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Research Paper: Clinical and Epidemiological Profile of Oral Squamous Cell Carcinoma in Southeast Iran

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ABSTRACT

Introduction: Effective root canal treatment requires complete disinfection of the root canal system, which is largely achieved through the use of chemical irrigants and adjunctive techniques. This study aimed to evaluate the practice of general dental practitioners in Khorramabad, Iran, regarding their use of chemical irrigants and adjunctive techniques during endodontic treatment.

Materials and Methods: A descriptive cross-sectional survey was conducted on 300 general dentists in Khorramabad from January to December 2024. Data were collected using a validated and reliable questionnaire (content validity ratio [CVR]=0.88, content validity index [CVI]=0.91, intraclass correlation coefficient [ICC]=0.95, and Cronbach's α=0.83) which assessed demographic, professional characteristics, choice of chemical irrigants, irrigation techniques, and adjunctive methods. As this was a descriptive survey, no hypothesis testing was performed; results are reported as frequencies and percentages only.

Results: Sodium hypochlorite (NaOCl) was the most commonly used irrigant (54%), predominantly at 0.5% concentration (66% of all respondents). Chlorhexidine (CHX) was used by only 19.3% of participants. Most dentists used 27- or 30-gauge needles, with irrigation performed 3-4 mm from the apex and for 30 seconds to 1 minute per canal. Approximately 60% of participants used irrigation adjuncts, primarily manual activation, while only 11% targeted smear layer removal. Antibacterial and tissue-dissolving properties were the primary reasons for irrigant selection.

Conclusions: The findings highlight the need for improved education on evidence-based irrigation practices, particularly regarding the optimal concentration of NaOCl, smear layer removal, and the effective use of adjunctive activation systems.

1. Introduction

Secondary or persistent endodontic infections can be caused by any failure in the chemical and mechanical preparation of the root canal system and low-quality root canal filling, which is usually characterized by the presence of an apical periodontitis and radiographic lesion (1).

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In other words, root canal treatment failure is mainly caused by microorganisms remained in the root canal system after disinfection or those recolonized and survived in the filled spaces of the canal system (2).

An ideal irrigating solution has the following features is needed to effectively clean and disinfect the root canal system: A broad antimicrobial spectrum and high effectiveness; necrotic tissue-dissolving power; smear layer removal potential; long-lasting anti-bacterial effects; lubricant for endodontic instruments; and non-carcinogenicity. It should be cost-effective and easy to use, and should not cause tooth discoloration or adversely affect dentin or the sealing ability of filling materials (3).

Due to its antibacterial properties and tissue-dissolving capability, sodium hypochlorite (NaOCl), is the most commonly used irrigant in endodontics (4, 5), It is regarded as the gold standard of root canal irrigants. NaOCl is used in 0.5-6% concentrations. Some studies documenting the stronger antibacterial effects of higher concentrations (5.25-6%) compared to mild concentrations (2-2.5%) (6). In contrast, some researchers have reported no significant differences between these concentrations in terms of effectiveness. Since it meets most of the criteria of an ideal irrigant despite its unpleasant odor and taste, toxicity, and limited removal of inorganic tissue, it has become the recommended irrigant of choice (7).

Considering its high clinical efficacy and lubricating properties, Chlorhexidine (CHX) is used as an irrigating solution or intra-canal medication in endodontics because of its broad antimicrobial activity and substantivity (residual antimicrobial activity) and its lower cytotoxicity compared to NaOCl (8). However, CHX fails to fully replace NaOCl because it does not contain tissue-dissolving properties (9).

An irrigant that can dissolve inorganic tissue is required for the complete disinfection of the root canal system. The removal of the smear layer is of paramount importance for complete disinfection and the three-dimensional filling of the root canal system, thereby affecting the root canal treatment outcome (10).

Some irrigants, including NaOCl, CHX, and a mixture of doxycycline (a tetracycline isomer), citric acid, and a detergent (Tween 80) (MTAD), are utilized because of their tissue-dissolving properties and antimicrobial activities (11). Regardless of their limited antibacterial activity, 17% EDTA (ethylenediaminetetraacetic acid) and citric acid are options for smear layer removal (12).

According to previous studies, due to its high antibacterial properties, QMix (Dentsply Tulsa, Tulsa, OK, USA) removes the smear layer (13). Controversial findings have been reported when comparing the antimicrobial properties of QMix with other irrigants versus *Enterococcus faecalis* (14-18).

The complexities of the root canal system make bacterial removal a challenge. In this regard, irrigation adjuncts, including hydromechanical agitation and systems such as the Endo Activator, a sonic-driven device, and EndoVac, are proposed to enhance the effectiveness and enhance the penetration of irrigants inside the root canal system.

In order to improve the overall success of root canal therapy, dentists need to be aware of current trends and expand their knowledge and understanding of chemical irrigant and their applications. This study aimed to evaluate the use of irrigants and adjuncts by dentists in Khorramabad, Iran, and to identify gaps relative to international recommendations. Therefore, our aim was to determine the current trends in the use of all available chemical irrigant and irrigant adjuncts during root canal therapy by licensed general dental practitioners (GDPs) sectors in the city of Khorramabad, Iran.

2. Materials and Methods

A descriptive cross-sectional survey was conducted on 300 dentists in Khorramabad, Iran, from January to December 2024. The study protocol was approved by the ethics committee of Lorestan University of Medical Sciences and adhered to the principles of the declaration of Helsinki (19). Participation was voluntary, and written informed consent was obtained from all dentists. No personal identifiers were collected. Completed questionnaires were kept confidential and stored securely with access limited to the research team.

Based on the target population of 685 dentists, a 95% confidence level, and a 5% margin of error (assuming P=0.50), the minimum required sample size after finite population correction was 300. Allowing for an anticipated 8% non-response, at least 326 invitations were needed; to ensure ≥300 completed questionnaires, we oversampled and distributed 350 questionnaires.

GDPs who were actively practicing in Khorramabad at the time of the study and consented to participate were included. Dentists who were specialists, interns, retired, or not currently engaged in clinical practice were exclud-

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ed. All general dentists practicing in Khorramabad, Iran, were identified from the official list provided by the local branch of the Iranian Medical Council. A census approach was used, inviting all listed dentists to participate voluntarily and anonymously.

A structured questionnaire was developed and validated for this study. The questionnaire was adapted from a previously validated tool and translated into Persian using forward-backward translation by bilingual experts. The questionnaire was reviewed by faculty members of the Endodontics Department for content validity and a pilot study with 20 dentists assessed reliability. Items with low reliability were revised, resulting in a final instrument with a content validity ratio (CVR) of 0.88, content validity index (CVI) of 0.91, intraclass correlation coefficient (ICC) of 0.95, and Cronbach's α of 0.83.

The questionnaire comprised three main domains and a total of 16 open- and close-ended questions consisting of numerical rankings, multiple choice questions, and multiple selections with options for free text answers that were appropriate. The first section captured participants' demographic (age, gender) and professional (years of practice, workplace type) information. The remaining sections, adapted from previously validated instruments, addressed the use of chemical irrigants and irrigation adjuncts in endodontics.

The survey was administered in paper format. Two trained dental students distributed the questionnaires in person to general dental practitioners at their workplaces in Khorramabad. Participants were asked to complete the forms on-site or return them within a few days. Two weeks later, a follow-up visit was conducted to collect any remaining questionnaires and to remind non-respondents. All returned surveys were checked for completeness, and data were entered into a secure database by two independent researchers to ensure accuracy and minimize data entry errors.

Questionnaires with substantial missing items were excluded from analysis. For remaining questionnaires, missing responses were handled using pairwise deletion. Single- choice items were coded as responses (e.g. irrigant choices) were coded in to separate binary variables to reflect all selected options. Data entry was checked for accuracy by two independent researchers.

Descriptive statistics (frequencies and percentages) were calculated using SPSS software, version 19. No inferential tests were applied. After accounting for the finite population correction and a potential 8% non-response rate, a final sample of 300 dentist was targeted.

3. Results

Of the 350 questionnaires distributed, 300 were completed and included (response rate=85.7%), exceeding the minimum required sample (Figure 1). Among the 300 completed self-reported questionnaires, there were 22 participants (7.33%) from the private sector, 100 participants (33.33%) from the public sector, and 178 participants (59.33%) from both public and private sectors. In this regard, the respondents were 194(64.7%) men and 106(35.3%) women, with work experiences ranging from 1 to 30 years (Table 1).

As presented in Table 2, 54% (n=162) of the participants primarily used NaOCl as the main chemical irrigant, with only 10 persons (3.33%) preferring full-strength NaOCl (concentration ≥5.25%). On the other hand, 80.7% of the respondents (n=234) reported not using CHX in root canal treatments (Table 3).

4. Discussion

This cross-sectional survey was adapted from study of Alzamzami et al. (7). The present study mainly aimed to collect data from GDPs in Khorramabad to determine their use of chemical irrigants and adjuncts during endodontic treatment. Consistent with the findings of Albahiti (20) and Alzamzami (7), a majority of the participants (n=162, 54%) introduced NaOCl as their preferred irrigant Table 1.

The antibacterial and tissue-dissolving properties of this irrigating solution makes it the gold standard for root canal irrigants (4). From another perspective, CHX was not used by 242 participants (80.7%; Table 2). Despite its substantivity properties, CHX lacks tissue-dissolving properties, and its mixture with NaOCl forms a toxic compound called parachloroaniline, leading to tooth discoloration (7).

There are controversies regarding the removal of the smear layer in endodontics. This layer comprises dentinal debris, cellular remnants, and dentin chips extending into the dentinal tubules as long as a few micrometers. It may get infected and protect bacteria within the dentinal tubules. To decrease bacterial load and allow irrigants to penetrate the tubules, removing the smear layer is thus recommended to promote sealer penetration and gutta-percha adaptation to canal walls (21). In our study,

Table 1. Demographic and professional characteristics of participants

Variables		Mean±SD/No. (%)
Age (y)		36±7
Gender	Male	194(64.7)
	Female	106(35.3)
Years of practice		10±6
Workplace type	Public clinic	100(33.33)
	Private clinic	22(7.33)
	Both	178(59.33)

11.3% of participants reported aiming to remove the smear layer.

Removing the smear layer allows for further cleaning and disinfection of the root canal walls and better adaptation of the root canal filling material (22-24). However, the presence of the smear layer can act as a seal for the dentinal tubules, minimizing the ability of bacteria and their toxins to penetrate the dentinal tubules (25).

Some participants (11.3%) used chelating agents as an adjunct (Table 4); however, 14.3% of the individuals reported using this adjunct in Albahiti's study (20). Alzamzami et al. found that 54(18%) and 52(17%) participants used chelating agents such as EDTA alone or n combination with other solutions such as EDTA and saline, respectively (7).

In line with the findings of Alzamzami et al. (7), Gopikrishna et al. (2), Dutner et al. (26), and Koppolu et al. (27), the main reasons for selecting irrigants were their antibacterial and tissue-dissolving properties.

Table 2. Frequency distributions and percentages of chemical solutions used as the primarily irrigant*

Type of chemical Solution	No. (%)
NaOCl	162(54)
CHX; saline	40(13.3)
Saline	4(1.3)
NaOCl; EDTA	12(4)
NaOCl; saline	44(14.7)
NaOCl; CHX	2(0.7)
NaOCl; CHX; EDTA	2(0.7)
NaOCl; saline; EDTA	2(0.7)
NaOCl; CHX; saline	10(3.3)
Others (combinations)	22(7.3)
Total	300(100)

EDTA: Ethylenediaminetetraacetic acid, MTAD: Mixture of tetracycline isomer, acid, and detergent.

*Descriptive frequencies; no inferential test applied.

Table 3. Concentrations of NaOCl and CHX and syringe irrigation details*

Variables	Responses	No. (%)
Concentrations of NaOCl	0.5%	198(66)
	2.5%	40(13.3)
	5.25%	12(4)
	I don't use NaOCL	50(16.7)
Concentrations of CHX	0.12%	20(6.7)
	0.2%	24(8)
	2%	14(4.7)
	I don't use CHX	242(80.7)
Routine gauge of the needle	26 gauge	70(23.3)
	27 gauge	156(52)
	30 gauge	56(18.7)
31 gauge		18(6)
Depth of penetration of needle	1 mm from apical foramen	14(4.7)
	2 mm from apical foramen	10(3.3)
	3 mm from apical foramen	108(36)
	4 mm from apical foramen	168(56)
Duration of irrigation per canal	<30 seconds	24(8)
	30 seconds - 1 minute	204(68)
	Minutes1 – 2	56(18.7)
	>2 minutes	16(5.3)
Volume of irrigating solution (mL)	5	42(14)
	10	178(59.3)
	15	58(19.3)
	>15	22(7.3)

*Descriptive frequencies; no inferential test applied.

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In this study, 198(66%), 40(13.33%), and 12(4%) participants used NaOCl 0.5%, NaOCl 2.5%, and NaOCl 5.25%, respectively Table 2. Some studies have documented the greater antibacterial effects of higher NaOCl concentrations (5.2-6%) compared to its lower concentrations (2-2.5%) (28-30). Although higher NaOCl concentrations significantly reinforce disinfection properties, Pereira et al. (31) concluded that there is no relationship between NaOCl concentration and biofilm removal from the isthmus and lateral canal during syringe irrigation. Similarly, Verma et al. (32) detected no significant difference between groups using high (5%) and low (1%) concentrations in terms of healing rates or postoperative pain. Future studies are suggested to address the necessity of using high-concentration NaOCl in clinical operations.

Table 4. Use of irrigation adjuncts*

Use of Irrigation Adjuncts	Irrigation Adjunct	No. (%)
I use adjuncts irrigation devices	Negative pressure (example: Endovac)	6(2)
	Sonic activation	30(10)
	Ultrasonic activation	0(0)
	Sub sonic activation (example: Endoactivator)	4(1.3)
	Manual activation	140(46.7)
I don't use adjuncts irrigation devices	Irrigation adjunct	120(40)
Total		300(100)

*Descriptive frequencies; no inferential test applied.

Table 5. In which endodontic treatment do you prefer adjunct to irrigation*

Adjunct Use Preference	Type of Treatment	No. (%)
Using adjunct to irrigation	NSRCRT	100(33.3)
	All cases	58(19.3)
	None	44(14.7)
	NSRCT	98(32.7)
Total		300(100)

NSRCRT: Non-surgical root canal retreatment, NSRCT: Non-surgical root canal treatment.

*Descriptive frequencies; no inferential test applied.

The higher the concentration of NaOCl, the lower the mechanical strength of the root dentin. Therefore, endodontists should avoid using excessively high concentrations of NaOCl for irrigation to prevent possible root fracture in root-treated teeth (33). Although the use of low concentrations of NaOCl may reduce the effectiveness of soft tissue solubilization, this reduction can be compensated for by other safer methods, for example, the use of higher temperatures, continuous agitation, surfactants, or simply frequent replacement of washing solutions (34).

In this study, 156(52%) and 56(18.7%) participants used 27-gauge needles and 30-gauge needles, respectively (Table 2). According to the literature, 27-gauge or preferably 30-gauge needles are necessary to access the apical region of the canal (35, 36).

Similar to Alzamzami et al. (7) study, most of the participants in the present study believed that the optimal irrigation time ranged from 30 seconds to 1 minute (Table 3). There is a direct correlation between increasing exposure time and enhancing the antibacterial effect of NaOCl. In their study, Ma et al. showed that extending the exposure time from 1 to 3 minutes caused a higher proportion of dead cell volume in dentin, regardless of NaOCl concentration (37).

NaOCl has traditionally been injected into the root canal system via a syringe, which has not been accompanied by high satisfaction (3). Consequently, some agitation techniques, including passive ultrasonic irrigation (PUI), passive sonic irrigation (PSI), and laser-activated irrigation (LAI), have been introduced for disinfection and debridement of the root canal system. Compared to studies by Dutner et al. (26) and Alzamzam et al. (7), more participants in the present study used irrigation adjuncts (60%) and manual activation (46.66%) (Table 4). The higher frequency of manual activation reports can be attributed to its low cost and the non-requirement of special devices.

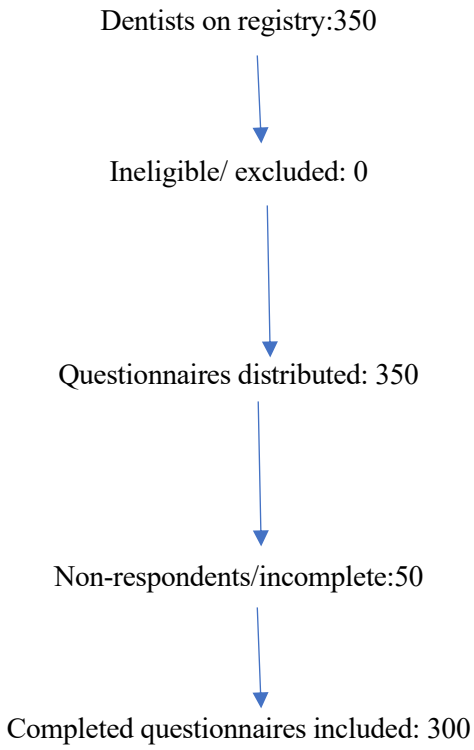

Figure 1. Flow of study participants

Table 5 also shows the use of adjunct to irrigation in various types of root canal treatment. In the present study, about one-third of participants used irrigation adjuncts in non-surgical root canal treatment (32.7%) and non-surgical root canal retreatment (33.3%), while 19.3% reported using them in all cases, which was lower than that reported by Alzamzami et al (7).

Limitations of this study include its cross-sectional design, reliance on self- reported practices, restriction to Khorramabad, and descriptive analysis without inferential statistics. While the results provide insight in to local endodontic practices, further multicenter studies with objective outcome measures are recommended to validate these finding and inform clinical guidelines. Moreover, future researchers should repeat this study in other cities with larger sample sizes to delve into the challenges dentists face in performing effective disinfection procedures in endodontics.

Conclusions

The majority of surveyed dentists relied on suboptimal irrigant concentrations, indicating the need for national and continuing education programs to align endodontic practice with evidence-based irrigation protocols. Only 11.33% of participants aimed to remove the smear layer, while more than half reported using irrigation adjuncts, predominantly manual activation. Antibacterial and tissue-dissolving properties were the main factors influencing irrigant selection, which are also the primary features of NaOCl.

These findings highlight the importance of regular training workshops to update dentists' knowledge on optimal irrigant use and to promote the adoption of state-of-the-art disinfection techniques, including manual or device-assisted activation of irrigants.

Ethical Considerations

This study was approved by the Research Ethics Committee of Lorestan University of Medical Sciences, Khorramabad, Iran (Code: IR.LUMS.REC.1402.200).

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Author's Contributions

Maryam Dalaei-Moghadam: Conceptualization, Methodology, Writing-Review and Editing Abbas Asefi: Methodology, Investigation, Writing-Review and Editing Alaedin Mirmoosavi: Investigation, Visualization, Writing-Original draft.

Conflict of Interest

The authors declared no conflict of interest.

Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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