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# An in-vitro method to assess the sealing ability of root-canal obturation by computer-assisted microscopic analysis

**Language:** English

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## Introduction

Literature survey: in the last decade - very few computer-analysed image studies on the sealing ability of Thermafil, no in-vivo (ex-vivo) study at all.

## Objectives

Aim of the present study was to evaluate ex-vivo the sealing ability of the Thermafil system + a conventional sealer in root canals treated with the ProTaper system.

## Material and Methods

Thirty-two roots of single- and multi-rooted periodontally involved teeth with indication of extraction or amputation of compromised roots, were included. Teeth included: 1 lower incisor, 2 upper incisors, one upper canine, 3 lower premolars, 4 upper premolars, 8 lower molars,13 upper molars. Roots with minimal curvature, as determined on the radiograph, were included. After pre-flaring with the ProTaper SX instrument, a #10 K-file was placed in the canal to determine the WL, which was set using the Morita TrZX 0.5mm short-of-apex. After periodontal initial therapy, the root canals were instrumented in-vivo using ProTaper instruments, according to manufacturer's instructions. Irrigation was performed using 1ml NaOCl 2.5% between each file. Smear layer was removed from the canals by rinsing with 2 ml of EDTA17% for 5 min, followed by flushing again with 2 ml of NaOCl and finally with1 ml saline solution. Final apical enlargement was performed, depending on the initial canal size, without exceeding a size 30 file. The canals were dried with paper points. Root canals were obturated with Thermafil + the sealer AHPlus, as specified by the manufacturer. We selected a Thermafil obturator the same size as the size verifier that fit passively at WL. The single-rooted-teeth were extracted and the multi-rooted-teeth underwent amputation during flap surgeries. Calculus and remaining periodontal ligament was carefully removed. Separated roots were embedded in acrylate. A special blocking method of the samples was imagined in order to maintain the original position of the acrylate cylinders under the microscope for successive examinations. Transversal sections were obtained at every 0.5mm up to 2.5mm, starting with the apex. The sections were obtained by progressive reductions using the metallographic samples polishing device WIRTZ Phoenix 4000. After each 0.5 mm of coarse reduction using abrasive paper discs, the sections were high-polished using paper discs and special diamond paste. Every reduction occurred under permanent water-cooling. In the end, the polished surface of each section were degreased with alcohol, washed with water and dried with filter paper, before being examined. Sections were examined under direct and polarized-light microscope at 100X and 500X magnifications, and under stereomicroscope at 50X magnification. All measurements were performed using the 100X magnified images. 500 X magnification was used only when details of the images were necessary.

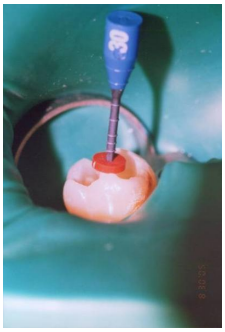

Fig. 1 Thermafil obturator in place

Fig. 2 Multi-rooted teeth with amputated roots - intraoperatory view

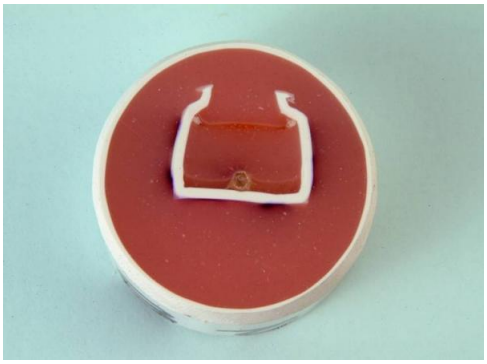

Fig. 3 Sample of obturated root embedded in acrylate

Fig.4 The metallographic samples polishing device WIRTZ Phoenix 4000

Images were captured using an Olympus C-3040 digital camera, were elaborated with the Camedia-Olympus-dpsoft-3.1, analyzed using the AUTOCAD 2002 software. For each section, the following data were recorded: the total perimeter of the canal, the rotary-instrumented perimeter of the canal, the perimeter in contact with the obturation, the total area and the obturated area of the canal. The obtained data were put in relation, and the percentage of the instrumented perimeter, the percentage of the obturated perimeter and of the obturated areas of the canals were calculated. Additional details (anatomical recesses, visible lateral canals, fractures, artifacts, debris, separated instruments) were registrated. Some series of images were used in the end for computer-assisted 3D reconstructions of the inner architecture of the canal and of the obturation, using the SolidWorks 2005 software.

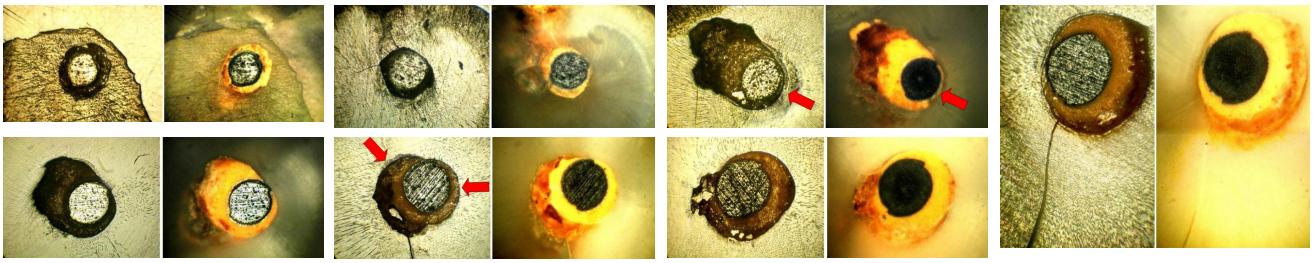

Fig.5 a) - g) Incremental series of root canal sections

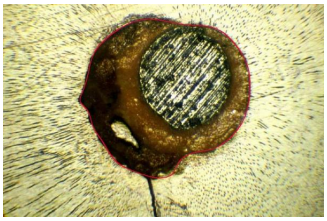

Fig.6. The total perimeter of the canal section

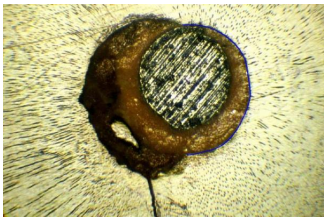

Fig.7 The instrumented perimeter of the canal section

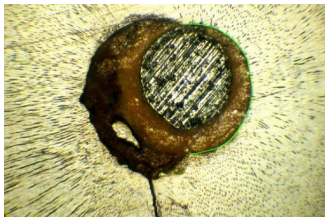

Fig.8 The perimeter in contact with the obturation

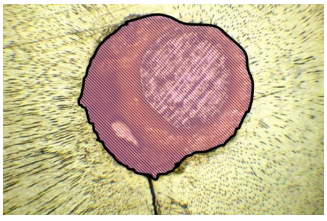

Fig.9 The total area of the canal section

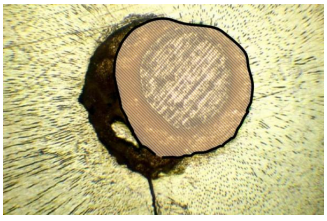

Fig.10 The obturated area of the canal section

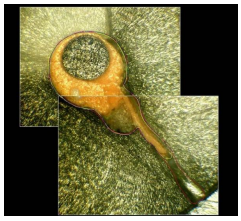

Fig.11 Composed image of a section; obturated lateral canal visible


Graph 1. Instrumented perimeter/total perimeter (%)


Graph 2. Obturated perimeter / total perimeter (%)


Graph 3. Obturated area / total area (%)

Fig.12 Separated ProTaper instrument - section

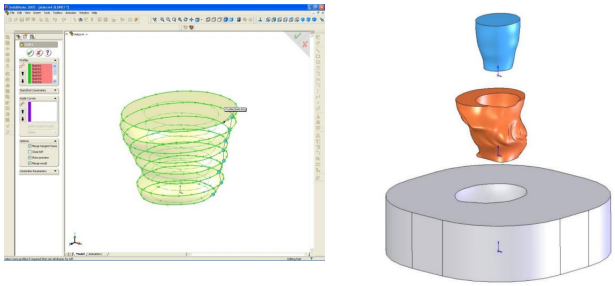

Fig.13. 3D composition using SolidWorks software: the sections processed and the 3D reconstruction

## Results

Results show that only 21% of the perimeter at the apical oriffice was instrumented. This increased progressively with up to 66% of the perimeter being instrumented 2.5mm back from the first reading.
A similar increase was seen for the presence of obturation material, with 45% seen at the apex and increasing to 92% 2.5mm back. The slight decrease of the perimeter in contact with the obturation parallels the increase of the obturated area mentioned already, suggesting the lack of congruence between the ProTaper system and the apical dimension of the canals. On the final half of mm beyond the WL, 40.6% of the samples displayed mechanical instrumentation and 46.9% displayed obturation, possibly because of the screwing effect of the ProTaper instruments.
Separated instruments and foreign bodies were found in 6.25% of sections. 25% of sections displayed anatomical recesses on the final 2.5mm.

## Conclusions

1. The ex-vivo evaluation of the sections demonstrates a good sealing ability of Thermafil on the final 2.5mm.
2. A surprising slight decrease in mean percentage of obturated perimeter was found. This may support the idea of using a hybrid technique of preparation.
3. Computer-assisted-analysis of incremental transversal sections proved to be highly descriptive and can be a valuable tool in assessing the quality of the root canal filling.
4. The fact that the root canal treatments were performed in-vivo describes the truth from the clinical practice.
5. The study can be refined by diversifying improving the standardization of the groups according to the tooth type, to the curvature degree, etc.
6. Further studies should compare present data with data from in-vitro studies or different filling-systems.
7. The method allows accurate envelopment 3D analysis of root canal obturations.

## Abbreviations

WL - working length

*This Poster was submitted by Assist. Prof. Dr. Dr. Stefan-Ioan Stratul.*

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**Poster Faksimile:**

# An *in-vitro* method to assess the sealing ability of root-canal obturation by computer-assisted microscopic analysis.


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## ABSTRACT


**Aim**: to evaluate ex-vivo the sealing ability of Thermafil system plus conventional sealer. **Methodology**: Thirty-two root-canals of single- and multi-rooted teeth with indication of extraction or amputation, were instrumented in vivo using the ProTaper (Dentsply-Maillefer, Ballaigues, Switzerland) instruments. NaOCl 1% and EDTA 17%. Working-length was set using Mortia TriZX(Morita Mfg.Corp. Japan) 0.5 mm short of apex. Root canals were obturated using the Thermafil system (Dentsply-Maillefer, Ballaigues-Switzerland) with sealer AH-Plus (Dentsply-DeTrey GmbH, Konstanz-Germany). The obturated single-rooted-teeth were extracted, multi-rooted-teeth underwent amputation for periodontal reasons. Separated roots were embedded in acrylate. Transversal sections were performed at every 0.5mm up to 2.5mm. Sections were examined under direct polarized light microscope and stereomicroscope(100X, 500X magnification). Images were captured using digital camera, photos elaborated with Carmedia-Olympus-dsoft-3.1, analyzed using AUTOCAD2002. Data were registered for each section: total perimeter of the canal, instrumented perimeter, perimeter in contact with obturation, total area of the canal, obturated area. Percentage of instrumented perimeter, of obturated perimeter and of obturated areas of the canals were calculated. Spectacular details-anatomical recesses, visible lateral canals, fractures, artifacts, foreign bodies, separated instruments were registrated. **Results** show increase in mean percentage of instrumented perimeter from 21% (phase 0=apex) to 66% (phase 6=2.5mm), increase in mean percentage of obturated area from 45% (phase 0) to 92% (phase 6) and a surprising slight, continuous decrease of mean percentage of obturated perimeter from 97% (phase 0) to 86% (phase 6). 40.6% of the samples displayed instrumentation, 46.9% displayed obturation on final 0.5mm, separated instruments and foreign bodies were found in 6.25%, 25% of sections displayed anatomical recesses, starting predominantly at 1.5 mm from the apex. **Conclusions**: Results show satisfactory, yet surprising picture of the outcome of treatment. Data must be refined by diversifying the groups according to tooth type, root shape, curvature, further compared with similar data from in-vitro studies, evaluation should be extended to various root-canal filling-systems.


## INTRODUCTION

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## OBJECTIVE

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Fig.1 Incremental series of root canal sections

Fig.6. The total perimeter of the canal section

Fig.7 The instrumented perimeter of the canal section

Fig.8 The perimeter in contact with the obturation

Fig.9 The total area of the canal section

Fig.10 The obturated area of the canal section

Fig.11 Composed image of a section, obturated lateral canal visible

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