



Application of calcium hydroxide in preclinical endodontic education in Türkiye: a nationwide cross-sectional survey

Calcium hydroxide in endodontic education

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Abstract

Aim: Calcium hydroxide (Ca(OH)₂) is commonly used as an intracanal medicament in endodontic treatment due to its antibacterial properties. Despite its frequent clinical use, incorrect application may lead to serious complications, highlighting the importance of adequate education. However, the extent to which Ca(OH)₂ application is systematically included in preclinical endodontic education in Türkiye remains unclear. This cross-sectional study aimed to assess its inclusion, instructional approaches, and general tendencies in preclinical endodontic education programs in Türkiye.

Methods: This descriptive cross-sectional survey included faculty members and research assistants involved in preclinical endodontic education at dental faculties in Türkiye. A 27-item structured questionnaire was electronically distributed to 97 actively admitting dental faculties. The survey assessed the inclusion of Ca(OH)₂ application in preclinical education, application techniques, and perceived student competence. Descriptive statistics were calculated, and comparisons between faculties were performed using Pearson's chi-square test ($P < .05$).

Results: Forty-six dental faculties participated (response rate: 47%). Although all respondents reported clinical use of Ca(OH)₂, 58.7% stated that its application was not taught preclinically. The most commonly reported technique was a powder-liquid mixture applied with manual files. Most instructors rated students' performance as only partially correct. No significant differences were found between faculties that did and did not provide preclinical instruction regarding application accuracy or apical extrusion ($P > .05$).

Conclusion: Ca(OH)₂ application is insufficiently standardized in preclinical endodontic education in Türkiye. Integrating structured theoretical and practical training into preclinical curricula may improve clinical competence and reduce application-related complications.

Keywords

calcium hydroxide, preclinical endodontic education, endodontic training, undergraduate dental curriculum, intracanal medicament

DOI: 10.4328/ACAM.50014 Ann Clin Anal Med 2026;17(8):818-823

Received: 11.01.2026

Accepted: 22.04.2026

Published Online: 22.04.2026

Printed: 01.08.2026

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Table 1. Descriptive characteristics of the participating dental faculties (N = 46)

Overall (N = 46)	
What is the type of university?	
Public university	43 (93.5)
Private university	3 (6.5)
How many years has your faculty been providing education?	
0-5 years	8 (17.4)
6-10 years	10 (21.7)
11 years and above	28 (60.9)
In your faculty, in which year is preclinical endodontic training?	
2 nd year	20 (43.5)
3 rd year	11 (23.9)
2 nd year, 3 rd year	15 (32.6)
How many hours does preclinical endodontic practice last? (Total)	
2 hours	2 (4.3)
3 hours	4 (8.7)
4 hours	28 (60.9)
5 hours	3 (6.5)
6 hours	5 (10.9)
7 hours	1 (2.2)
8 hours	2 (4.3)
9 hours	1 (2.2)

Introduction

Dental education is a demanding process consisting of preclinical and clinical phases delivered through both theoretical and practical training. In Türkiye, preclinical education is generally provided during the second and third years, although variations exist. During this phase, students develop psychomotor skills using phantom heads and simulated models, while in the clinical phase, they perform procedures on patients. The preclinical curriculum also includes basic science courses. Adequate preclinical education is essential for performing all stages of root canal treatment.^{1,2} However, previous studies have shown deficiencies in practitioners’ knowledge of root canal therapy, and many treatments performed by general dentists are of suboptimal quality, emphasizing the need for improved education.^{3,4}

As of 2023, 105 dental schools exist in Türkiye, 97 of which actively admit students. Differences in practical training may lead to inequalities in educational quality.² Preclinical endodontic education typically includes access cavity preparation and canal instrumentation using extracted teeth.^{5,6} However, there is no standardized protocol for curriculum content or materials, potentially leading to variability in graduates’ competence.^{6,7}

Calcium hydroxide (Ca(OH)₂) is widely used as an intracanal medicament due to its antibacterial and tissue-dissolving properties. Improper use may lead to complications, highlighting the need for comprehensive education.⁸ Although generally safe, adverse effects such as tissue necrosis, inflammation, and cytotoxicity have been reported, emphasizing cautious application.⁹

This study aims to provide an exploratory assessment of the inclusion of Ca(OH)₂ application in preclinical endodontic education in Türkiye and to describe current teaching practices. Given the exploratory nature of the study, no hypothesis-testing comparisons are intended; instead, the focus is on describing existing practices.

Materials and Methods

This study was designed as a descriptive, cross-sectional survey. Faculty members or instructors responsible for preclinical endodontic education in dental faculties in Türkiye were included, while those not involved or with incomplete responses were excluded.

The survey, created via Google Forms, was distributed by e-mail and restricted to a single researcher. The questionnaire was reviewed by experts for content validity before finalization.

The questionnaire consisted of two main sections. The first section (4 questions) collected information on the participant’s affiliated university, type of university, number of years the faculty had been providing education, and academic title (faculty member or instructor). The second section (23 questions) addressed the presence of Ca(OH)₂ application in preclinical endodontic education, the method and duration of application, its educational contribution, and students’ knowledge levels regarding this topic. The original questionnaire comprised a total of 27 questions (Supplementary Table 1).

Based on official records, 97 dental schools in Türkiye offering active dental education and preclinical endodontic training were identified and included in the study.

Interrater and Intrarater Reliability

To assess the reliability of the survey application, interrater and intrarater comparisons were performed to evaluate the consistency of responses. For this purpose, approximately 15% of the universities nationwide were included. At these institutions, the questionnaire was administered to two different academicians working at the same faculty at separate times and independently of each other. Responses from these two participants from the same institution were compared to assess interrater reliability. Additionally, one of the same participants was asked to complete the questionnaire again one month after the initial administration, and responses from the two time points were compared to assess

intrarater reliability. This approach enabled the evaluation of data consistency over time and across participants.

Ethical Approval

This study was approved by the Ethics Committee of Recep Tayyip Erdoğan University (Date: 24.04.2025, Decision No:2025/186).

Statistical Analysis

All the statistical analyses were conducted via Jamovi (version 2.3.28, The Jamovi Project). Descriptive statistics were applied to summarize the data. Categorical variables are expressed as frequencies and percentages, whereas continuous variables are reported as the means ± standard deviations or medians with interquartile ranges, depending on distribution normality. For questions allowing multiple responses, each option was analyzed individually and presented as a proportion of the total number of respondents. Comparisons between faculty members who did and did not teach Ca(OH)₂ application in preclinical training were performed via Pearson's chi-square test. A *P* value < .05 was considered statistically significant.

Reporting Guidelines

This study is reported in accordance with the STROBE guidelines.

Results

Of the 97 faculties invited to participate in the survey, 50 responded. However, one response was excluded due to incomplete submission within the allotted time, and three additional responses were excluded because of missing data. As a result, a total of 4 responses were excluded, leaving 46 valid responses for analysis. Most were state universities (93.5%), while 6.5% were private. The majority of these faculties had been providing education for ≥11 years (60.9%), whereas 17.4% had operated for <5 years. Preclinical endodontic training was most commonly conducted in the 2nd year

(43.5%), followed by combined 2nd–3rd years (32.6%) and the 3rd year only (23.9%). The predominant duration of preclinical practice was 4 hours per session (60.9%), with fewer faculty members reporting shorter (2–3 hours) or longer sessions (5–9 hours) (Table 1). All the participating faculty members (100%) reported using Ca(OH)₂ in their clinical practice. The most commonly used form was the powder-liquid mixture (63.0%), followed by the ready-to-use syringe either alone (10.9%) or in combination with the mixture (26.1%). The most frequent method of application was manual file use (32.6%), which was often combined with Lentulo spirals (21.7%) or ready-to-use syringes (13.0%). During the student treatments, the powder-liquid mixture was predominantly applied (82.6%), whereas a smaller proportion used a ready-to-use syringe (10.9%) or both (6.5%). Most instructors indicated that students could apply the material partially accurately (60.9%), whereas 21.7% believed that they could not apply it correctly. Apical extrusion was rarely reported in most clinics (63.0%), and the most frequent problem encountered was insufficient application (82.2%), followed by prolonged application and apical extrusion (each 13.3%) (Supplementary Table 2). More than half of the participating faculty members (58.7%) reported that Ca(OH)₂ application was not taught in preclinical training. The most common reasons cited were curriculum continuation from previous terms (55.6%), a perceived lack of necessity (29.6%), and exclusion from the curriculum (29.6%), with additional barriers including limited time (22.2%), insufficient equipment or materials (22.2%), and a lack of instructors (14.8%). Despite this deficiency, most respondents stated that it rarely causes clinical problems (70.4%), although insufficient application (74.1%) and prolonged treatment duration (33.3%) were identified as the most common clinical challenges. Regarding curricular development, two-thirds (66.7%) were uncertain about plans to include this procedure. Among the

Table 2. Comparison of institutional and preclinical training characteristics by preclinical Ca(OH)₂ teaching status (N = 46)

	Is the application of calcium hydroxide taught in preclinical training?		P value
	No (N = 27)	Yes (N = 19)	
What is the type of university?			.356 ¹
Public university	26.0 (96.3)	17.0 (89.5)	
Private university	1.0 (3.7)	2.0 (10.5)	
How many years has your faculty been providing education?			.960 ¹
0–5 years	5.0 (18.5)	3.0 (15.8)	
6–10 years	6.0 (22.2)	4.0 (21.1)	
11 years and above	16.0 (59.3)	12.0 (63.2)	
In your faculty, in which year is preclinical endodontic training?			.363 ¹
2 nd year	14.0 (51.9)	6.0 (31.6)	
3 rd year	6.0 (22.2)	5.0 (26.3)	
2 nd year, 3 rd year	7.0 (25.9)	8.0 (42.1)	
How many hours does preclinical endodontic practice last? (Total)			.375 ¹
2 hours	1.0 (3.7)	1.0 (5.3)	
3 hours	4.0 (14.8)	0.0 (0.0)	
4 hours	16.0 (59.3)	12.0 (63.2)	
5 hours	2.0 (7.4)	1.0 (5.3)	
6 hours	1.0 (3.7)	4.0 (21.1)	
7 hours	1.0 (3.7)	0.0 (0.0)	
8 hours	1.0 (3.7)	1.0 (5.3)	
9 hours	1.0 (3.7)	0.0 (0.0)	

¹Pearson's Chi-squared test

faculties providing preclinical instruction, the dominant approach was theoretical and practical training (85.0%), primarily using the hand-mixed form (84.2%), which was applied most frequently with manual files (57.9%) (Supplementary Table 3). Most respondents (63.2%) reported observing the benefits of preclinical Ca(OH)₂ training in clinical practice, and a majority (63.0%) agreed that this practice should be taught in preclinical education. Nearly all the participants (91.3%) favored a theoretical-demonstration-practical approach as the most appropriate training method. With respect to preferred application techniques, half (50.0%) supported teaching all available methods, followed by manual files (36.9%), lentulo spirals (15.2%), and syringes (15.2%). Finally, more than half of the faculties (52.2%) indicated that awareness of this topic has increased and that future inclusion is being considered, whereas 32.6% already plan to add it to the curriculum (Supplementary Table 4). When comparing faculties that teach and do not teach Ca(OH)₂ application in preclinical training, no statistically significant differences were observed across institutional or educational characteristics (all $P > .05$). Most faculty members in both groups were from public universities (93.5%) and had been providing education for over 11 years (60.9%). Preclinical endodontic training was most commonly conducted in the 2nd year (43.5%), followed by joint implementation in the 2nd and 3rd years (32.6%). The majority of faculties (60.9%) allocated 4 hours per week to preclinical endodontic practice, regardless of whether Ca(OH)₂ instruction was included (Table 2). When comparing faculties that teach and do not teach Ca(OH)₂ application in preclinical training, no statistically significant differences were found in students' ability to apply the material accurately or in the frequency of apical extrusion ($P > .05$). In both groups, the majority of respondents indicated that students could partially apply the material correctly (57.1% vs. 42.9%), whereas a smaller proportion believed that students could apply it accurately (37.5% vs. 62.5%). Reports of apical extrusion were predominantly rare in both groups (62.1% vs. 37.9%), and only one faculty member reported it as frequent (Table 3).

Discussion

Successful root canal treatment requires effective elimination of microorganisms, primarily through cleaning and shaping of the root canal system. However, the complex anatomy of the canal system limits the ability of hand and rotary instruments to reach all areas. Consequently, effective irrigation protocols and intracanal medicaments are essential components of endodontic treatment. These medicaments reduce microbial load, support healing of infected periapical tissues, help prevent interappointment pain, and contribute to coronal sealing in temporary restorations.⁸

Undergraduate endodontic education plays a crucial role in developing students' clinical competence. According to the 2024 curriculum guidelines of the European Society of Endodontology, substantial variability exists among institutions, leading to differences in graduates' knowledge and clinical experience.⁶ In Türkiye, preclinical endodontic education is generally provided during the second and third years, although course structure and practical training duration vary considerably among faculties.² International comparisons also reveal significant differences in training hours; for example, shorter durations are reported in some countries, whereas others allocate substantially more time.^{10,11} The present study suggests an approximate annual total of 60 hours, reflecting moderate but inconsistent training exposure. Such variability may result in inequalities in educational quality and heterogeneity in graduates' skill levels, highlighting the need for a standardized national curriculum.

Given the exploratory design and limited sample size, the findings should be interpreted as descriptive. This study evaluated Ca(OH)₂ use and teaching methods in preclinical endodontic education in Türkiye. All faculty members reported using it clinically, consistent with previous national and international studies.^{8,12,13} It has also been identified as a first-choice medicament among general dental practitioners, although protocols vary with experience.¹⁴ Despite widespread use, variability in application highlights the need for standardized training. In this study, more than half of the participants reported that Ca(OH)₂ is not taught preclinically. Similarly, previous multicenter and global surveys show inconsistent inclusion in preclinical curricula, despite frequent clinical use.^{10,15} This indicates a mismatch between clinical practice and theoretical instruction, largely attributed to curriculum structure and its exclusion from formal teaching programs.

In the present study, the most commonly used form of Ca(OH)₂ in preclinical education was the powder-liquid mixture, followed by syringe-based systems used alone or in combination. Ca(OH)₂ can be applied in viscous, aqueous, and oily forms.⁸ Injectable formulations facilitate placement, especially in the apical region, and may offer prolonged alkalinity and stability, whereas traditional mixtures remain common due to cost and familiarity.^{9,16} Manual files were the most frequently preferred placement method, followed by Lentulo spirals and prefilled syringes. Various techniques exist, including manual files, Lentulo spirals, injection syringes, and ultrasonic methods. Although Lentulo spirals are often considered standard, injection systems may reduce working time but are more costly.¹⁶ Some studies report that injection syringes are preferred over Lentulo spirals.¹² While Lentulo spirals may provide more homogeneous fillings,^{9,17} injectable systems can achieve denser placement.¹⁸ Manual file techniques show comparable results,¹⁹ but injection systems may increase the risk of apical extrusion if

Table 3. Comparison of students' application accuracy and incidence of apical extrusion by preclinical calcium hydroxide teaching status

	Is the application of calcium hydroxide taught in preclinical training?		P value
	No (N = 27)	Yes (N = 19)	
In your opinion, can students apply the material accurately?			.184 ¹
No	8.0 (80.0)	2.0 (20.0)	
Partially	16.0 (57.1)	12.0 (42.9)	
Yes	3.0 (37.5)	5.0 (62.5)	
Have any incidents of apical extrusion of the material occurred?			.512 ¹
No, has never occurred	8.0 (50.0)	8.0 (50.0)	
Yes, rarely	18.0 (62.1)	11.0 (37.9)	
Yes, frequently	1.0 (100.0)	0.0 (0.0)	

¹Pearson's Chi-squared test

not used carefully.⁹

Ca(OH)₂ is widely used in cases of apical periodontitis because of its antibacterial properties.^{16,20} However, incorrect application has been associated with complications such as apical extrusion, cytotoxic effects, and tissue damage.^{9,20} Also, residual Ca(OH)₂ not fully removed before obturation may impair dentin adhesion and reduce filling quality.²⁰ Therefore, students must acquire both theoretical and practical skills in their application. In this study, many instructors rated student performance as only partially adequate, indicating educational deficiencies that may affect clinical outcomes. Although direct evidence is limited, previous surveys have identified knowledge gaps regarding intracanal medicaments, particularly in their correct use and application protocols.^{12,21}

In this study, clinical complications were rare despite the lack of preclinical Ca(OH)₂ training, but insufficient application and prolonged treatment time were common issues. Apical extrusion is generally uncommon in clinical practice. However, low complication rates do not necessarily reflect adequate application quality. Ca(OH)₂ placement is technically demanding and challenging for undergraduate students.^{20,22} Previous surveys have reported difficulties in medicament selection and application among students.²² Since endodontic training often involves multi-visit treatments,²³ the use of Ca(OH)₂ becomes more relevant.²⁰ Given that incorrect application may cause serious complications,^{9,20} structured preclinical instruction may reduce errors.

In this study, most participants considered the theory–demonstration–practice model the most appropriate educational approach. Similarly, previous studies have shown that demonstrations improve learning outcomes and clinical performance in endodontic education.⁵ A global survey also reported that lectures and practical training remain the dominant teaching methods worldwide,¹⁵ indicating consistency between participants’ views and international practices.

When faculties were compared based on whether Ca(OH)₂ application was taught preclinically, no significant differences were found in students’ ability to apply the material correctly or in apical extrusion rates. Similarly, previous studies reported that omitting intracanal medicaments in multivisit treatments did not significantly increase interappointment emergencies.²⁰ A survey in Türkiye also found that students generally did not perceive intracanal medicament use as problematic.²⁴ However, lack of statistical significance does not imply that preclinical training is unnecessary. Common clinical issues such as insufficient application and prolonged treatment may reflect variability in teaching, limited practice opportunities, and inadequate training. In this study, faculties with preclinical instruction showed higher rates of correct application, suggesting that structured education may improve clinical competence, particularly for complex procedures.

Limitations

This study has several limitations. Although all 97 dental faculties in Türkiye were invited, only 46 participated, limiting generalizability and introducing potential non-response bias. The self-reported electronic survey may not fully reflect actual educational practices. Given the relatively small sample size and exploratory design, findings should be considered descriptive rather than confirmatory. Differences in curriculum structure, session duration, and teaching methods may also affect comparability. Despite these limitations, the study provides preliminary insights into Ca(OH)₂ teaching in preclinical endodontic education in Türkiye. Further research with larger, more representative samples is needed to confirm these findings.

Conclusion

This study demonstrates that Ca(OH)₂ application is not sufficiently standardized in preclinical endodontic education in Türkiye. Although it is widely used clinically, more than half of the faculty do not teach this procedure preclinically, which may contribute to inadequate application and prolonged treatment times. Faculties that provide preclinical instruction appeared to report more favorable student performance and clinical outcomes. These findings support the consideration of structured theoretical and practical training in the application of Ca(OH)₂ to improve clinical competence and reduce complications.

Declarations

Animal and Human Rights Statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent

Written informed consent was obtained from all participants.

Data Availability

The datasets used and/or analyzed in the current study are not publicly available due to participant confidentiality but are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare no conflict of interest.

Funding

None.

Author Contributions (CRediT Taxonomy)

Conceptualization: N.G.A., H.A.
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Writing – Review & Editing: N.G.A., P.M., A.M.A., Ö.Z., H.A.
Visualization: N.G.A., H.A.
Supervision: N.G.A., P.M., A.M.A., Ö.Z., H.A.
Project Administration: N.G.A., H.A.
Funding Acquisition: N.G.A.

AI Usage Disclosure

The authors declare that no AI-assisted technologies were used.

Abbreviations

Ca(OH)₂: Calcium hydroxide
SD: Standard deviation
STROBE: Strengthening the reporting of observational studies in epidemiology
YÖK: Council of Higher Education (Türkiye)

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Additional Information

Publisher's Note

Bayrakol MP remains neutral with regard to jurisdictional and institutional claims.

How to cite this article:

Medine Çiçek, Fatma Pertek Hatipoğlu. Application of calcium hydroxide in preclinical endodontic education in Türkiye: a nationwide cross-sectional survey. *Ann Clin Anal Med* 2026;17(8):818-823. doi:10.4328/ACAM.50014