ORIGINAL ARTICLE

ANNALS OF PUNJAB MEDICAL COLLEGE

Knowledge and Awareness of Dentists about Hypochlorite Emergencies and their Management during Endodontic Treatment

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Submitted for Publication: 21-07-2024
Accepted for Publication 13-08-2024

How to Cite: Riaz S, Hassan H, Naz S, Iqbal K, Haider I, Sajjad M. Knowledge and Awareness of Dentists about Hypochlorite Emergencies and their Management during Endodontic Treatment. APMC 2024;18(4):278-283. **DOI: 10.29054/APMC/2024.1655**

ABSTRACT

Objective: This study aims to evaluate and compare dentists' knowledge and awareness of hypochlorite emergencies during endodontic treatment and their management. **Study Design:** Cross-sectional study. **Settings:** de 'Montmorency College of Dentistry, Lahore Pakistan. **Duration:** From July 2023 to January 2024. **Methods:** The study involved 206 dentists from various dental institutes in Punjab, Pakistan. A meticulously self-developed 21-item questionnaire assessed demographics, knowledge, and awareness of hypochlorite accidents. Data were analyzed using SPSS version 25, with non-parametric tests applied due to non-normal data distribution. **Results:** Female participants demonstrated significantly higher knowledge scores than males (p=0.012). No significant differences in knowledge scores were found between participants from public and private institutes (p=0.859). Assistant Professors and above had the highest mean knowledge scores (p<0.001). Participants taught about hypochlorite emergencies scored significantly higher (p<0.001). Irrigation beyond the apex was the most frequently reported emergency, particularly among those with more than five years of practice (p=0.004). **Conclusion:** The study highlights the need for comprehensive training and continuous education to manage hypochlorite emergencies effectively. Addressing knowledge gaps, especially in public institutes, and ensuring the availability of emergency kits can significantly improve patient safety and outcomes. Future research should focus on developing standardized training modules and assessing the long-term impact of enhanced educational interventions.

Keywords: *Sodium hypochlorite, Patient safety, Endodontics, Dental irrigation.*

INTRODUCTION

Endodontic therapy, also known as root canal therapy, is an essential aspect of contemporary dentistry that aims to preserve natural teeth by treating the infected pulp and root canal system.[1] Due to its exceptional antimicrobial properties and tissue-dissolving ability, sodium hypochlorite (NaOCl) is commonly used as an irrigant in endodontic procedures. However, despite its benefits, NaOCl can pose risks and complications, particularly when used improperly or in high concentrations.[2,3] Hypochlorite emergencies during endodontic treatment, such as accidental extrusion into periapical tissues, can result in severe complications, including pain, swelling, tissue necrosis, and in extreme cases, life-threatening consequences.[2,4]

Hypochlorite accident typically occurs in teeth with large apical foramina or when the apical constriction is lost during root canal preparation. In addition, excessive pressure during irrigation can cause significant volumes of the irrigant to come into contact with the apical tissues.[5] If this occurs, NaOCl's exceptional tissue-dissolving capacity will damage endothelial and fibroblast cells, cause hemolysis and ulceration, suppress neutrophil migration, and cause necrosis, manifesting as acute pain, swelling, ecchymosis, paresthesia, and secondary infection.[6] NaOCl's optimal effective

percentage varies from 2.6% to 5.25%. It has been established, however, that concentrations above 0.5% are cytotoxic and capable of corroding metals. Accidental spillage can cause damage to clothing as well as severe injuries to the eyes, epidermis, and oral mucosa.[7]

The effective management of hypochlorite emergencies requires the knowledge and vigilance of dental professionals, particularly dentists performing endodontic procedures. Understanding the potential risks associated with hypochlorite use, recognizing the symptoms of hypochlorite accidents, and possessing the skills necessary to manage these emergencies promptly and effectively is essential for ensuring patient safety and positive treatment outcomes.[5,6]

Multiple studies have indicated that dentists' knowledge of the potential complications associated with hypochlorite accidents varies.[8,9] Roshan *et al*. (2022) found that many dentists were unaware of the potential adverse impacts of hypochlorite accidents.[9]

A survey conducted by Glassman *et al*. (2015) revealed that many dentists lacked a protocol or emergency equipment for dealing with hypochlorite accidents. In addition, the study revealed that dentists lacked confidence in managing such emergencies effectively and lacked knowledge of the appropriate management techniques.[10]

Several studies have evaluated dentists' awareness and knowledge of hypochlorite emergencies during endodontic treatment.[8,9,11] Still, there are no recognized standards for managing NaOCl incidents; the primary goal of conservative management is to eradicate the problem entirely. Pain management, oedema reduction, and averting secondary infections are regarded as the most important aspects of treatment. In severe cases, hospitalization or surgical intervention may be required.[5,12]

This research aims to evaluate and compare the knowledge and awareness of dentists regarding hypochlorite emergencies during endodontic treatment and their management. This research intends to provide valuable insights into the current state of knowledge among dentists and identify potential areas for improvement in dental education and clinical practice.

METHODS

This questionnaire-based cross-sectional study was conducted between July 1, 2023, and January 1, 2024. The study received approval from the Institutional Review Board (IRB) of the de' Montmorency College of Dentistry (vide letter No. 2983/DCD), and the respective administrations of the participating institutes.

The study employed a questionnaire-based descriptive cross-sectional design to assess dentists' knowledge and awareness of hypochlorite emergencies during endodontic treatment. Online questionnaires were distributed among dentists using Google Forms (Google Inc.) and disseminated through social media and WhatsApp, ensuring a broad reach among the target population.

The target population included house officers, general dentists, demonstrators, post-graduate trainees, assistant professors, and senior dental professionals working in private and public dental institutes in Punjab, Pakistan. Inclusion criteria for participants were dental house officers, demonstrators, post-graduate trainees, assistant professors, and above, as well as general dentists actively involved in clinical practice. These participants were chosen to ensure a comprehensive understanding of hypochlorite emergencies across different levels of dental professionals. Exclusion criteria included dental students, as they are still in training and may not have sufficient clinical experience, and individuals who did not provide consent to participate in the study.

A non-probability purposive sampling technique was employed to select participants. The sample size was calculated to be 383 participants using the formula $n=Z2 \cdot p \cdot (1-p)/\Delta 2$, using a 5% level of significance, 0.05 margin of error, and an expected prevalence of 0.471.[13]

The authors meticulously developed the questionnaire after a thorough literature review, incorporating various items from previous studies and relevant questionnaires. It comprised 21 items divided into three sections: demographics, knowledge, and awareness/experiences of dentists regarding hypochlorite accidents in clinics. Knowledge-based questions included items about the purpose of sodium hypochlorite, recommended concentration, cytotoxic levels, recommended irrigation needle, depth of irrigation, life-threatening complications, first line of action during treatment, and first line of action in case of accidental splash in eyes and ingestion.

The questionnaire underwent face and content validity checks by three research experts: two from the operative department and one from the community dentistry department. It was then pilot-tested and revised several times before the final draft was selected. The Cronbach's alpha for reliability analysis was found to be 0.711, indicating acceptable reliability. The survey was conducted by circulating the questionnaires to house officers, demonstrators, post-graduate residents, general dentists, and assistant professors or higher employed at private and public dental institutes in Punjab. The questionnaire included 21 close-ended questions, with a confidentiality and consent statement at the beginning.

The first section gathered demographic information, while the second section focused on the dentists' knowledge and awareness of hypochlorite emergencies during endodontic treatment and their management.

Data collected from the questionnaires were entered, stored, and analyzed using the IBM Statistical Package for Social Sciences (SPSS version 25, IBM Corporation, USA, New York, 2011). The normality of the data was assessed using the Shapiro-Wilk test, which revealed that the data were abnormally distributed. Consequently, nonparametric tests, specifically the Mann-Whitney U test and Kruskal-Wallis H test, were applied to analyze the mean knowledge scores among different groups. Chi-square tests were used to compare the frequencies of categorical variables. A p-value less than or equal to 0.05 was considered statistically significant. This approach ensured that the statistical analysis was robust and accounted for the non-normal distribution of the data.

RESULTS

A total of 206 participants were included in the study. The mean knowledge scores of females (4.66 ± 1.41) were significantly higher than those of males (4.11 ± 1.35) (p=0.012). Participants from public institutes (n=131, 63.6%) and private institutes (n=75, 36.4%) showed similar mean knowledge scores (4.53 ± 1.64 vs. 4.47 ± 1.26, p=0.859) (Table 1).

Table 1: The demographic variables and their comparison with Mean Knowledge scores

Variables		N (%)	Mean Knowledge Scores	p-value
Gender	Male	62 (30.1)	4.11,1.35	0.012
	Female	144 (69.9)	4.66,1.41	
Institute	Private	75 (36.4)	4.47,1.26	0.859
	Public	131 (63.6)	4.53,1.64	
Designation	House-officers	42 (20.4)	3.95,0.98	<0.001
	Demonstrators	30 (14.6)	4.40,1.19	
	General Dentists	55 (26.7)	4.60,1.60	
	Postgraduate Trainees	65 (31.6)	4.52,1.51	
	Assistant Professor and Above	14(6.8)	5.79,0.69	
Years of Practice	Less than two years	90(43.7)	4.30,1.32	0.105
	Two to five years	71(34.5)	4.56,1.53	
	More than five years	45(21.8)	4.78,1.34	
Taught about hypochlorite emergencies	Yes	128(62.1)	4.85,1.45	<0.001
	No	58(28.2)	4.05,1.14	
	Don't Remember	20(9.7)	3.50,0.94	

p-values were obtained using Mann-Whitney U and Kruskal-Wallis H test

Frequency of various signs and symptoms of hypochlorite accidents experienced in clinics is exhibited in Figure 1. The frequency of various causes of hypochlorite accidents is shown in Figure 2. The frequencies of various measures taken to avoid hypochlorite accidents is displayed in Figure 3.

Figure 1: Frequency of various signs and symptoms of Hypochlorite accidents experienced in clinics

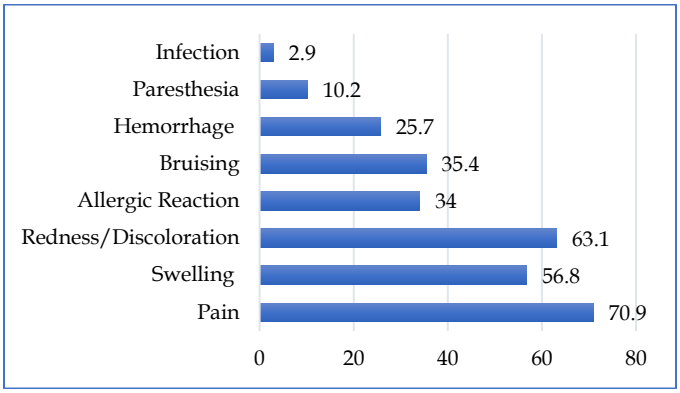


Figure 2: Frequency of various causes of hypochlorite accidents

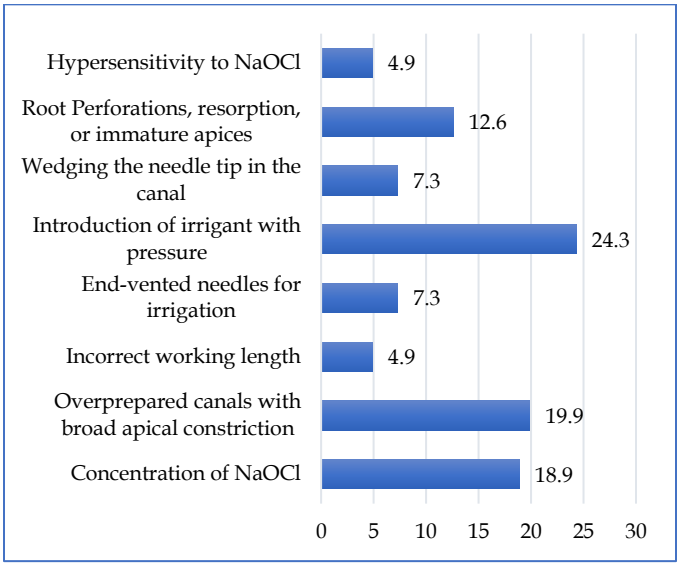
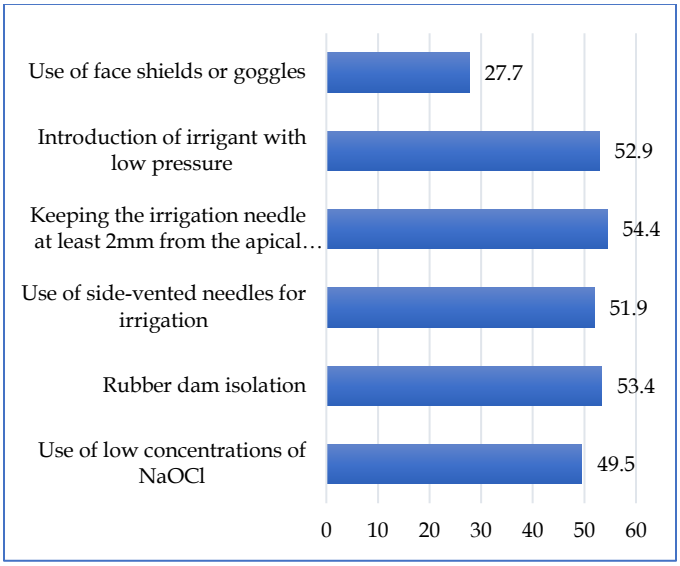


Figure 3: Frequency of various measures taken to avoid hypochlorite accidents



The designation of participants significantly impacted knowledge scores (p<0.001), with Assistant Professors and above having the highest mean score. Participants with less than two years of practice had lower mean knowledge scores compared to those with two to five years and more than five years of experience, though this difference was not statistically significant (p=0.105) (Table 1).

Those who had been taught about hypochlorite emergencies had significantly higher mean knowledge scores (p<0.001) (Table 1). Moreover, a higher percentage of participants from private institutes (97.7%) were taught about hypochlorite accidents compared to those from public institutes (52.0%) (p=0.017) (Table 2). The availability of emergency kits did not show a significant difference between public and private institutes (p=0.563). However, a considerable number of participants (30.6%) were unaware of the availability of emergency kits (Table 2).

Table 2: Awareness and Availability of Emergency Kits in Public and Private Institutes

Variables		N (%)	Public N (%)	Private N (%)	X2	p-value
Taught about hypochlorite accidents	Yes	128 (62.1)	39 (52.0)	128 (97.7)	8.182	0.017
	No	58 (29.1)	30 (40.0)	58 (44.2)		
	Don't Remember	20 (9.7)	6 (8.0)	20 (15.2)		
Availability of emergency kit	Yes	55 (26.6)	23 (30.6)	55 (42.0)	1.149	0.563
	No	88 (42.7)	29 (38.6)	88 (67.1)		
	Unaware	63 (30.6)	23 (30.6)	63 (48.0)		

p-values were calculated using Chi-square test

The hypochlorite emergencies experienced by participants with different years of practice are presented in Table 3. Irrigation beyond the apex was the most frequently reported emergency (29.1%), significantly higher among participants with more than five years of practice (p=0.004) (Table 3).

Table 3: Hypochlorite Emergencies Experienced by Participants with Different Years of Practice

Hypochlorite emergencies experienced	n(%)	<2 years n(%)	2-5 years n(%)	>5 years n(%)	X2	p
Accidental ingestion	27 (13.1)	12 (13.3)	7 (9.8)	8 (17.7)	1.52	0.467
Accidental injection in soft tissue	31 (15.0)	10 (11.1)	12 (16.9)	9 (20.0)	2.14	0.342
Irrigation beyond apex	60 (29.1)	22 (24.4)	16 (22.5)	22 (48.8)	10.96	0.004
Accidental splash in eyes	18 (8.7)	5 (5.5)	6 (8.4)	7 (15.5)	3.77	0.152

p-values were calculated using Chi-square test

DISCUSSION

Inadvertent extrusion of sodium hypochlorite into periapical tissues is an uncommon yet concerning complication of root canal therapy. Failure to acquire a correct diagnosis alongside adequate management in the event of a NaOCl accident might lead to life-threatening harm.[14] This study sought to critically examine dental practitioners' understanding of sodium hypochlorite incidents, identify the knowledge gaps, and guide future research.

Female participants exhibited significantly higher knowledge scores compared to their male counterparts. Pai, A.V. observed that female operators exhibit fewer cases of NaOCl accidents, which can be attributed to the fact that female operators deliver NaOCl with reduced pressure and flow rate compared to male operators.[15] This could suggest a greater emphasis on continuing education and professional development among female dental practitioners.

The present study saw a significant variation in knowledge scores among different professional designations, highlighting the importance of experience and advanced training. Assistant Professors and above scored the highest, similarly reported by Pai, A.V. in 2023,

reflecting the advanced expertise and continuous learning associated with higher academic positions.[15] these findings were consistent with the previous data and suggest that higher education and professional development levels contribute to greater knowledge of hypochlorite emergencies.[16,17] Although not statistically significant, a trend indicated that practitioners with more years of practice had higher knowledge scores. This trend underscores the value of accumulated experience in handling hypochlorite emergencies. Continuing education and refresher courses could further enhance the knowledge of less experienced practitioners.

A significant difference in awareness of hypochlorite accidents between public and private institutes was observed. Private institute participants were more likely to have been taught about hypochlorite accidents. While the availability of emergency kits did not differ significantly between public and private institutes, a higher percentage of private institute participants reported having access to emergency kits. The results were found to be coherent with a survey conducted by Glassman *et al*. in 2015 that found a notable proportion of dentists did not have a protocol or emergency tools to handle hypochlorite accidents.[10] This indicates a potential gap in training and education in public institutes, which are usually underfunded and lack resources in developing countries like Pakistan.[18,19] This should be addressed to ensure uniform safety standards across all institutions. The notable proportion of participants needing to be made aware of the availability of emergency kits suggests a need for improved communication and training regarding emergency preparedness in dental practices.

The data revealed that irrigation beyond the apex was the most frequently reported hypochlorite emergency, particularly among those with more than five years of practice. Maud Guivarc'h *et al*. argue that irrigation beyond the apex may be facilitated by factors like open apices, either caused by medical intervention or anatomical reasons. Undiagnosed perforation, needle wedging, and proximity to surrounding structures such as an antral tooth might also play a role. This finding highlights the need for precise techniques and careful monitoring during procedures to prevent such incidents.[20]

Accidental ingestion and injection into soft tissue were more common among experienced practitioners, contradicting previous literature. This may be due to a higher volume of procedures experienced practitioners perform, increasing the likelihood of encountering such emergencies. To prevent accidental injection of sodium hypochlorite during root canal treatment, it is important to prepare NaOCl solutions in distinct syringes that can be easily differentiated from syringes used for other solutions or anaesthetics.[21]

Pain, swelling, and redness/discoloration were the most commonly reported symptoms by the participants; Özdemir, O. *et al*. describe acute pain, extensive bleeding, and nearly instantaneous swelling as a pathognomonic triad of symptoms associated with NaOCl extrusion from the apex.[22] This information is crucial for practitioners to recognize and promptly manage hypochlorite accidents to minimize patient discomfort and complications.

The introduction of irrigants with pressure and overprepared canals with broad apical constriction were found to be the primary causes of hypochlorite accidents. The irrigation pressure increases when a canal is enlarged to a size of 30 or greater and the irrigant is administered with greater or improper force, when an open-ended needle or a needle without safety features is used, and when a positive-pressure irrigation technique is utilised.[15] These findings emphasize the need for meticulous technique and adherence to guidelines during endodontic procedures to avoid such accidents.

Using side-vented needles, keeping the irrigation needle at least 2mm from the apical terminus, and rubber dam isolation were identified as effective measures to prevent hypochlorite accidents by the study participants. Ensuring the concentration of the solution, maintaining the working length of the needle, applying the appropriate pressure to the plunger, allowing the irrigation needle free movement within the root canal during irrigation, utilizing perforated-side needles, or employing negative pressure irrigation systems are the fundamentals that may help reduce the occurrence of mishaps. These preventive strategies should be reinforced in training programs to enhance patient safety.[23,24]

CONCLUSION

The study underscores the importance of comprehensive training and continuous education in managing hypochlorite emergencies in dental practice. Addressing gaps in knowledge and preparedness, particularly in public institutes, can significantly improve patient safety and outcomes. Future research should focus on developing standardized training modules and investigating the long-term impact of enhanced educational interventions on the management of hypochlorite emergencies.

LIMITATIONS

The study's cross-sectional design captures data at a single point in time, limiting the ability to infer causality or changes over time. Moreover, the study was conducted with a limited sample size from various dental institutes

in Punjab, which restricts the generalizability of the findings.

SUGGESTIONS / RECOMMENDATIONS

Future research should aim to include larger, more diverse samples and employ longitudinal designs to track changes over time. Integrating clinical data to correlate knowledge with actual practice and patient outcomes is crucial. Developing standardized training modules on hypochlorite emergency management, enhancing continuous education, and improving emergency preparedness in dental institutes are essential steps. Public awareness campaigns can also help inform patients about the risks associated with endodontic treatments and the importance of seeking care from trained professionals.

CONFLICT OF INTEREST / DISCLOSURE

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

None.

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