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ORIGINAL RESEARCH

Evaluation of Quality of Endodontic Retreatment: A Cross-sectional Study among Private Moroccan Dentists

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ABSTRACT

Objectives: This study aims to examine the attitude of dentists toward root canal retreatment performed in the private sector in Casablanca.

Material and methods: An anonymous questionnaire was distributed to a representative sample of 314 Moroccan dentists to conduct a descriptive cross-sectional study. Sample size calculation and sampling were performed using Epi Info software. Data were analyzed using the SPSS (Statistical Package for the Social Sciences) software. Qualitative variables were expressed by their effectiveness and percentage, and quantitative ones were represented by their mean and standard deviation.

Results: In total, 91.5% of dentists used endodontic retreatment in their daily practice, with 84.4% routinely recommending it when faced with a missing root canal filling or a painful apical lesion.

When disobturating, 51.1% of dentists used desocclusol as a root canal solvent, and 57.4% opted for a combination of manual and rotary mechanized instrumentation.

The most common accidents encountered were instrument fractures (68.4%), followed by stoppers (45.7%).

Conclusion: The results of this study revealed that dentists in Casablanca did not comply with the preliminary stages of endodontic retreatment. However, we noted an evolution toward the use of new mechanized preparation techniques and digital radiography.

KEYWORDS: retreatment, root canal therapy, endodontic reprocessing, solvents, endodontics, accidents.

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INTRODUCTION

Despite advancements in dental technology, the failure rate for endodontic retreatment is still high.

Depending on the clinical situation, there are several potential therapeutic approaches to the failure of initial endodontic treatment: orthograde and/or retrograde endodontic retreatment or tooth extraction if the tooth is irrecoverable (1).

Orthograde retreatment restores tooth function and allows for complete repair of the supporting tissues (2). It is a meticulous procedure that takes longer and is more complex than initial endodontic treatment, making it difficult to systematize given the wide range of clinical situations (3).

To investigate the attitudes of dentists in private practice in Casablanca toward endodontic retreatment. We carried out a descriptive study with the following objectives:

- To evaluate the conditions and stages of taking over an endodontic retreatment.
- To determine any accidents that may occur during this treatment.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted among private-sector dentists in the city of Casablanca registered with the National Order of Dentists.

Sampling criteria :

The sample size calculation was carried out using Epi info software. Since we had no Moroccan statistical data on the subject, we opted for an expected percentage of 50%. So, we used the formula for calculating the sample size by taking precision i of 5%, which is an expected percentage of 50%. So, on a population of 1560 dentists, the sample size was 314 dentists.

Inclusion criteria:

Our study included dentists in private practice in Casablanca-Morocco.

Exclusion criteria:

- Dentists who have closed or abandoned their practices.
- Specialists in exclusive orthodontics.
- Specialists in exclusive periodontology and oral surgery.

Data were collected using an auto-administered questionnaire that was given to the dentists on a face-to-face visit.

This questionnaire consisted of two main parts; the first part was interesting, with the variables about gender, age, place of graduation, nature of practice, and length of practice. The second one addresses the following information:

- **Root canal retreatment:** its place in daily practice, its indications, the average number per month, the type of teeth most frequently treated, and the operator who performed the initial TE.
- **Steps prior to removing root canal filling:** use of radiography and optical aids, removal of any coronal-radicular obstacles encountered, means of isolating the tooth, preendodontic reconstitution, and instruments used.
- **The root canal filling materials** most frequently found during **endodontic retreatment**.
- **Root canal cleaning products** used and method for determining working length (WL).
- **Irrigation products** used and use of intracanal medication for periapical lesions.
- **Root canal filling** techniques used.

Statistical analysis:

The study data were entered and analyzed using SPSS software at the Epidemiology and Biostatistics Laboratory of the Faculty of Dentistry of Casablanca.

The qualitative variables were described by their numbers and percentages.

The quantitative variables were represented by their numbers and means.

RESULTS

3.1 Sociodemographic and professional characteristics

In total, 314 dentists, including 176 females and 107 males, were included in this study.

They were aged between 25 and 65 years, with 37.9% (107 practitioners) aged between 36 and 45 years.

The majority (70.6%) had obtained their dental diplomas in Casablanca, with an average practice duration of 10 years. **(Table I)**

Table I: Age, gender, place of graduation and practice duration distribution

	EFFECTIVE (N)	PERCENTAGE (%)
Gender		
FEMALE	176	61,7
MALE	107	38,3
Age		
25-35 YEARS	73	26
36-45 YEARS	107	37,9
45-55 YEARS	68	24,1
55-65 YEARS	23	8,1
UNKNOWN	11	3,9
Place of graduation		
MOROCCO	241	88,5
OTHER COUNTRIES	31	11,5
UNKNOWN	41	14,5
Draduate from		
CASABLANCA	199	70,6
RABAT	42	14,9
Practice duration		
<10 YEARS	116	41,1
>10 YEARS	159	56,4
NO ANSWER	7	2,5
Type of graduation		
GENERAL PRACTITIONER	227	80,5
SPECIALIST	55	19,5

3.2 Steps of Endodontic Retreatment

3.2.1 Recourse to endodontic retreatment

The results indicated that 91.5% of practitioners who responded to the questionnaire had used endodontic retreatment for a variety of reasons:

- Pain from a forgotten root canal was mentioned by 62.1% of practitioners.
- 63.8% of practitioners who performed endodontic retreatment prior to a prosthetic project cited prosthetic reasons for a leaking filling.

Radiographic indications: The most common reason for endodontic retreatment, according to 78.7% of dentists, is an apical reaction.

- 84.4% of dentists used endodontic retreatment when there was a lack of root canal filling or a painful apical lesion. In contrast, 68.8% reported pain from root canal overfilling.

Practitioners retreated 1 to 5 teeth per month (54.6%), with multiradicular teeth being the most frequently retreated (56%). Furthermore, 79.4% of the teeth requiring endodontic retreatment had previously been treated by another practitioner (Table II).

Table II: Average number of endodontic retreatments performed per month, type of teeth treated and initial treatment operator.

	(N)	(%)
NUMBER OF ENDODONTIC RETREATMENTS PERFORMED PER MONTH		
1 TO 5	154	54,6
6 TO 10	31	10,9
11 TO 15	35	12,4
PLUS DE 15	2	0,7
INFREQUENT	4	1,5
TYPE OF TEETH TREATED		
MULTI-ROOTED	158	56
MONO-ROOTED	52	18,4
BI-ROOTED	47	16,6
NO ANSWER	25	8,8
TOOTH PREVIOUSLY TREATED BY		
OTHER DENTIST	224	79,4
ILEGAL PRACTITIONER	155	55
SAME PRACTITIONER	83	29,4
NO ANSWER	23	8,2

3-2-2 Root canal disinfection and management of special cases:

- **Removing root canal filling:**

The findings revealed that 51.1% of practitioners used desocclusol as the primary solvent when removing the root canal filling, and the insulin syringe was the most used by 42.9% of practitioners to deliver solvent to the root canal.

The root canal filling material most frequently removed during retreatment was gutta percha (GP) for 91.1% of dentists.

57.4% of dentists opted for a combination of manual and mechanized instrumentation to remove root canal filling of these:

23.4% preferred the R-Endo system combined with manual files.

19.1% opted for the FKG system combined with manual files.

18.5% used the CMA system with manual files (Table III).

Table III: Technics of removing root canal filling materials

		(N)	(%)
SOLVENTS			
	Desocclusol	144	51,1
	Eucalyptol	92	32,6
	Citrol	17	6
	Resolv	15	5,3
	Others	78	27,7
	No answer	23	6
REMOVED MATERIALS			
	Gutta percha	257	91,1
	Sealing cement alone	78	27,7
	Silver cone	27	9,6
	Resin	27	9,6
	No answer	23	8
INSTRUMENTATION USED			
	Manual + mechanized	162	57,4
	Manual	73	25,9
	Rotative mechanized	23	8,2
	No answer	24	8,5
	***Manual**		
	Lime H	27	9,6
	Lime K	28	9,6
	Lime K+H	33	11,7
	***Rotary**		
	CMA	18	6,4
	FKG	14	5
	R-ENDO	14	5
	***Manual & Rotary**		
	Lime H/K+ R-ENDO	38	23,4
	Lime H/K+ FKG	31	19,1
	Lime H/K+CMA	30	18,5
	Lime H/K+PROTAPER	16	9,9
	Lime H/K+ENDOSTAR	8	4,9
	LimeH/K+VDW MECANISE	7	4,3
	Lime H/K+REVO-S	5	3,1

- **Management of special cases:**

The outcomes demonstrated that 80.9% of clinicians used a temporary intracanal medication in cases of chronic endodontic periapical lesions. For 75.5% of practitioners, this was primarily calcium hydroxide Ca(OH)2.

In the case of acute periapical lesions, 36.5% of practitioners left the tooth open; 21.3% closed the tooth either with a medicated cotton pellet only or with a cotton pellet and a temporary filling.

3-2-3 Root canal preparation:

NaOCl was the chemical root canal disinfection solution of choice for 88.7% of practitioners. 50% of dentists used ethylene diamine tetra-acetic acid (EDTA) as a chelating agent during endodontic retreatment. 39% of dentists used NaOCl with «¼ NaOCl + 3/4 H2O ».

Regarding root canal shaping, 62.8% of dentists combined manual and mechanized rotary techniques; 62.4% of practitioners used radiovisiography (RVG) as a means of LW determination **(Table IV)**.

Table IV: Root canal Preparation

	(N)	(%)
CHOICE OF CANAL IRRIGATION PRODUCT		
NAOCL	250	88,7
PHYSIOLOGIC SERUM	2	0,7
CHELATEURS : EDTA	141	50
CHLORHEXIDINE	28	9,9
OTHER	8	2,8
NAOCL CONCENTRATION		
¼1/4 NAOCL + 3/4 H2O	110	39
2/3 NAOCL +1/3 H2O	27	9,6
1/3 NAOCL + 2/3H20	44	15,6
1/2 NAOCL + 1/2H2O	42	14,9
OTHER	17	6
AUCUNE REPONSE	32	11
LW DETERMINATION METHODS		
RAVISIOGRAPHY	176	62,4
APEX LOCATER	112	39,7
RETROALVEOLAR RADIOGRAPHY	43	15,2
TACTILE SENSITIVITY	8	28,4
ROOT CANAL SHAPING TECHNIQUES		
MANUAL + CONTINUOUS ROTATION	177	62,8
MANUAL + RECIPROCITY	42	14,9
MANUAL ONLY	35	12,4
NO RESPONSE	28	10

3.2.4 Root canal and coronal filling:

Gutta-percha (GP) and root canal sealer were the root canal filling materials of choice for 86.9% of practitioners.

Eugenol-based cements were used by 35.5% of dentists, while 51.1% of dentists used the monocone technique to fill root canals.

However, 80.9% of dentists did not perform the final coronal restoration in the same session after root canal obturation.

Composite was the material of choice for coronal restoration for 70.2% of practitioners **(Table V).**

Table V: Root canal obturation and coronal restoration

	(N)	(%)
ROOT CANAL SEALERS		
GP+ ENDODONTIC CEMENT	245	86,9
SILVER CONE	2	0,7
ENDODONTIC CEMENT	2	0,7
TYPE OF ENDODONTIC CEMENT		
EUGENOL CEMENT	100	35,5
CORTICOID-BASED CEMENT	72	25,5
OTHER	38	13,5
NONE	4	1,4
NO RESPONSE	68	24
ROOT CANAL FILLING TECHNIQUES		
LATERAL CONDENSATION	106	37,6
VERTICAL CONDENSATION	24	8,5
THERMOMECHANICAL CONDENSATION	22	7,8
SINGLE-CONE	144	51,1
THERMAFIL	19	6,7
FINAL RESTORATION IN THE SAME SESSION AS ROOT CANAL FILLING		
NO	228	80,9
YES	30	10,6
NO RESPONSE	24	8,5
MATERIALS FOR DEFINITIVE CORONAL RESTORATIONS		
COMPOSITE	198	70,2
CROWN	123	43,6
GLASS IONOMER+COMPOSITE	120	42,6
AMALGAME	38	13,5
INLAY/ONLAY	33	11,7
NO RESPONSE	26	9

3.3 Success rate of endodontic retreatment:

The percentage of practitioners who felt that their ETR was often successful was 75.9%. The most frequent causes of failure were:

- 39.7% of practitioners had an accident.
- No initial input/treatment for 39% of dentists.
- Persistent pain for 22.3%.
- Persistence of apical lesions for 13.5%.

Among the accidents most frequently encountered during the endodontic retreatment:
68.4% of dentists reported instrument fractures.
45.7% reported the occurrence of abutments.
46.1% said that accidents often occurred during root obstacle removal.

DISCUSSION

The study population of practicing dentists in Casablanca is predominantly female (61.7%). Their average age is 40, with a minority of practitioners over 55 (8.7%). By contrast, the 35–45 age group accounts for 37.9%.
6.4% of practitioners had more than 10 years' experience.
Endodontic retreatment is designed to be a very long-term, sustainable therapy. Rigorous disinfection, followed by a high-quality filling, will enable the treated tooth to be preserved on the arch (3,4). However, despite technological advances in endodontics, the number of TE failures continues to rise over time (5,6,7).
Recently, growing demand for TE has been seen in the liberal omni-practice, dictated by an increasing patient demand to preserve their natural dentition (6,8,9,10).
Accordingly, our study demonstrates that 91.5% of practitioners performed TEN within their practice. This percentage is significantly higher than those obtained in Jerusalem, where 20% of practitioners performed endodontic retreatment (Stabholz A, 1990) (11). The results obtained in our study seem to be linked to the inadequate quality of TE in Morocco. Thus, endodontic retreatment decision-making is a complex process involving exhaustive analysis of general, clinical, and radiographic parameters related to the patient. Added to this are the technical resources available and the skills of each practitioner. The indications for TEN can be algal, radiological, or prosthetic (4).
Indeed, the results of our study revealed that 62.1% of practitioners frequently repeated the TE in the event of an untreated canal. Other studies have reported lower rates:

- 42% in the USA (Hoen and Pink, 2002) (9)
- 32% in Nepal (Gautam et al., 2012) (12)
- 12% in the United States (Baruwa et al., 2020) (13)

The very high rate observed in our study seems to indicate a lack of clinical rigor during initial TE and low use of radiography and optical aids. Moreover, the nondetection of certain canals is the direct result of an incorrect access cavity, a lack of knowledge of the anatomy of the root canal system, or the nonuse of magnification systems (3,4).
The presence of an apical radiolucency was considered by 78.7% of practitioners to be the most frequent indication of TEN. This result is close to the 71% observed in Canada by Farzaneh et al. in 2004 (14). However, it is higher than the 33% observed in Pakistan by Nagi et al. in 2017 (10).
According to a recent systematic review and meta-analysis, the prevalence of apical periodontitis in filled teeth reaches 39% (Tibúrcio-Machado et al.,2021). Causes of apical periodontitis include insufficient irrigation, inadequate instrumentation, and incomplete obturation of the root canal system; this may be due to anatomical problems preventing accessibility or coronal microleakage (Nair et al.,2005). Unfortunately, even if all procedural steps have been followed, intraradicular microorganisms, in the form of biofilms (Ricucci et al., 2009; Ricucci & Siqueira,2010), may persist in inaccessible branches and anastomoses of the primary and accessory canals and inside dentinal tubules (Nair et al.,2005; Peters et al.,1995; Vieira et al.,2012). Consequently, apical periodontitis can still emerge, persist, or recur (Siqueira et al.,2014). Additionally, there are extraradicular factors associated with biofilm formation on the outer root surface that can interfere with posttreatment healing of apical periodontitis and contribute to endodontic treatment failure (Nair et al., 2005; Ricucci et al., 2005) (15).
Root canal underfilling has been shown to have the most negative impact on the prognosis of endodontic treatment (16,17). As a result, 42.9% of practitioners surveyed indicated endodontic retreatment in the face of **insufficient root canal obturation**. This rate is similar to that found in Pakistan, where 39% of dentists mentioned underfilling as the most frequent reason for EBR (Nagi et al., 2017) (10).
Theoretically, **obturation density** and lateral canal wall sealing represent endodontic treatment evaluation criteria. 14.9% of the dentists questioned in our survey took back the TE when faced with a lack of density. This result is lower than that found in other studies, where the rates were as follows:

- 59% in the USA (Hoen et Pink., 2002) (9)
- 45% in Nepal (Gautam et al., 2012) (12)
- 30.4% in South Korea (Song et al., 2011) (18)

According to our findings, 68.8% of practitioners systematically took back the TE when faced with an overrun associated with pain, and only 4.6% of practitioners did so when faced with an overrun without pain. This percentage remains higher than that found in other countries, where the rates of TE practice in the face of an overrun were as follows:

- 4.2% in China (Qian et al., 2015) (19)
- 3% in South Korea (Song et al., 2011) (18)
- 2% in Pakistan (Nagi et al., 2017) (10)

54.6% of practitioners removed between 1 and 5 teeth per month. This result is close to that observed in Pakistan by Nagi et al. in 2017, where 60% of dentists interviewed in a survey performed between one and three cases of TEN per month (10).
The types of teeth most frequently reprocessed were pluriradiculate (56%) and monoradiculate (18.4%). These results are close to the rates observed in Saudi Arabia, where 64.4% of reprocessed teeth were pluriradiculate and 14.3 were monoradiculate (20).
Root canal desobturation is based firstly on the recognition of existing intra-root canal materials and then on their removal (21). Various materials can be found, the most common of which are as follows:
Root canal pastes and cements: the most frequently encountered are based on zinc oxide-eugenol (ZOE) or resin. More recently, bioceramic cements have been introduced.
Semisolid materials: GP or Resilon, flexible stakes: plastic or GP-coated and cross-linked GP cones.
Solid materials: silver cones and fractured instruments.
The outcomes of our study revealed that 91% of practitioners frequently found GP during TENs. This remains higher than the 65% found by Farzaneh et al. in 2004 in Canada (14). **Desocclusol** was the solvent of choice for 46% of practitioners. This result is close to the 51% obtained by Nagi et al. in 2017 in Pakistan (10).

However, the literature was not clear on the actual effectiveness of these solvents in removing GP.

Based on the current data, regardless of the instrumentation technique (manual or mechanical) chosen by the clinician, the use of solvents during the disobturation process can lead to disadvantages in root canal cleanliness and should only be considered if the previous working length could not be accessed without it. Some studies demonstrated that solvents can make the removal of root-filling material more difficult, as they can make the material structure viscous and highly adhesive, leading to the formation of softened GP films on the root canal surface, even penetrating irregularities in the root canal or dentinal tubules. Alteration of material properties in response to solvent use can even make the retreatment procedure longer or more difficult (22).

To unblock root canals, 57.4% of dentists opted for a combination of manual and mechanized instrumentation. This result is similar to that found in Pakistan by Nagi et al. (2017) (55%) (10).

The occurrence of a chronic or acute periapical or lateroradicular lesion most often manifests as an endodontic failure. These are defined as inflammatory lesions of the deep periodontium, mainly in the periapical region, resulting from bacterial infection of the endodontium. In these cases, intraroot canal medications are particularly useful. They reduce the bacterial load, eliminating existing infection and preventing re-infection of the root canal system. These antimicrobial agents are placed within the canals intersequently after chemical and mechanical disinfection (23). In our study, 80.9% used intracanal medication for LIPOE. However, this result is higher than those in other studies:

- 2.7% observed in Jordan (Al-Omari WM, 2004) (24)
- 53% observed in Saudi Arabia (Natto ZS, 2014) (25)

Indeed, most dentists (88.7%) used NaOCl as their main irrigant. The result obtained is in line with studies carried out in other countries where the use of NaOCl reaches:

- 93% in the USA (Savani et al., 2014) (26).
- 90% in (Treguer C, 2012) (27).

However, 39% of practitioners in our sample used ¼ NaOCl and ¾ H2O for root canal disinfection.

A study published in 2022 evaluating the presence of aerobic bacteria, anaerobic bacteria, *E. faecalis, F. nucleatum, Propionibacterium ssp., Actinomyces ssp.*, and their reduction at different stages of endodontic reprocessing using the conventional protocol (5.25% sodium hypochlorite as irrigant with calcium hydroxide as intracanal medicament) and the recommended protocol (SmearOFF as irrigant with 2% chlorhexidine gel (CHX) as intracanal medicament).

SmearOFF as the final irrigant resulted in a significantly greater reduction in bacterial load for *E. faecalis and F. nucleatum* compared with NaOCl gel. 2% CHX may be recommended in cases of retreatment, as it has been reported to be significantly effective against E. faecalis (28). Concerning the root canal shaping technique, 62.8% of the study population chose manual and rotary techniques. This result is close to the 55% observed in England (Palmer et al., 2009) (29).

Root canal reobturation using the monocone technique was the technique most frequently used by dentists (51.1%). This result is still very high compared with the 7% found by Farzaneh et al. in 2004 in Canada (14).

Although the monocone technique is quick and straightforward, it cannot reliably ensure three-dimensional obturation of the entire root canal system **except with calcium silicate cements**.

For this reason, we are increasingly adopting cold and hot gutta percha compaction techniques to achieve three-dimensional obturation within safe apical limits and reduce the rate of apical protrusion.

It is widely accepted that a watertight coronal filling is the only guarantee of successful endodontic therapy, hence the importance of choosing the most appropriate material. In fact, our results revealed that composite was the material of choice for coronal reconstruction for 70.2% of the dentists questioned. Indeed, when bonded partial reconstruction is indicated, the material with the best physicochemical, mechanical, and aesthetic qualities is composite. Moreover, it requires the application of a system that significantly strengthens residual tooth structures. As for amalgam, it was used by only 13.5% of practitioners, as it does not offer all the required qualities.

A high proportion of practitioners (76%) often passed the endodontic retreatment. This result is in line with the findings of a number of studies in different countries, where TEN success rates were as follows:

- 88% to 92% in Canada (Farzaneh et al., 2004) (14).
- 85% in England (Peak et al., 2001) (30).
- 83% in 4 to 6 years in the USA, (Torabinejad et al., 2009) (31).

To update their knowledge and skills in the recovery of TE, 76% of practitioners mentioned their need for dedicated training on this subject, primarily in the form of workshops (39.7%). This is in line with a study carried out in England, where 70% of practitioners mentioned their need for continuing education in endodontics. Practical courses were the method preferred by the majority (29).

CONCLUSION

This work gave us an insight into the attitudes of private practitioners in Casablanca toward TEN. We were able to conclude that the rules of good endodontic practice are not generally respected, notably the use of the dam, pre-endodontic reconstitution, radiography, and irrigation methods.

The quality of care through better training of practitioners and adequate remuneration for endodontic care, in line with the time and resources involved, has to be improved.

Two conditions must be met to achieve this: improved quality of care through better training of practitioners and adequate remuneration for endodontic care in line with the time and resources invested.

The obsolete nomenclature for endodontic procedures (endodontic treatment, endodontic retreatment, endodontic surgery) should be reviewed.

Treatment-related difficulties and complications should be considered, such as costs of treatment management, removal of fractured instruments, treatment of perforations, and false routes.

The quality of the treatment provided before approving a prosthetic restoration also needs to be checked.

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AUTHORS' CONTRIBUTIONS
The participation of each author corresponds to the criteria of authorship and contributorship emphasized in the Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly work in Medical Journals of the International Committee of Medical Journal Editors. Indeed, all the authors have actively participated in the redaction, the revision of the manuscript, and provided approval for this final revised version.

COMPETING INTERESTS
The authors declare no competing interests with this case.

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