively by radiographic assessment, with parameters of evaluation including the length of the filling material in the canal and its density, shape, and uniformity of appearance in relation to the walls of the canal (Quality Assurance Guidelines, American Association of Endodontists, 1987).

Because gutta-percha obturation techniques generally require some type of condensation (lateral, vertical), their final radiographic appearance may or may not be fraught with undesirable variations in appearance such as sealer voids, spreader tracks, condenser voids and material welds (in the case of heated techniques) (Gutmann & Hovland 1992). While various studies have attempted to relate these aberrancies with case unacceptability and failure, little correlation exists at present, except for the standard that a dense, well-adapted root filling is clinically and radiographically acceptable.

In the last 15 years, efforts have been made to produce fillings and techniques which can achieve the maximum canal adaptation with the minimum amount of leakage. In the late 1970s and early 1980s, the development of the injectable thermoplasticized gutta-percha techniques has made material adaptation not only much easier, but also equal in quality if not superior, to previously advocated techniques (Yee *et al.* 1977, Torabinejad *et al.* 1978, Michanowicz & Czonstkowsky 1984, Michanowicz *et al.* 1986). Even with new developments, however, the presence of short root fillings and those with voids is common, primarily due to lack of operator expertise and skill in the application of these new advances (Gutmann & Rakusin 1987).

In 1978 Johnson presented a simple method for the delivery of thermoplasticized gutta-percha to the properly prepared canal, which appeared to minimize or eliminate problems in the radiographic appearance of

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the root canal obturation. Fillings could be placed to the prepared apex with reasonable apical control and filling density was uniform, as the softened material adapted easily to the prepared canal walls and flowed into the irregularities often found in the root canal system. The initial development of this system relied on metallic carriers for delivery and placement of the softened gutta-percha. Present technology has resulted in a plastic carrier (Thermafil Endodontic Obturators–plastic; Tulsa Dental Products, Tulsa, Oklahoma, USA) which can deliver the softened material with ease and considerable accuracy. While still in its infancy, the application of this technique shows great promise. Clinically relevant evaluations of this technique are necessary, however to ensure that minimal standards of acceptability are met and that the clinician can assess properly the attainment of these standards. The purpose of this initial study in a series of evaluations of the Thermafil technique, was to assess the radiographic appearance of canal obturation with the plastic Thermafil obturator, and compare it to accepted standards using a clinically relevant model.

Materials and methods

Fifty-one extracted human permanent mandibular molars were used in this study. The teeth were sectioned buccolingually through the furcation with a diamond saw. The mesial and distal roots were accessed and radiographed with working length files (No. 10 K-file) in each canal to examine the anatomy and ensure the patency of the canal system (Fig. 1). Roots were selected for the study based on the following criteria: curvature of the root of 15° or greater; two separate root canals; and separate apical orifices.

A size 10 K-Flex file (Kerr Manufacturing Co., Romulus, Michigan, USA) was passed down each canal of the mesial root until the tip was seen to perforate just through the apical part of the root. The instrument was withdrawn 1.0 mm and this recorded as the working length. Further working radiographs were taken if necessary from both a mesiodistal and buccolingual orientation.

Preparation of the root canals was performed with K-Flex files and Hedstrom files (Kerr Manufacturing Co., Romulus, Michigan, USA), alternately, until the apical portion of each root canal was filed to a size 30. This was accompanied by irrigation, after the use of each size of instrument, with 2 ml of 2.5% sodium hypochlorite solution, delivered from an Endodontic syringe (Sherwood Medical, St Louis, Missouri, USA) with a 23 gauge needle. The remainder of the root canal was prepared with a step-back technique (Mullaney 1979) using Hedstrom files along with recapitulation with a size 30 K-file to the working length to remove dentinal debris. Adequate flaring of the canal was considered to have been attained when a D-11T endodontic spreader (HuFriedy, Chicago, Illinois, USA) and a No. 30 plastic Thermafil core without gutta-percha, could be fitted loosely in the root canal to the working length. Following preparation the master apical file was placed in each canal and radiographs taken to verify the working length. Patency of the apical foramen was ensured with the tip of a size 10 K-file.

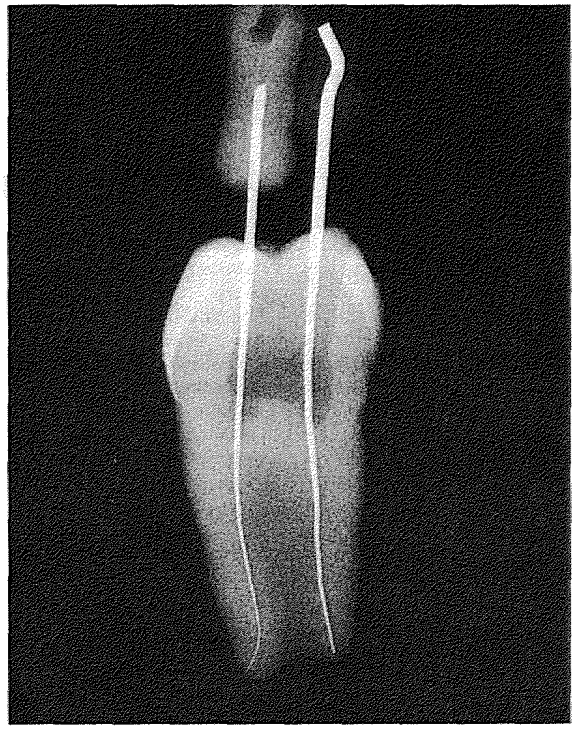

Fig. 1. Proximal radiograph demonstrating canal working length, separate canals and patent apical foramen.

The prepared mesiobuccal and mesiolingual root canals of each tooth were irrigated with 3.0 ml of 2.5% sodium hypochlorite, dried with paper points, and obtuated randomly with either lateral condensation of cold gutta-percha or Thermafil with plastic cores. The canal to be filled by lateral condensation was fitted with a master gutta-percha cone (Union Broach, Long Island City, New York) that gave a snug fit at the working length. This cone was lightly coated with root canal sealer, Sealapex (Kerr Manufacturing Co.) and used to

Table 1. Criteria for radiographic evaluation of filling material

Ratings	Criteria for each rating
0	Consistently dense, radiopaque fill in all three segments (apical, middle and coronal); gutta-percha is well adapted to the canal outline
1	Minimal variation in density throughout; some evidence of small voids (< 0.5 mm) or instrument marks < 10% of total fill
2	Moth-eaten appearance or voids (< 0.5 mm) in the apical third, and/or evident throughout the filling
3	Voids (> 0.5 mm but < 1.0 mm) in the apical third, and/or evident throughout the filling
4	Voids (> 1.0 mm) in the apical third, and/or evident throughout the filling

Table 2. Criteria for extrusion of material through apical foramen

Ratings	Criteria for rating extrusion of materials
0	No sealer or gutta-percha beyond the working length
1	Sealer and/or gutta-percha beyond the working length but not at radiographic apex
2	Sealer and/or gutta-percha at the radiographic apex
3	Sealer and/or gutta-percha beyond the radiographic apex

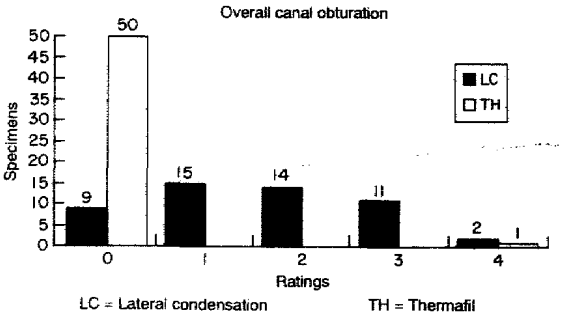

Fig. 2. Bar graph showing ratings for overall obturation.

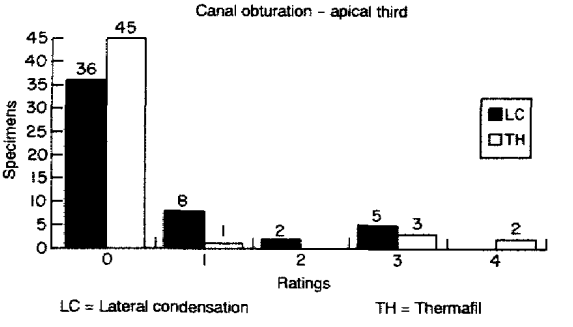

Fig. 3. Bar graph showing ratings for obturation in the apical third.

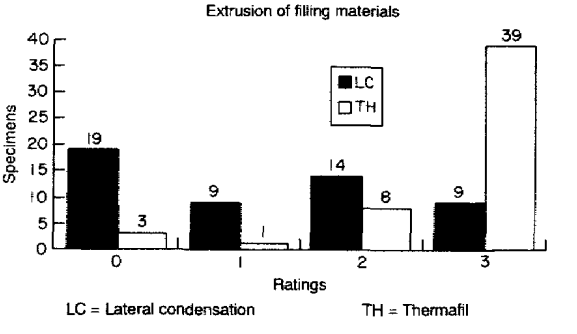

Fig. 4. Bar graph showing ratings for extrusion of filling materials.

wipe the walls of the canal. Following a second light coating with sealer, the master cone was inserted to the working length of the canal and held there for 5 s before condensation commenced. Lateral condensation was completed using a D-11T spreader (HuFriedy) and accessory cones (Union Broach) until the spreader could not penetrate more than 1 to 2 mm into the canal orifice.

The remaining root canal was filled with a No. 30 Thermafil obturator containing the plastic core. The obturating core was heated in the ThermaPrep oven for a minimum of 4 min, as recommended by the manufacturer. A small amount of Sealapex was applied twice to the walls of the root canal with a No. 30 master gutta-percha cone and the heated Thermafil obturator was positioned to the proper depth in the canal.

Proximal radiographs were exposed of all roots and subjected to evaluation at × 6 magnification using a Realistic-Vantage 5 Magnifier (ANACOMP, Multiprodux Division, Hartford, Wisconsin, USA). Teeth were evaluated as to the overall obturation, apical third obturation and material extrusion. Three examiners, who had been trained in the criteria for evaluation of obturation and material extrusion (Tables 1 and 2), reviewed and rated each radiograph. All cases in which there was a discrepancy, were re-reviewed and a score was agreed upon by all examiners.

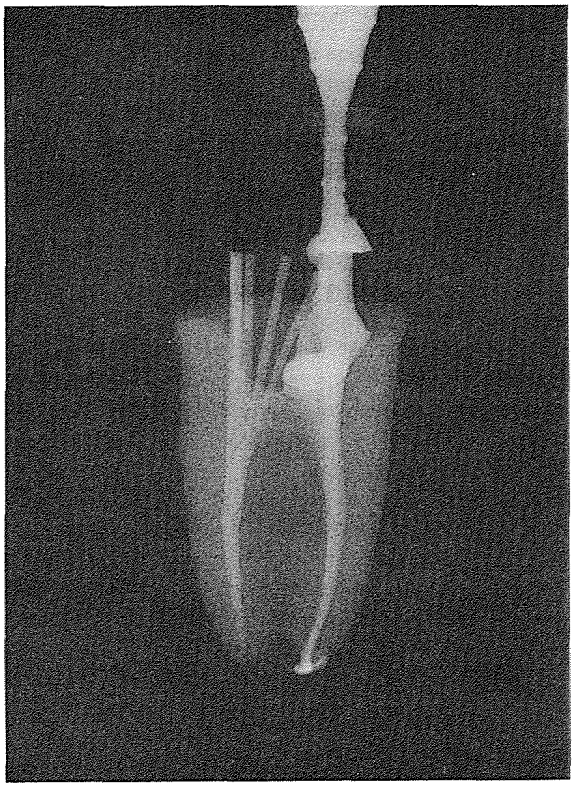

Fig. 5. Radiograph showing good overall obturation in both canals. Right canal is the Thermafil.

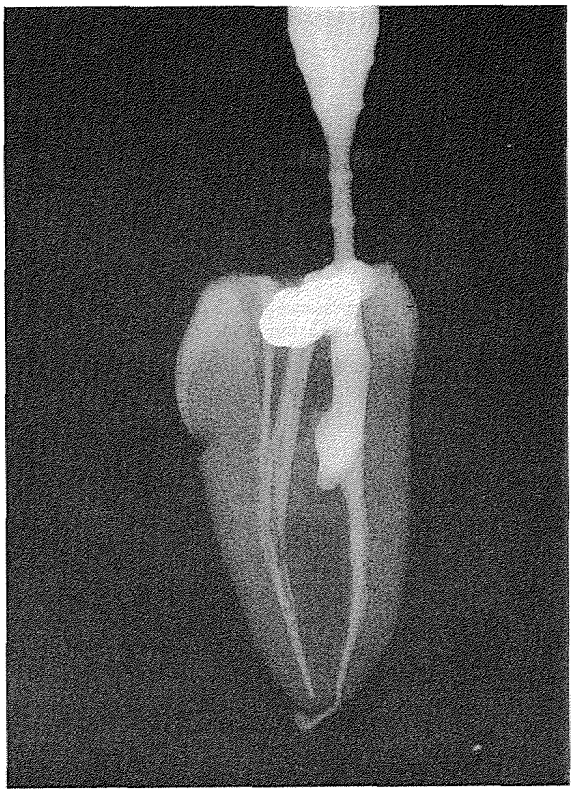

Fig. 6. Radiograph showing good overall obturation in the Thermafil obturated canal (right), with material extrusion; poor overall obturation of lateral condensation (left). Note however, the quality of the apical condensation of the gutta-percha in both canals is excellent.

Statistical analysis was performed using the Mann–Whitney *U*-test to compare both the overall quality of the two obturation techniques and the quality in the apical third of the root canal. In addition, comparisons were made on the amount of extrusion of obturating material through the apical foramina.

Results

The results of the radiographic evaluation are shown in Figs 2–4. Statistical analysis showed that Thermafil obturation gave a significantly better overall obturation using the criteria stated, $P < 0.001$. No significant differences were noted between the two methods of obturation in the apical third, $P > 0.05$ (Fig. 5). Thermafil obturation, however, resulted in significantly more material extrusion beyond the apical preparation, $P < 0.001$ (Fig. 6).

Discussion

The importance of radiographic criteria and their consistent application cannot be over emphasized in the evaluation of root canal treatment. This is essential to support standards of care which must be attained if a reasonable degree of success is to be achieved in patient treatment. Clinical guidelines published in the *Quality Assurance Guidelines* by the American Association of Endodontists (1987), indicate that radiographically, there should be the appearance of a dense, three-dimensional filling which extends as close as possible to the cemento-dentinal junction. Gross overextensions of the filling material into the periradicular tissues and underfilling or undercondensation in the presence of patent canal space are considered undesirable. In this respect, there was a predisposition for extrusion of filling materials with the Thermafil obturation technique when the apical foramen was patent. These findings have been noted in other studies using Thermafil (Lares & ElDeeb 1990, Haddix *et al.* 1991, Clark 1991, Christiansen 1991, Mattison *et al.* 1991, Scott & Vire 1992). Prevention of this occurrence with the use of an apical dentine

plug has been demonstrated by Scott & Vire (1992). Even with this predisposition, however, evidence of leakage has been shown to be non-existent (Clark 1991) and periradicular tissue response to material extrusion with Thermafil has been shown to be similar to that observed with the lateral condensation (Mattison *et al.* 1991).

In this study, both filling techniques radiographically satisfied the established criteria for root canal fillings in the apical third of the canal. Canals were three-dimensionally and densely filled, with filling material extending at least to the apical constriction, which is crucial to prevent or minimize leakage from the surrounding tissues. Equally important though, is the dense, three-dimensional obturation of the entire canal, to assist in the control of coronal leakage. In this regard, and with respect to the overall adaptation of the filling material to the canal irregularities, the Thermafil technique provided a significantly better result. The fact that a root canal appears densely obturated, on radiographic examination, does not indicate, however, that the seal of the canal system is adequate. Kersten (1987) has shown that the use of the proximal radiograph gives a better prediction of the quality of gutta-percha adaptation and compaction. In the cases evaluated, filling materials were seen adapted to the highly irregular nature of the canal systems, which is often only seen from the proximal view.

The application and comparison of the two filling techniques in the model described tended to minimize variables often encountered in individual samples for each technique. Likewise it provided the evaluators with a direct comparison as both techniques could be viewed simultaneously within the same anatomical surroundings.

The three examiners who radiographically evaluated the specimens, had been standardized to the criteria listed in Tables 1 and 2. This was essential because observer bias is a major factor in dental radiographic interpretation (Zakariasen *et al.* 1984, Lambrianidis 1985). Likewise the formal structuring of all radiographic evaluative studies is essential (Reit & Hollender 1983, Halse & Molven 1986, Reit & Grondahl 1987), especially the use of large sample sizes, multiple standardized observers, and standardized agreed-upon criteria (Koran 1975, Reit 1987).

Conclusions

Within the parameters of this study and based upon standardized radiographic criteria the following conclusions can be drawn.

(1) Obturation of curved root canals with alpha-phase gutta-percha on a plastic core-carrier, Thermafil, resulted in a more dense and well adapted root canal fill throughout the entire canal system, than lateral condensation with standard gutta-percha.

(2) Both lateral condensation and Thermafil plastic core-carrier obturations demonstrated acceptable root canal fillings in the apical one-third of the canal.

(3) There was a significant predisposition for material extrusion beyond a patent apex with Thermafil obturation using plastic core-carriers.

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References

Christiansen KR (1991) *An in vitro comparison and quantitative analysis of warm lateral condensation and the Thermafil obturator.* Indiana University School of Dentistry, USA: Master Thesis.

Clark DC (1991) *The apical sealing ability of metal versus plastic carrier Thermafil obturators.* University of Minnesota, USA: Masters Thesis.

Gutmann JL, Hovland EJ (1992) Problems in root canal obturation. In: Gutmann JL, Dumsha TC, Lovdahl PE, Hovland EC, eds. *Problem Solving in Endodontics* St Louis: Mosby Year-Book Inc., pp. 92–116.

Gutmann JL, Rakusin H (1987) Perspectives on root canal obturation with thermoplasticised injectable gutta-percha. *International Endodontic Journal* **20**, 261–70.

Haddix JE, Jarrell M, Mattison GD, Pink FE (1991) An in vitro investigation of the apical seal produced by a new thermoplasticized gutta-percha obturation technique. *Quintessence International* **22**, 159–63.

Halse A, Molven O (1986) A strategy for the diagnosis of periapical pathosis. *Journal of Endodontics* **12**, 534–38.

Johnson WB (1978) A new gutta-percha technique. *Journal of Endodontics* **4**, 184–88.

Kersten HW, Wesselink PR, Thoden van Velsen SK (1987) The diagnostic reliability of the buccal radiograph after root canal filling. *International Endodontic Journal* **20**, 20–24.

Koran LM (1975) The reliability of clinical methods, data and judgments. *New England Journal of Medicine* **293**, 642–46, 695–701.

Lambrianidis T (1985) Observer variation in radiographic evaluation. *Endodontics and Dental Traumatology* **1**, 235–41.

Lares C, Eldeeb ME (1990) The sealing ability of the Thermafil obturation technique. *Journal of Endodontics* **16**, 474–79.

Mattison G, Haddix J, Pink F, Baughman R, Collins R (1991) Periapical issue response to root canals filled with Thermafil. *Journal of Dental Research* **70**, 362 (Abstract no. 771).

Michanowicz A, Czonstkowsky M (1984) Sealing properties of an injection-thermoplasticied low-temperature (70°) gutta-percha: a preliminary study. *Journal of Endodontics* **10**, 563–66.

MULLANEY TP (1979) Instrumentation of finely curved canals. *Dental Clinics of North America* **23**, 575–92.

QUALITY ASSURANCE GUIDELINES (1987) Chicago: American Association of Endodontists, pp. 1–27.

REIT C (1987) The influence of observer calibration on radiographic periapical diagnosis. *International Endodontic Journal* **20**, 75–81.

REIT C, GRONDAHL H-C (1987) Endodontic decision-making under uncertainty: a decision analytic approach to management of periapical lesions in endodontically treated teeth. *Endodontics and Dental Traumatology* **3**, 15–20.

REIT C, HOLLENDER L (1983) Radiographic evaluation of endodontic therapy and the influence of observer variation. *Scandanavian Journal of Dental Research* **91**, 205–12.

SCOTT AC, VIRE DE (1992) An evaluation of the ability of a dentin plug to control extrusion of thermoplasticized gutta-percha. *Journal of Endodontics* **18**, 52–57.

TORABINEJAD M, SKOBE Z, TROMBLY PL *et al.* (1978) Scanning electron microscopic study of root canal obturation using thermoplasticized gutta-percha. *Journal of Endodontics* **4**, 245–50.

YEE FS, MARLIN J, KRAKOW AA, GRON P (1977) Three-dimensional obturation of the root canal using injection-molded, thermoplasticized dental gutta-percha. *Journal of Endodontics* **3**, 168–74.

ZAKARIASEN KL, SCOTT DA, JENSEN JR (1984) Endodontic recall radiographs: how reliable is our interpretation of endodontic success or failure and what factors affect or reliability. *Oral Surgery Oral Medicine and Oral Pathology* **57**, 343–47.