

ROOT CANAL FILLING REMOVAL DURING ENDODONTIC RETREATMENT - A SURVEY OF GHANAIAN DENTISTS

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DOI: <https://dx.doi.org/10.4314/gdj.v19i1.5>

ABSTRACT

BACKGROUND: Endodontic treatment aims to thoroughly clean and shape the root canal system to rid it of any infected pulpal tissue or bacteria and to provide a three-dimensional hermetic seal to the root canal system to prevent re-infection.

Despite the high rates of success of endodontic treatment, failures do occur, and these may be attributed to the persistence of bacteria in the root canal system, lack of a hermetic seal during obturation, inadequate condensation of gutta-percha, inadequate cleaning and shaping of the canal, coronal leakage or the presence of unidentified accessory canals.

For successful endodontic retreatment to occur, all traces of the root filling material (gutta-percha and the sealant) must be removed from the canal walls to enable access to the apical third of the root canal system to be regained.

Removal of gutta-percha can be carried out by thermal, laser, chemical, and mechanical techniques or a combination of the above.

GENERAL AIM: To determine which instruments and solvents Ghanaian dentists use to remove gutta-percha during endodontic retreatment.

METHODOLOGY: A cross-sectional study was done by giving out a structured questionnaire at a Continuous Professional Development (CPD) event held for dentists. Simple descriptive statistics were used together with Chi-square (χ^2) and one-way Analysis of Variance (ANOVA) tests. The chosen level of significance was set at $p < 0.05$. Unanswered questions were treated as missing values.

RESULTS: A total of 64 dental practitioners were surveyed in this study. 32 out of 63(50.8%) respondents performed 2-4 root canal treatments (RCTs) per week, and 49 out of 62(79.0%) performed 0-1% of re-RCTs per week. 59 out of 62(95.2%) practitioners used hand files during root canal treatment. 44 out of 57(77.2%) practitioners used hand files in combination with solvents, Gates Glidden burs, and barbed broaches during endodontic retreatment. Eucalyptol was the most used solvent during endodontic retreatment, accounting for 31 out of 39(79.5%) positive responses by practitioners.

CONCLUSION: Most Ghanaian dentists use hand files (K-files-54.3%) with solvents (Eucalyptol-79.5%) in the removal of gutta-percha during endodontic retreatment.

KEYWORDS: endodontics, gutta-percha solvents, hand files, endodontic retreatment

INTRODUCTION

Endodontic retreatment (re-RCT) may be carried out by either surgical or non-surgical means.¹ Non-surgical endodontic retreatment or endodontic revision involves removing root canal filling materials from the root canals, followed by cleaning, shaping, and obturating the canals.² Surgical endodontic retreatment is carried out when there is an associated periapical pathology on a previously root treated tooth or when non-surgical retreatment is ineffective, not feasible, or contraindicated.¹

Bacteria play an essential role in the initiation, progression, and persistence of dental pulp diseases.² Bacteria implicated in deep dentinal caries are responsible for the inflammation and subsequent damage to pulpal tissues. The bacterial effects on the pulp are caused either by bacterial virulence factors and antigens that diffuse through the dentinal fluid or by the bacterial cells themselves, which may reach the pulp via dentinal tubules, especially in very deep caries cavities.³

The outcome of either healing or persistence of apical disease depends mainly on the presence of bacteria in or around the root canal system.⁴ Non-surgical endodontic therapy success rates between 86%-98% have been reported in the literature.⁵ Despite the progress in root canal treatment techniques and the high success rates, root canal treatments sometimes fail due to persistent or secondary intra-radicular infection.⁶ Endodontic treatment failure may occur due to inadequate

debridement of root canals, procedural errors, missed or secondary canals, the presence of apical ramifications, or the lack of a hermetic seal.⁷

Depending on the cause of endodontic treatment failure, treatment options may be limited to either endodontic retreatment or an extraction. Causes of endodontic failure can be classified into the following groups: persistent or reintroduced intra-radicular microorganisms, extra-radicular infections, foreign body reactions such as foreign body giant cell granulomas, true cysts, procedural errors

such as root perforations, ledge formations, separated instruments, missed canals, anatomical difficulties such as apical ramification, isthmuses, and other morphologic irregularities, periodontal disease, and unrestorable crowns.⁸

Endodontic retreatment is a procedure performed on previously root-treated teeth to remove root canal filling materials from the tooth, followed by cleaning, re-shaping, and obturating the canals.⁹

Removal of the root filling material must be done before effective chemo-mechanical instrumentation can be carried out in the retreatment of a failed endodontic case.⁷ Remnants of root-filling material in the canal may harbour microorganisms which will lead to their growth and multiplication and cause the failure of the re-endodontic treatment.¹⁰

Root-filling materials may be pastes and cement, semi-solid and solid materials. Solid materials such as silver points are no longer used in the obturation of root canals.¹¹ Pastes such as zinc oxide eugenol paste, calcium hydroxide paste, and iodoform paste are mostly used as root filling materials in paediatric patients.¹² AH plus and zinc oxide pastes impregnated with phenol, camphor, creosote, and paraformaldehyde were previously used in adult patients.¹¹ Newer bioceramic formulations such as ProRoot MTA, Biodentine, Endosequence BC sealer, Bioaggregate, and Generex A are currently available as root canal filling materials.¹³

Gutta-percha, a semi-solid material, is the most widely used root canal filling material. For over a hundred and fifty years, it has been used as the main material for the obturation of the root canal system.¹⁴ It contains gutta-percha 18.9% to 21.8%, zinc oxide 59.1% to 75.3%, metal sulphates 1.5% to 17.3%, and wax and/or resin 1.0% to 4.1%.¹⁴

Instruments used in removing root canal fillings depend on the type of material used for the filling. They include thermal, e.g., heated instruments, mechanical, e.g., rotary and hand files, ultrasonic tips and files, and chemical, e.g., solvents, lasers, or a combination of the four.^{15,16} Despite which technique is used, the total patency of the canal system must be regained.

The vegetable resin contained in gutta-percha cones enables them to dissolve easily.¹⁷ The following solvents have been found to have excellent gutta perch dissolving properties: Carbon tetrachloride, Benzene, Xylene, and Chloroform, but they are highly toxic and have been found to be carcinogenic.^{18,19}

This study seeks to determine the various instruments and solvents used by Ghanaian dentists in the removal of root filling materials during endodontic retreatment.

METHODOLOGY

This was a cross-sectional study using a structured questionnaire which was given to all participants at a continuous professional development (CPD) program for dentists. A total enumeration sampling method was used. All the available dentists who consented to be included in the study were enrolled. A total of sixty-four dentists took part in the survey.

The questionnaire included basic demographic data, endodontic retreatment instruments, and solvents. The responses were multiple-choice, where a respondent could choose more than one option. Each chosen option was then coded as a Yes or No. Unanswered questions were treated as missing values.

Data was coded and captured using Microsoft Access. The Data was cleaned using Microsoft Excel. The cleaned data were analysed using Statistical Package for Social Science (SPSS) 22.0.

Simple descriptive statistics (counts and percentages) were used in the analysis together with the Chi-square (χ^2) test and the one-way Analysis of Variance (ANOVA), which were used to test the difference between proportions. The chosen level of significance was set at $p < 0.05$.

Ethical approval was obtained from the Ethics and

Protocol Review Committee of the College of Health Sciences, University of Ghana.

RESULTS

Sixty-four questionnaires were given out during a continuous professional development (CPD) event for all categories of dentists. All questionnaires were retrieved after the event, but not all questions were answered. This led to the calculation of valid percentages for entries with missing data.

Table 1: Demographics and Results

Variable	Frequency	Percent	Valid Percent
Ages of respondents			
20-30 years	20.0	31.3	34.5
31-40 years	32.0	50.0	55.2
41-50 years	2.0	3.1	3.5
51-60 years	0.0	0.0	0.0
> 60 years	4.0	6.3	6.9
Total	58.0	90.7	100.0
Missing	6.0	9.4	
	64.0	100.0	
Gender			
Male	28.0	43.8	45.2
Female	34.0	53.1	54.8
Total	62.0	96.9	100.0
Missing	2.0	3.1	
	64.0	100.0	
Facility of Practice			
Private Practice	15.0	23.4	
District Hospital	20.0	31.2	
Regional Hospital	5.0	7.8	
Teaching Hospital	12.0	18.8	
More than one facility	12.0	18.8	
Total	64.0	100.0	
Duration of practice			
< 2 years	5.0	7.8	7.9
2-5 years	22.0	34.4	34.9
6-10 years	22.0	34.4	34.9
11-20 years	8.0	12.5	12.7
> 20 years	6.0	9.3	9.5
Total	63.0	98.4	100.0
Missing	1.0	1.6	
	64.0	100.0	
Average number of RCTs per week			
0-1	25.0	39.1	39.7
2-4	32.0	50.0	50.8
5-6	5.0	7.8	7.9
7-8	0.0	0.0	0.0
9-10	0.0	0.0	0.0
>10	1.0	1.6	1.6
Total	63.0	100.0	100.0
Missing	1.0	1.6	
	64.0	100.0	
Average number of re-RCTs per week			
0-1	49.0	76.6	79.0
2-4	9.0	14.1	14.5
5-6	1.0	1.6	1.6
7-8	1.0	1.6	1.6
9-10	1.0	1.6	1.6
>10	1.0	1.6	1.6
Total	62.0	100.0	100.0
Missing	2.0	3.1	
	64.0	100.0	
Obturation Materials			
Gutta Percha	63.0	98.4	
Other (ZOE)	1.0	1.6	
Total	64.0	100.0	
Sealant			
Calcium Hydroxide - based	36.0	56.3	58.1
ZOE-based sealant	14.0	21.9	22.6
Resin-based sealant	8.0	12.5	12.9
Glass Ionomer- based sealant	3.0	4.7	4.8
Other	1.0	1.6	1.6
Total	62.0	97.0	100.0
Missing	2.0	3.1	
	64.0	100.0	
Warming of Eucalyptol Before Use			
Yes	0.0	0.0	0.0
No	31.0	100.0	100.0
Total	31.0		

A structured questionnaire was given out to respondents, and the following information was captured.

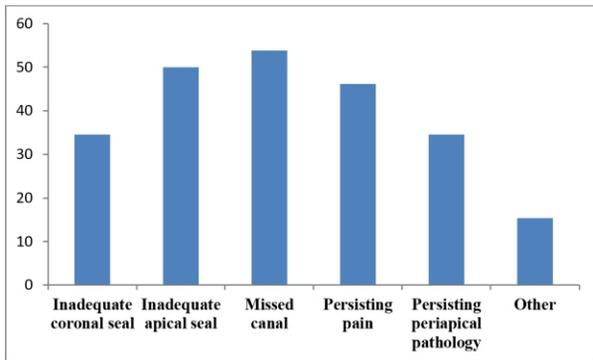


Figure 1: Causes of RCT Failure

Out of 64 respondents, 26(40.6%) indicated the following causes of RCT failures: missed canals 14(53.8%), inadequate apical seals 13(50.0%), and persisting pain 9(46.1%), as the highest positive responses for reasons for RCT failure.

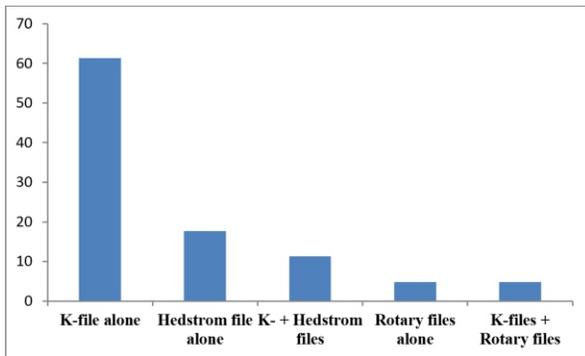


Figure 2: Instruments Used in RCT

Out of 64 respondents, 62(96.9%) used the following instruments in root canal treatment: K-files were the commonest files used to clean and shape root canals. They were either used alone 38(61.3%), or in combination with Hedstrom files 7(11.3%), or in combination with rotary files 3(4.8%). 11(17.7%) used only Hedstrom files and 3(4.8%) only rotary files.

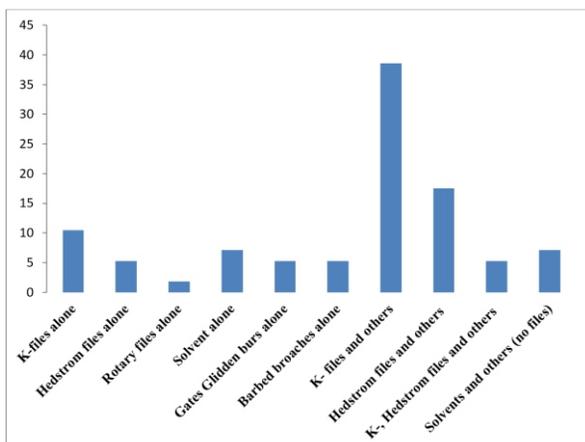


Figure 3: Instruments Used in Root-filling Material Removal

Out of 64 respondents, 57(89.1%) used the following instruments in root-filling removal: K-files alone 6(10.5%), Hedstrom files alone 3(5.2%), K-files in combination with other instruments (e.g. Gates Glidden burs and solvents) 22(38.6%), Hedstrom files in combination with other instruments (e.g. Gates Glidden burs and solvents) 10(17.5%) and both K-and Hedstrom files with others 3(5.2%).

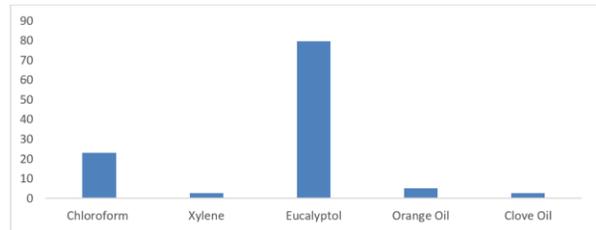


Figure 4: Solvents Used in Endodontic Retreatment

Out of 64 respondents, 39(60.9%) used the following solvents in endodontic retreatment: Eucalyptol 31(79.5%), Chloroform 9(23.1%), Orange oil 2(5.1%) and both Xylene and Clove Oil 1(2.6%).

Table 2: Age vs. File Types Used During RCT

File Type		Mean	N	Std. Deviation	p-value
	No	34.209	43	9.4933	0.078
	Yes	40.833	12	16.4750	
	Total	35.655	55	11.5329	
K-file					
	No	37.500	12	11.8973	0.538
	Yes	35.182	44	11.3880	
	Total	35.679	56	11.4290	
Rotary					
	No	35.021	47	10.7309	0.250
	Yes	40.125	8	15.5236	
	Total	35.764	55	11.5164	

Using the one-way ANOVA test, there was no association between the ages of respondents and the type of file they preferred to use for RCT treatment.

Table 3: Duration of practice vs. Average number of RCTs per week

Duration of practice	Average Number of RCTs per week				Total
	0-1	2-4	5-6	>10	
<2 yrs	1(20.0%)	3(60.0%)	1(20.0%)	0(0.0%)	5(100.0%)
2-5 yrs	8(36.4%)	12(54.5%)	2(9.1%)	0(0.0%)	22(100.0%)
6-10 yrs	11(45.8%)	8(36.4%)	2(9.1%)	1(4.5%)	22(100.0%)
11-20 yrs	3(37.5%)	5(62.5%)	0(0.0%)	0(0.0%)	8(100.0%)
>20 yrs	1(20.0%)	4(80.0%)	0(0.0%)	0(0.0%)	5(100.0%)
Total	24 (37.8%)	32(51.6%)	5(8.1%)	1(1.6%)	62(100.0%)

Chi-square cross-tabulation yielded a p-value of 0.918, indicating no association between the duration of practice versus the average number of RCTs done per week.

DISCUSSION

Endodontic retreatment is a procedure performed on previously root-treated teeth to remove root canal filling materials from the tooth, followed by cleaning, re-shaping, and obturating the canals.⁹

This survey looked at instruments and solvents used by dentists in Ghana to remove gutta-percha during endodontic retreatment. The response rate in this study was 100%. In a similar study by Touré et al.,⁸ where questionnaires were sent via email, the response rate was 27.5%. The high response rate in this study was due to the mode of collection of the data, where the questionnaires were distributed and collected at the same venue. This allowed participants to fill out and return the forms immediately.

Facilities in which respondents worked included private practice, district hospitals, regional hospitals, and teaching hospitals, with most respondents (31.2%) working in a district hospital. In a study by Topkara et al.,²⁰ 142 out of 275 participants (51.6%) worked in private offices and polyclinics, 93(33.8%) worked at public hospitals and Oral and Dental Health Centres affiliated with the Ministry of Health, and 40(14.5%) worked at University Hospitals. The higher number of practitioners in the district setting might be because there are more vacancies for dental practitioners in district settings than in the other facilities. Also, district hospitals are usually the first point of call for most patients.

The 31-to-40-year age group had the highest number of respondents in our study, with 68.4% of respondents who had worked for 2-10 years. This compares favourably with the survey by Touré et al.,⁸ where the mean age was 43.85+7.96. Our results for the duration of practice were lower than that of Touré et al.,⁸ which was 14.06 +7.68 years. In the study by Topkara et al.,²⁰ out of 275 respondents, 64(23.3%), had practised for more than 7 years. The rest had years of practice ranging from 17 years (47.6%) to 57 years (1.1%). The result in this study was due to the nature of the event where the questionnaires were distributed. Dentists must attend Continuous Professional Development events for relicensing every year by their professional body. Younger dentists tend to travel for these CPDs compared to the older dentist, who participate if the venue is convenient for them.

Any of the following may cause root canal treatment failure: remnants of necrotic pulpal tissue, the persistence of peri-radicular infection, root fractures, mechanical perforations, missed or unfilled canals, under-or overfilling of the root canals, inadequate coronal restorations, and complications of instrumentation (ledges, perforations, or separated instruments).²¹ A root-treated tooth that has failed may either be extracted or be retreated by either non-surgical or surgical means based on the cause of treatment failure.

From our survey, missed canals, inadequate apical seal, and persisting pain were the top three positive responses practitioners gave as the reasons for the failure of root-treated teeth. This is similar to results from the following studies: Song et al.²² analysed 493 failed root treated teeth and found leaky canals 150(30.4%) and missing canals 97(19.7%) to be the most common causes of failure. Olcay et al.²³ found that out of 1000 responses, combined restorative and endodontic causes in 439(43.9%)

responses and endodontic failure alone in 99(9.9%) responses. In a study by Iqbal,²⁴ in which 90 patients with endodontic failure were assessed, underfilled canals 30(33.3%) and missed and unfilled canals 16(17.7%) were the leading causes of failure. The reasons given for failures in our study may be due to the fact that most district hospitals do not have x-ray equipment, so dentists performing RCTs do so without periapical radiographs to guide them.

There was no association ($p=0.918$) between the duration of practice and the average number of RCTs done per week. Topkara et al.,²⁰ found that 40.7% of dental practitioners performed more than 10 RCTs per week. The difference in the number of RCTs per week may be attributed to patients' socioeconomic factors. Patients may opt to have their teeth extracted because it is cheaper than a root canal treatment. The smaller number of endodontic specialists available in the country might be another reason why the number of

RCTs is low. Insufficient endodontists might mean complex cases in the districts will be extracted since the patient will not want to travel several hours to see an endodontist in a regional capital. In the Topkara et al.²⁰ study, 275 practitioners were surveyed, of which 58(21.1%) were endodontists.

Gutta-percha is the most widely used root canal filling material and has been used for over a hundred years as the main material for the obturation of root canal systems.¹⁶ Gutta-percha was the main root-filling material used by respondents in our study.

There was no association ($p=0.538$, $p=0.078$, $p=0.250$) between the ages of respondents and the type of files (K-files, Hedstrom files, and Rotary files, respectively) used during root canal treatment. However, K-files were used by most respondents either alone (61.3%) or in combination with Hedstrom and rotary files (26.1%). In a study by Jenkins et al.,²⁵ the routine use of K-files was three times greater among dentists who were 29 years or less. In another study by Mankajola et al.,²⁶ only 28.6% used rotary files. A similar study conducted by Gupta et al.²⁷ and Al-Omari et al.²⁸ showed that 39% and 99.2% of practitioners used only hand files in root canal treatment. In a survey by Konadu et al.²⁹ among Ghanaian dentists, 13(27.3%) respondents had rotary endodontic kits at their workplaces. Only 14 respondents (31.8%) had used a rotary endodontic kit before. The results of our study are similar to the previous survey and show that a vast majority of Ghanaian dentists are yet to incorporate rotary endodontics in their practices. The continued use of hand files among the various groups of respondents may be due to the fact that during undergraduate training, students are taught to use hand instruments in root canal treatment. After graduation, if they do not attend any courses to upgrade their skills, they keep on practising what they were taught. Other factors might be the high cost of the rotary endodontic kit and the unavailability of periapical x-ray machines in many district facilities.

Recent advances in removing root filling material during endodontic retreatment involve rotary retreatment files, ultrasonic devices, and lasers.^{15,30} Solvents are still used as an adjunct with the newer instruments. Though eucalyptol was the most used solvent to soften gutta-percha during endodontic retreatment, no practitioners heated the eucalyptol before use. Heated eucalyptol is more clinically effective as a solvent than eucalyptol at

room temperature.³¹ Practitioners might not know that warmed eucalyptol softens gutta-percha faster than eucalyptol stored at room temperature.

Chloroform and Xylene are carcinogenic and toxic to tissues.^{18,19} Eucalyptol, Clove Oil, and Orange oil are both essential oils that are safe, biocompatible, and non-carcinogenic.³² Eucalyptol and Clove Oil have been shown to have both antibacterial and anti-inflammatory properties.³³ Data was not readily available from other studies to compare the preferred solvents dentists use in removing GP from root canals since more studies used rotary retreatment files to remove GP.

CONCLUSION

The majority of Ghanaian dentists use hand files for endodontic retreatment, with K-files being the preferred file. Eucalyptol is the most commonly used solvent.

ACKNOWLEDGMENTS

The University of Ghana Dental School CPD committee for allowing us to distribute the questionnaires during the CPD. All dentists who took the time to fill out the questionnaires.

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