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Original Article

Assessing Awareness, Decision-Making & Practice Patterns for Pulpotomy Versus Pulpectomy in Pediatric Endodontic Emergencies Among Dental Practitioners Across Pakistan – A Cross-Sectional Study

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ABSTRACT

Background: Appropriate selection of pulpotomy or pulpectomy in pediatric endodontic emergencies depends on accurate assessment of pulp vitality, inflammation, radicular involvement, and systemic signs. Although contemporary pediatric dentistry increasingly supports conservative vital pulp therapy where biologically indicated, practice variation may persist because of differences in training, guideline awareness, diagnostic confidence, and availability of clinical resources. Objective: To assess knowledge, clinical decision-making, and self-reported practice patterns regarding pulpotomy versus pulpectomy in pediatric endodontic emergencies among dental practitioners in Pakistan. Methods: A cross-sectional online survey was conducted among 340 dental practitioners from multiple regions of Pakistan using a structured questionnaire. Data were analyzed using IBM SPSS Statistics version 26.0. Descriptive statistics were calculated, and associations between total knowledge score and decision-making score were assessed using Spearman's rank correlation and Chi-square testing. Results: Most participants correctly identified indications for pulpotomy (84.4%) and pulpectomy (91.2%), while 60.6% selected MTA/bioceramics as the material with strongest current evidence for pulpotomy success. Only 19.1% had attended relevant CME/workshops in the previous three years, and 7.4% always used rubber dam isolation. Knowledge score showed a significant positive but weak correlation with decision-making score ($\rho = 0.268$, $p < 0.001$). Knowledge level was significantly associated with decision-making category ($\chi^2 = 13.087$, $p = 0.001$). Conclusion: Dental practitioners demonstrated good basic awareness of pulp therapy indications, but important gaps remain in continuing education, rubber dam use, guideline familiarity, and emergency decision-making. Structured training and standardized protocols are needed to improve pediatric endodontic care. Keywords: Pediatric dentistry; Endodontic emergency; Pulpotomy; Pulpectomy; Vital pulp therapy; Dental practitioners; Pakistan.

INTRODUCTION

Pediatric endodontic emergencies commonly arise from deep caries, traumatic pulp exposure, acute pulpal inflammation, and pulpal necrosis, requiring timely diagnostic assessment and appropriate emergency intervention to preserve function, prevent infection, and avoid avoidable loss of primary or immature permanent teeth. In clinical practice, the choice between pulpotomy and pulpectomy depends

on careful interpretation of pulp vitality, reversibility of inflammation, radicular involvement, radiographic findings, root development, and the presence or absence of swelling or systemic signs. Pulpectomy involves complete removal of coronal and radicular pulp tissue followed by canal debridement and obturation, and is generally indicated when the pulp is non-vital or necrotic, particularly in the presence of periapical or radicular pathology. Pulpotomy, in contrast, involves removal of the inflamed coronal pulp while preserving vital radicular pulp, and is indicated in selected cases of reversible pulpitis, vital pulp exposure, traumatic exposure, or immature permanent teeth where maintenance of pulp vitality is biologically desirable (1-4).

Contemporary pediatric endodontic practice has increasingly emphasized conservative vital pulp therapy where biologically appropriate, supported by improved diagnostic concepts, better understanding of pulpal healing, and the availability of bioactive materials. Mineral trioxide aggregate and other calcium silicate-based bioceramics have shown favorable clinical and radiographic outcomes in pulpotomy procedures compared with older medicaments such as calcium hydroxide and formocresol, particularly when case selection, isolation, and follow-up are adequate (5-7). However, the clinical value of these materials depends not only on their biological properties but also on the clinician's ability to correctly distinguish reversible from irreversible pulpal conditions, identify necrotic or infected teeth, recognize emergencies requiring drainage or urgent referral, and apply evidence-based procedural protocols.

Despite the availability of pediatric pulp therapy guidance, studies from Pakistan and other settings suggest persistent variation in dentists' knowledge, attitudes, material selection, isolation practices, and management of child patients in dental settings (8-11). This variability is clinically important because inappropriate selection of pulpotomy or pulpectomy may result in persistent infection, treatment failure, damage to the developing permanent successor, unnecessary removal of vital pulp tissue, or delayed management of spreading odontogenic infection. Current guidance from pediatric dentistry authorities emphasizes accurate diagnosis, appropriate use of radiographs and pulp assessment methods, rubber dam isolation where possible, evidence-based material selection, and structured follow-up after pulp therapy (12). Nevertheless, adherence to these principles may be influenced by undergraduate training, continuing professional development exposure, clinical confidence, availability of armamentarium, diagnostic uncertainty, patient anxiety, and referral access.

Although previous studies have evaluated selected aspects of pulp therapy knowledge, material preference, antibiotic prescription patterns, rubber dam use, and child-patient management among dental practitioners, limited regional evidence has simultaneously assessed knowledge, decision-making, and routine practice patterns for pulpotomy versus pulpectomy in pediatric endodontic emergencies among practitioners from multiple regions of Pakistan (8, 9, 13-16). This combined assessment is needed because knowledge of indications alone may not translate into guideline-consistent clinical behavior, particularly when emergency decisions are shaped by confidence, training, setting, and resource-related barriers. Therefore, this study aimed to assess knowledge, clinical decision-making, and practice patterns regarding pulpotomy and pulpectomy in pediatric endodontic emergencies among dental practitioners in Pakistan, and to identify educational and practice-related gaps that may inform continuing dental education, clinical guideline implementation, and referral standardization.

MATERIAL AND METHODS

This cross-sectional observational survey was conducted among dental practitioners from multiple regions of Pakistan over a six-month period from 8 September 2025 to 10 April 2026, following approval of the study synopsis and ethical clearance. The study was designed to assess knowledge, clinical decision-making, and self-reported practice patterns regarding pulpotomy and pulpectomy in pediatric endodontic emergencies. Eligible participants included house officers, general dentists, postgraduate trainees, and consultants or professors who were currently in dental practice or clinical training and

provided informed consent to participate. Undergraduate dental students and individuals who did not consent were excluded.

A non-probability convenience sampling technique was used because the target population was geographically dispersed and the study required timely recruitment of practicing dental professionals through accessible professional networks. Participants were approached through dental professional groups, academic networks, social media platforms, and institutional contacts. The survey was administered electronically using Google Forms, allowing participants to complete the questionnaire at their convenience. Written informed consent was obtained at the beginning of the online form before access to the survey items. Participation was voluntary, and responses were collected anonymously to maintain confidentiality.

The sample size was calculated using Cochran's formula, $n_0 = z^2p(1-p)/e^2$, with a 95% confidence level and a 5% margin of error, yielding a required sample size of 381 participants. Because of time constraints and response-rate limitations, 340 completed responses were included in the final analysis. The final sample size was therefore lower than the calculated target, and the findings should be interpreted as estimates from a convenience-based practitioner sample rather than as nationally representative prevalence estimates.

Data were collected using a structured, closed-ended questionnaire developed from previously published questionnaire-based studies and established clinical guidance relevant to pediatric pulp therapy, rubber dam use, diagnostic assessment, and emergency dental management (8, 9, 12, 15, 16). The questionnaire was organized into six domains: demographic and professional characteristics, knowledge of pulpotomy and pulpectomy indications, attitudes toward vital pulp therapy and diagnostic confidence, clinical practice patterns, emergency decision-making scenarios, and perceived barriers and future trends. Before final distribution, a pilot assessment was conducted among 17 participants, including individuals with relevant clinical or academic experience, to evaluate clarity, feasibility, and comprehension of the questionnaire items.

The demographic and professional variables included city, gender, professional role, years of clinical experience, and practice setting. Knowledge-related variables included the primary source of learning about pulpotomy and pulpectomy, awareness of the indication for pulpotomy in primary teeth, awareness of the indication for pulpectomy in primary teeth, identification of the material or medicament with the strongest current evidence for pulpotomy success, diagnostic tools routinely used for pulp status assessment, and awareness of major complications arising from inappropriate pulp therapy. Clinical attitude variables included perceived safety of pulpotomy compared with pulpectomy in vital pulp exposures of primary teeth and self-rated confidence in diagnosing pulp status in children using a five-point confidence scale. Practice variables included frequency of rubber dam isolation, referral timing for pediatric pulpal emergencies, and radiographic follow-up after pulpotomy or pulpectomy.

Knowledge was assessed using four predefined scored items: correct identification of the indication for pulpotomy, correct identification of the indication for pulpectomy, correct identification of MTA/bioceramics as the material with strongest current evidence for pulpotomy success, and awareness of major complications associated with inappropriate pulp therapy. Each correct or guideline-consistent response was assigned one point, producing a total knowledge score ranging from 0 to 4. Knowledge scores were categorized as low for scores of 0–1, moderate for scores of 2–3, and high for a score of 4. Multi-response items, such as diagnostic tools routinely used for pulp status assessment, were analyzed descriptively and were not included in the total knowledge score.

Clinical decision-making was assessed using two scenario-based emergency questions. The first scenario involved a 9-year-old child with traumatic pulp exposure in tooth 21, an open apex, no systemic signs, and controlled bleeding, where vital pulp therapy using partial pulpotomy with a bioceramic or MTA

was considered the appropriate response. The second scenario assessed immediate management of an acute endodontic emergency with facial swelling or systemic signs, where drainage, antibiotics, and urgent referral were considered the appropriate response. Each appropriate answer was assigned one point, yielding a total decision-making score from 0 to 2. For descriptive reporting, decision-making scores were retained as 0, 1, and 2 to preserve information on partial versus complete appropriateness. For association testing with categorized knowledge levels, decision-making was also dichotomized into inappropriate decision-making for a score of 0 and at least partially appropriate decision-making for a score of 1 or 2.

Data were exported from Google Forms and analyzed using IBM SPSS Statistics version 26.0. Data were screened for completeness and coding accuracy before analysis. Categorical variables were summarized as frequencies and percentages, including gender, professional role, clinical experience, practice setting, knowledge responses, attitude responses, practice behaviors, decision-making responses, perceived barriers, and future expectations. Continuous variables, including participant age where available, were summarized using mean values and measures of dispersion. Bar charts and frequency tables were used to present descriptive findings.

The association between total knowledge score and total decision-making score was assessed using Spearman's rank correlation coefficient because both variables were ordinal or bounded score-based measures. The relationship between categorized knowledge level and dichotomized decision-making status was examined using the Chi-square test of independence. Fisher's Exact Test was applied where expected cell counts were below five. Statistical significance was set at $p < 0.05$. Because the study used a cross-sectional survey design and non-probability sampling, all associations were interpreted as non-causal and exploratory. Ethical approval was obtained from the Institutional Review Board of the PRIDE Centre for Research and Learning Institute under reference number PRIDE/ERB/2025/046. Participant anonymity and confidentiality were maintained throughout data collection, handling, and analysis.

RESULTS

A total of 340 dental practitioners from multiple regions of Pakistan were included in the analysis. The mean age of participants was 25.56 years. Female participants represented 203 participants (59.7%), while 137 participants (40.3%) were male. Most respondents were general dentists (n = 196, 57.6%), followed by house officers (n = 99, 29.1%), postgraduate trainees (n = 30, 8.8%), and consultants or professors (n = 15, 4.4%). The majority of participants had five years or less of clinical experience, including 130 participants (38.2%) with less than one year of experience and 193 participants (56.8%) with one to five years of experience.

Table 1. Demographic and Professional Characteristics of Participants

Variable	Category	n (%)
Gender	Female	203 (59.7)
	Male	137 (40.3)
Professional role	General dentist	196 (57.6)
	House officer	99 (29.1)
	Postgraduate trainee	30 (8.8)
	Consultant/professor	15 (4.4)
Clinical experience	<1 year	130 (38.2)
	1–5 years	193 (56.8)
	6–10 years	7 (2.0)
	>10 years	10 (2.9)
Practice setting	Private clinic	138 (40.7)
	Teaching hospital	135 (39.8)
	Private hospital	25 (7.3)
	Trust hospital	21 (6.1)
	Not currently engaged in clinical practice	68 (20.1)

The study population was predominantly composed of early-career practitioners, with 323 participants (95.0%) reporting five years or less of clinical experience. General dentists and house officers together accounted for 295 participants (86.7%), indicating that the findings mainly reflect knowledge and practice patterns among early-career and general dental practitioners rather than specialist pediatric or endodontic providers.

Table 2. Regional Distribution of Participants

Region	n (%)
Punjab	178 (52.4)
Sindh	107 (31.5)
Islamabad Capital Territory	37 (10.9)
Khyber Pakhtunkhwa	17 (5.0)
Balochistan	1 (0.3)

More than half of the respondents were from Punjab (n = 178, 52.4%), followed by Sindh (n = 107, 31.5%) and Islamabad Capital Territory (n = 37, 10.9%). Representation from Khyber Pakhtunkhwa and Balochistan was limited, with 17 participants (5.0%) and 1 participant (0.3%), respectively.

Table 3. Primary Sources of Knowledge Regarding Pulpotomy and Pulpectomy Indications

Source of Knowledge	n (%)
Undergraduate studies	303 (89.2)
Internship/house job clinical experience	121 (35.5)
Independent clinical practice	97 (28.5)
Clinical guidelines	37 (10.8)
Postgraduate education	27 (7.8)
CMEs/workshops	26 (7.6)

Undergraduate education was the dominant reported source of knowledge, identified by 303 participants (89.2%). In contrast, only 37 participants (10.8%) reported clinical guidelines, 27 participants (7.8%) reported postgraduate education, and 26 participants (7.6%) reported CMEs or workshops as sources of knowledge, indicating limited reliance on continuing and guideline-based educational sources.

Table 4. Knowledge of Indications and Material Selection for Pediatric Pulp Therapy

Knowledge Item	Response Option	n (%)
Indication for pulpotomy	Reversible pulpitis or vital pulp exposure without root involvement	287 (84.4)
	Irreversible pulpitis with periapical pathology	51 (15.0)
	Extensive root resorption	2 (0.6)
Indication for pulpectomy	Non-vital/necrotic pulp with periapical involvement	310 (91.2)
	Superficial carious lesion	27 (7.9)
	Occlusal wear only	3 (0.9)
Material with strongest current evidence for pulpotomy success	MTA/bioceramics	206 (60.6)
	Calcium hydroxide	75 (22.1)
	Formocresol	59 (17.4)

Most participants correctly identified the indication for pulpotomy as reversible pulpitis or vital pulp exposure without root involvement (n = 287, 84.4%) and the indication for pulpectomy as non-vital or necrotic pulp with periapical involvement (n = 310, 91.2%). MTA/bioceramics were selected as the material with strongest current evidence for pulpotomy success by 206 participants (60.6%), while 75 participants (22.1%) selected calcium hydroxide and 59 participants (17.4%) selected formocresol.

Table 5. Diagnostic Tools Routinely Used for Pulp Status Assessment

Diagnostic Tool	n (%)
Periapical radiograph	225 (66.2)
Cold test	181 (53.2)
Clinical signs only	168 (49.4)
Electric pulp test	147 (43.2)
CBCT	8 (2.4)

Periapical radiographs were the most frequently reported diagnostic tool, used by 225 participants (66.2%). Cold testing was reported by 181 participants (53.2%), while 168 participants (49.4%) relied on clinical signs only. CBCT was rarely used as a routine diagnostic tool, reported by 8 participants (2.4%).

Table 6. Awareness, Attitude, and Continuing Education Related to Pediatric Pulp Therapy

Variable	Yes n (%)	No n (%)
Aware of major complications if inappropriate pulp therapy is chosen	297 (87.4)	43 (12.6)
Considers pulpotomy safer than pulpectomy in vital pulp exposures of primary teeth	297 (87.4)	43 (12.6)
Attended CME/workshop on pediatric or emergency pulp therapy in last 3 years	65 (19.1)	275 (80.9)

Most participants reported awareness of major complications associated with inappropriate pulp therapy (n = 297, 87.4%) and considered pulpotomy safer than pulpectomy in vital pulp exposures of primary teeth (n = 297, 87.4%). However, only 65 participants (19.1%) had attended a CME or workshop specifically related to pediatric or emergency pulp therapy within the preceding three years.

Table 7. Frequency of Rubber Dam Isolation During Pulpotomy or Pulpectomy

Frequency	n (%)
Always	25 (7.4)
Often	77 (22.6)
Sometimes	85 (25.0)
Rarely	96 (28.2)
Never	57 (16.8)

Routine rubber dam use was limited. Only 25 participants (7.4%) reported always using rubber dam isolation, while 77 participants (22.6%) reported often using it. In contrast, 153 participants (45.0%) reported rarely or never using rubber dam isolation during pulpotomy or pulpectomy procedures.

Table 8. Scenario-Based Clinical Decision-Making Responses

Clinical Scenario	Response Option	n (%)
Traumatic pulp exposure in tooth 21 with open apex, no systemic signs, and controlled bleeding	Vital pulp therapy with partial pulpotomy using bioceramic/MTA	149 (43.8)
	Apexification with calcium hydroxide	123 (36.2)
	Direct pulp capping with calcium hydroxide	58 (17.1)
	Pulpectomy and obturation	9 (2.6)
	Extraction	1 (0.3)
Acute endodontic emergency with facial swelling or systemic signs	Drainage, antibiotics, and urgent referral	231 (67.9)
	Immediate pulpotomy/pulpectomy in clinic	60 (17.6)
	Prescribe antibiotics and schedule	45 (13.2)
	Immediate extraction	4 (1.2)

For the traumatic pulp exposure scenario, 149 participants (43.8%) selected vital pulp therapy with partial pulpotomy using bioceramic or MTA. For an acute endodontic emergency with facial swelling or systemic signs, 231 participants (67.9%) selected drainage, antibiotics, and urgent referral. These findings show stronger decision alignment for infection-related emergency management than for traumatic pulp exposure with an open apex.

Table 9. Barriers Affecting Decision-Making in Pediatric Endodontic Emergencies

Barrier	n (%)
Lack of knowledge related to current guidelines	199 (58.5)
Lack of adequate training	190 (55.9)
Difficulty in diagnosing the condition appropriately	169 (49.7)
Patient anxiety	165 (48.5)
Lack of armamentarium/material	138 (40.6)
Difficulty navigating canal anatomy	132 (38.8)
Limited time availability	75 (22.1)

The most frequently reported barrier was lack of knowledge related to current guidelines, reported by 199 participants (58.5%), followed by lack of adequate training among 190 participants (55.9%).

Diagnostic difficulty and patient anxiety were also common, reported by 169 participants (49.7%) and 165 participants (48.5%), respectively.

Table 10. Expected Future Trends in the Management of Pediatric Endodontic Emergencies

Expected Trend	n (%)
Improved outcomes due to better materials/techniques	197 (57.9)
Greater use of advanced imaging and diagnostic tools	165 (48.5)
Increased reliance on conservative procedures such as partial pulpotomy and pulp capping	158 (46.5)
Increased reliance on regenerative procedures	156 (45.9)
Increased reliance on pulpotomy as a definitive treatment	86 (25.3)
Increased reliance on pulpectomy as a definitive treatment	73 (21.5)
No major changes expected	42 (12.4)

Participants most commonly expected future improvement in outcomes due to better materials and techniques (n = 197, 57.9%). Nearly half anticipated greater use of advanced imaging and diagnostic tools (n = 165, 48.5%), conservative procedures such as partial pulpotomy and pulp capping (n = 158, 46.5%), and regenerative procedures (n = 156, 45.9%).

Table 11. Correlation Between Total Knowledge Score and Total Decision-Making Score

Variables	Spearman's ρ	p-value	N
Total knowledge score and total decision-making score	0.268	<0.001	340

Spearman's rank correlation analysis demonstrated a statistically significant positive association between total knowledge score and total decision-making score ($\rho = 0.268$, $p < 0.001$). The direction of the association indicates that higher knowledge scores were associated with better decision-making scores; however, the magnitude of the correlation was weak.

Table 12. Association Between Knowledge Level and Decision-Making Category

Statistical Test	Test Statistic	df	p-value
Pearson Chi-square	13.087	2	0.001
Likelihood ratio	13.473	2	0.001
Fisher's Exact Test	13.416	—	0.001
Linear-by-linear association	10.345	1	0.001

The Chi-square test of independence showed a statistically significant association between categorized knowledge level and decision-making category, $\chi^2(2) = 13.087$, $p = 0.001$. Fisher's Exact Test also confirmed the association ($p = 0.001$), supporting the robustness of the finding despite one expected cell count below five. The linear-by-linear association was also significant, indicating a positive trend across increasing knowledge levels.

Reviewer-style note: The manuscript should include the actual cross-tabulation of knowledge level by decision-making category in the final results. Without the cell counts for low, moderate, and high knowledge groups across decision-making categories, the direction and practical magnitude of the Chi-square association cannot be fully evaluated by readers.

Reviewer-style note: The manuscript describes figures for self-perceived confidence, referral timing, and radiographic follow-up, but complete numeric distributions for these variables were not available in the supplied text. These should be converted into publication-ready tables before final submission. Raw SPSS outputs should not be retained as figures; they should be replaced with clean statistical tables such as Tables 11 and 12 above.

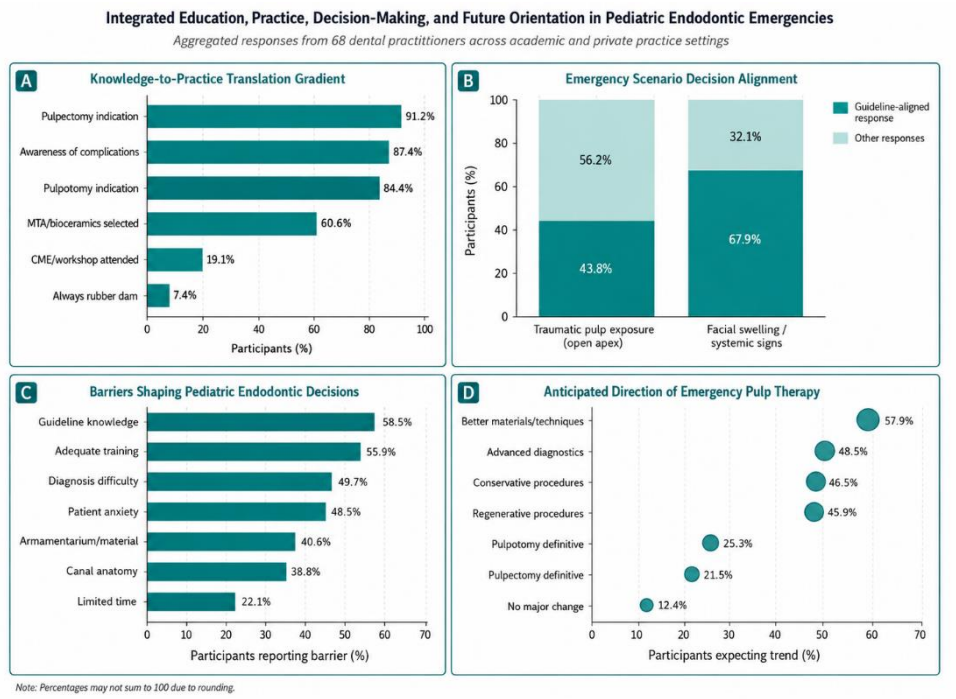

Figure 1 Integrated educational, practice, decision-making, and future-orientation patterns in pediatric endodontic emergencies among dental practitioners in Pakistan. Panel A demonstrates a knowledge-to-practice translation gradient, showing high awareness of pulpectomy indications (91.2%), complications of inappropriate pulp therapy (87.4%), and pulpotomy indications (84.4%), but substantially lower CME/workshop attendance (19.1%) and routine rubber dam use (7.4%). Panel B shows stronger guideline-aligned decision-making for facial swelling or systemic signs requiring drainage, antibiotics, and urgent referral (67.9%) than for traumatic pulp exposure with an open apex requiring vital pulp therapy (43.8%). Panel C highlights the leading barriers to decision-making, particularly limited knowledge of current guidelines (58.5%) and inadequate training (55.9%). Panel D summarizes future expectations, with most participants anticipating improved outcomes through better materials and techniques (57.9%), greater use of advanced diagnostics (48.5%), conservative procedures (46.5%), and regenerative approaches (45.9%).

DISCUSSION

The present study assessed knowledge, clinical decision-making, and self-reported practice patterns regarding pulpotomy versus pulpectomy in pediatric endodontic emergencies among dental practitioners in Pakistan. The findings indicate that most participants correctly identified the principal indications for pulpotomy and pulpectomy, yet important gaps remained in the translation of knowledge into evidence-aligned clinical practice. This pattern is reflected by the high proportion of respondents who correctly identified pulpectomy for non-vital or necrotic pulp with periapical involvement and pulpotomy for reversible pulpitis or vital pulp exposure without root involvement, while substantially lower proportions reported CME/workshop attendance and routine rubber dam use. These findings support the view that clinical knowledge alone is insufficient unless reinforced through continuing education, procedural training, guideline familiarity, and consistent implementation of infection-control and isolation protocols.

The positive association between total knowledge score and total decision-making score suggests that participants with higher knowledge levels were more likely to select appropriate clinical decisions in pediatric endodontic emergency scenarios. However, the correlation was weak, indicating that decision-making in clinical dentistry is influenced by multiple interacting factors beyond factual knowledge alone. This interpretation is consistent with evidence-based dentistry principles, which emphasize integration of best available evidence, clinical expertise, and patient-related factors in clinical decision-making (17, 18). It also aligns with previous evidence showing that endodontic education level can influence treatment decisions, but that clinical choices are frequently shaped by diagnostic uncertainty, prior experience, access to materials, financial constraints, patient expectations, and confidence in performing procedures (19-24). In the present study, lack of guideline knowledge, inadequate training,

diagnostic difficulty, and patient anxiety were among the most frequently reported barriers, supporting the interpretation that knowledge improvement must be accompanied by practical decision-training and system-level support.

The demographic structure of the sample is important when interpreting these findings. Most respondents were general dentists or house officers, and the majority had five years or less of clinical experience. This early-career distribution may explain why undergraduate education was the dominant reported source of knowledge, whereas postgraduate education, clinical guidelines, and CME/workshop participation were reported much less frequently. Reliance on undergraduate learning has also been observed in other survey-based dental studies, where foundational education strongly influences clinical decision-making after graduation (25). However, pediatric pulp therapy is an evolving area, particularly with increasing use of bioactive materials and vital pulp therapy approaches. Therefore, limited engagement with current guidelines and continuing dental education may contribute to delayed adoption of updated evidence and inconsistent clinical practice (26-29).

Material selection findings provide further insight into the knowledge–practice interface. Most participants selected MTA/bioceramics as the material with the strongest current evidence for pulpotomy success, although a considerable proportion still selected calcium hydroxide or formocresol. This indicates partial alignment with contemporary evidence but also persistence of older material preferences. Previous Pakistani studies have reported variable material choices among dentists, including calcium hydroxide, formocresol, and MTA, suggesting heterogeneity in clinical training and practice exposure across settings (8, 29, 30). Current evidence increasingly supports MTA and calcium silicate-based bioceramics because of their favorable biological properties, sealing ability, and clinical/radiographic success in primary tooth pulpotomy, although material selection must still be guided by case diagnosis, isolation, operator skill, and follow-up feasibility (31-34). Therefore, the present findings suggest that although awareness of newer materials is growing, continuing education should also emphasize case selection, procedural standards, and outcome monitoring.

The decision-making scenarios revealed clinically relevant differences in response patterns. Participants were more likely to select guideline-aligned management for facial swelling or systemic signs than for traumatic pulp exposure in an immature tooth with controlled bleeding. This suggests that recognition of infection-related emergencies may be stronger than understanding of biologically conservative vital pulp therapy in traumatic or immature tooth contexts. Similar gaps may arise when clinicians are uncertain about pulp vitality, apex status, bleeding control, or the distinction between direct pulp capping, partial pulpotomy, apexification, and pulpectomy. Accurate diagnosis and treatment selection are essential in pediatric and young permanent teeth because inappropriate intervention may compromise pulp vitality, root development, tooth survival, and succedaneous tooth health (35-47). This finding supports the need for scenario-based training rather than didactic knowledge alone, especially for emergency presentations requiring rapid but biologically precise decision-making.

Rubber dam isolation emerged as a major practice gap. Although rubber dam use is widely recommended in endodontic and pediatric pulp therapy because it improves isolation, reduces contamination, and enhances procedural safety, only a small proportion of respondents reported always using it. Nearly half reported rarely or never using rubber dam isolation. This is concerning because successful pulpotomy or pulpectomy depends not only on diagnosis and material selection but also on asepsis, moisture control, and procedural quality. Pediatric dentistry guidelines and endodontic literature consistently emphasize the importance of rubber dam isolation during pulp therapy (48, 49). Similar underuse has been reported in other settings and may be related to inadequate training, perceived difficulty, time constraints, cost, patient behavior, or limited availability of materials (50-53). The present findings therefore identify rubber dam use as a practical and measurable target for clinical training interventions.

Referral and follow-up behaviors also require standardization. Although the manuscript reports referral timing and radiographic follow-up patterns, complete numeric distributions were not available in the supplied results text and should be reported in final tabular form. In pediatric endodontic emergencies, timely referral is important when the case exceeds the clinician's competence, when systemic signs are present, when complex anatomy or immature permanent teeth require specialist input, or when definitive care cannot be safely provided in the current setting. Similarly, radiographic and clinical follow-up are essential for monitoring healing, identifying treatment failure, and preventing complications. Existing literature shows that adherence to pediatric dental guidelines and referral pathways may vary among general practitioners, and barriers to referral may include cost, perceived loss of patient trust, access issues, and practice-related pressures (54-58). The present study supports the need for clearer referral criteria and follow-up protocols in general dental practice.

This study has several strengths. It assessed knowledge, decision-making, and practice patterns within a single survey, allowing a broader understanding of pediatric pulp therapy behavior than knowledge-only studies. The sample size was relatively large for a practitioner survey and included participants from several regions and professional roles. The study also incorporated scenario-based questions, which are more clinically informative than isolated factual questions. However, limitations must be acknowledged. The use of non-probability convenience sampling limits generalizability, and the sample was concentrated in Punjab and Sindh, with limited representation from Khyber Pakhtunkhwa and Balochistan. The sample was also dominated by early-career practitioners, which may underrepresent specialist and consultant-level practice. Because responses were self-reported, social desirability bias and recall bias may have influenced reported knowledge, attitudes, and clinical behaviors (59). In addition, the questionnaire validation process and psychometric properties require fuller reporting, and the cross-sectional design does not permit causal inference between knowledge and decision-making.

Future research should use representative regional sampling and include larger numbers of pediatric dentists, endodontists, postgraduate trainees, and experienced consultants to better compare decision-making across professional groups. Studies using validated questionnaires, clinical vignettes, and objective assessment of practice behavior would strengthen evidence regarding knowledge translation in pediatric endodontic emergencies. Interventional studies evaluating the impact of CME workshops, simulation-based training, guideline dissemination, and rubber dam skill training may be particularly useful. The current findings suggest that educational interventions should prioritize guideline-based diagnosis, vital pulp therapy decision-making, rubber dam isolation, emergency referral criteria, and radiographic follow-up standards.

CONCLUSION

This study found that dental practitioners in Pakistan demonstrated generally good awareness of the basic indications for pulpotomy and pulpectomy in pediatric endodontic emergencies, but important gaps persisted in evidence-aligned decision-making and routine clinical practice. Higher knowledge scores were significantly associated with better decision-making scores, although the weak correlation indicates that clinical decisions are also shaped by training, diagnostic confidence, guideline familiarity, availability of armamentarium, patient-related factors, and practice setting. Limited CME exposure, inconsistent rubber dam use, and reported barriers related to inadequate training and lack of guideline knowledge highlight a clear need for structured continuing dental education, scenario-based emergency training, and standardized pediatric pulp therapy protocols. Strengthening these areas may improve consistency of treatment selection, promote conservative vital pulp therapy where appropriate, support timely referral in complex or systemic presentations, and enhance clinical outcomes for pediatric patients requiring emergency endodontic care.

REFERENCES

1. Esteve-Pardo G, Barreiro-Gabeiras P, Esteve-Colomina L. Pulpectomy vs. pulpotomy as alternative emergency treatments for symptomatic irreversible pulpitis-a multicenter comparative randomised clinical trial on patient perceptions. Clin Pract. 2023;13(4):898-913. doi:10.3390/clinpract13040082.

2. Shueb SS, Nixdorf DR, John MT, Alonso BF, Durham J. What is the impact of acute and chronic orofacial pain on quality of life? J Dent. 2015;43:1203-1210. doi:10.1016/j.jdent.2015.06.001.

3. Duncan HF, Galler KM, Tomson PL, Simon S, El-Karim I, Kundzina R, et al. European Society of Endodontology position statement: management of deep caries and the exposed pulp. Int Endod J. 2019;52(7):923-934.

4. Philip N, Cherian JM, Mathew MG, Thomas AM, Jodhka S, John N, et al. Treatment outcomes of pulpotomy versus pulpectomy in vital primary molars diagnosed with symptomatic irreversible pulpitis: protocol for a noninferiority randomised controlled trial. BMC Oral Health. 2024;24(1):626. doi:10.1186/s12903-024-04411-6.

5. Coll JA, Seale NS, Vargas K, Marghalani AA, Al Shamali S, Graham L. Primary tooth vital pulp therapy: a systematic review and meta-analysis. Pediatr Dent. 2017;39(1):16-123.

6. Elhamouly Y, Adham MM, Dowidar KML, El Backly RM. Outcome assessment methods of bioactive and biodegradable materials as pulpotomy agents in primary and permanent teeth: a scoping review. BMC Oral Health. 2024;24(1):496.

7. Wang X, Xiao Y, Song W, Ye L, Yang C, Xing Y, et al. Clinical application of calcium silicate-based bioceramics in endodontics. J Transl Med. 2023;21(1):853.

8. Lone MM, Khan FR, Lone MA, Rehman M. A survey on current trends in primary tooth pulpotomy in Karachi. J Ayub Med Coll Abbottabad. 2015;27(3):643-646.

9. Wali A, Siddiqui TM, Khan R, Batool K. Knowledge, attitude, and practices of dental surgeons in managing child patients. Int J Clin Pediatr Dent. 2016;9(4):372-378. doi:10.5005/jp-journals-10005-1393.

10. Cotton KT, Seale NS, Kanellis MJ, Damiano PC, Bidaut-Russell M, McWhorter AG. Are general dentists' practice patterns and attitudes about treating Medicaid-enrolled preschool age children related to dental school training? Pediatr Dent. 2001;23(1):51-55.

11. Baier K, Milgrom P, Russell S, Mancl L, Yoshida T. Children's fear and behavior in private pediatric dentistry practices. Pediatr Dent. 2004;26(4):316-321.

12. American Academy of Pediatric Dentistry. Pulp therapy for primary and immature permanent teeth. In: The Reference Manual of Pediatric Dentistry. Chicago: American Academy of Pediatric Dentistry; 2025. p. 487-496.

13. Yildiz E, Tosun G. Evaluation of formocresol, calcium hydroxide, ferric sulfate, and MTA primary molar pulpotomies. Eur J Dent. 2014;8(2):234-240. doi:10.4103/1305-7456.130616.

14. Mainkar A, Kim SG. Diagnostic accuracy of 5 dental pulp tests: a systematic review and meta-analysis. J Endod. 2018;44(5):694-702. doi:10.1016/j.joen.2018.01.021.

15. Mashyakhy M, Boreak N, Hanbashi A, Otayf H, Alshawkani H, Chourasia H. Dentist's attitudes, practice, and barriers toward the use of rubber dam during operative and endodontic treatments: an online questionnaire survey. World J Dent. 2021;12:306-310. doi:10.5005/jp-journals-10015-1840.

16. Ahsan S, Hydrie MZI, Hyder Naqvi SMZ, Shaikh MA, Shah MZ, Jafry SIA. Antibiotic prescription patterns for treating dental infections in children among general and pediatric dentists in teaching institutions of Karachi, Pakistan. PLoS One. 2020;15(7):e0235671. doi:10.1371/journal.pone.0235671.

17. Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richardson WS. Evidence based medicine: what it is and what it isn't. BMJ. 1996;312(7023):71-72.

18. Afrashtehfar KI, Assery MK. From dental science to clinical practice: knowledge translation and evidence-based dentistry principles. Saudi Dent J. 2017;29(3):83-92. doi:10.1016/j.sdentj.2017.02.002.

19. Alim-Uysal BA, Dincer AN, Yurtgezen B, Guneser MB. Does the endodontic education level affect decision-making for endodontically treated teeth with apical periodontitis? A web-based survey. Int Dent J. 2021;71(6):477-483. doi:10.1016/j.identj.2021.01.003.

20. Feller L, Lemmer J, Nemutandani MS, Ballyram R, Khammissa RAG. Judgment and decision-making in clinical dentistry. J Int Med Res. 2020;48(11):300060520972877. doi:10.1177/0300060520972877.

21. Spallek H, Song M, Polk DE, Bekhuis T, Frantsve-Hawley J, Aravamudhan K. Barriers to implementing evidence-based clinical guidelines: a survey of early adopters. J Evid Based Dent Pract. 2010;10(4):195-206. doi:10.1016/j.jebdp.2010.05.013.

22. Neuppmann Feres MF, Roscoe MG, Job SA, Mamani JB, Canto GL, Flores-Mir C. Barriers involved in the application of evidence-based dentistry principles: a systematic review. J Am Dent Assoc. 2020;151(1):16-25.e16. doi:10.1016/j.adaj.2019.08.011.

23. Alfaisal Y, Idris G, Peters OA, Zafar S, Nagendrababu V, Peters CI. Vital pulp therapy-factors influencing decision-making for permanent mature teeth with irreversible pulpitis: a systematic review. Int Endod J. 2024;57:505-519. doi:10.1111/iej.14036.

24. Murdoch AIK, Blum J, Chen J, Baziotis-Kalfas D, Dao A, Bai K, et al. Determinants of clinical decision making under uncertainty in dentistry: a scoping review. Diagnostics. 2023;13(6):1076. doi:10.3390/diagnostics13061076.

25. Scalzilli P, Jara Pintos C, Flores D, Heinzmann D, Figueiredo JA, Scarparo R. Decision-making for dental pulp exposure: a survey in graduate programs at Brazilian universities. Braz Oral Res. 2022;36:e087. doi:10.1590/1807-3107bor-2022.vol36.0087.

26. Amin M, Ahmed B. Dental education in Pakistan: current trends and practices. J Coll Physicians Surg Pak. 2010;20:497-498.

27. Sutoi D, Popa DI, Cindrea CA, Trebuian CI, Williams C, Sutoi M, et al. The impact of a one-day multidisciplinary workshop on medical students' self-assessed confidence, knowledge, and teamwork skills: a pre-post study. Adv Med Educ Pract. 2025;16:401-410. doi:10.2147/AMEP.S509297.

28. World Dental Federation FDI. Continuing dental education: adopted by the FDI General Assembly: August 2017, Madrid, Spain. Int Dent J. 2018;68(1):12-13. doi:10.1111/idj.12370.

29. Zalan AK, Bibi AS, Ismail M, Gul A, Masood S, Babar P, et al. Knowledge of general dental practitioners, postgraduate residents, and specialists from various dental specialties towards pediatric dentistry in Pakistan. J Khyber Coll Dent. 2022;12(1):47-52. doi:10.33279/jkcd.v12i1.85.

30. Rafiq M, Bukhari J, Shaukat M, Saleem M, Tahir A, Abdullah S. Knowledge, attitude and practice regarding dental pulp treatment in teaching sector of South Punjab. Pak J Med Health Sci. 2022;16:1458-1460. doi:10.53350/pjmhs221651458.

31. Lima R, Moura AP, Miranda Filho AE, Queiroz A, Nelson-Filho P, Silva L, et al. Endodontic treatments in primary teeth among Brazilian dental practitioners: a preliminary nationwide cross-sectional e-survey. Pesqui Bras Odontopediatria Clin Integr. 2026;26. doi:10.1590/pboci.2026.039.

32. Beldar TL, Jawdekar AM, Mistry LN. Success of pulpotomy with MTA in primary teeth: a systematic review and meta-analysis. Bioinformation. 2025;21(8):2574-2580. doi:10.6026/973206300212574.

33. Tawil PZ, Duggan DJ, Galicia JC. Mineral trioxide aggregate: its history, composition, and clinical applications. Compend Contin Educ Dent. 2015;36(4):247-264.

34. Kaur M, Singh H, Dhillon JS, Batra M, Saini M. MTA versus Biodentine: review of literature with a comparative analysis. J Clin Diagn Res. 2017;11(8):ZG01-ZG05. doi:10.7860/JCDR/2017/25840.10374.

35. Khan FR, Mahmud S, Rahman M. The need of paediatric dentistry specialists in Pakistan. J Coll Physicians Surg Pak. 2013;23(4):305-307.

36. Javed M, Wyne A, Hassan H. Practices of dental care and treatment provided to pediatric patients in private dental clinics in Lahore, Pakistan. BioMedica. 2024;40:100-106. doi:10.24911/BioMedica/5-1156.

37. Alzain I, Albqmi SS, Alkatheeri SM. Evaluating the impact of preclinical and clinical exposure to the pediatric pulpotomy procedure on confidence among senior dental students: an analytical survey study. Clin Cosmet Investig Dent. 2025;17:85-97. doi:10.2147/CCIDE.S501541.

38. Simpson S, Wallace CK, Vernazza CR. Paediatric dentistry provision in the North East of England: workforce confidence and attitudes. Br Dent J. 2022. doi:10.1038/s41415-022-4045-9.

39. Garispe A, Sorensen C, Sorensen JR. Dental emergencies. In: StatPearls. Treasure Island: StatPearls Publishing; 2026.

40. Alhilou AM, Al-Moraissi EA, Bakhsh A, Christidis N, Näsman P. Pain after emergency treatments of symptomatic irreversible pulpitis and symptomatic apical periodontitis in the permanent dentition: a systematic review of randomized clinical trials. Front Oral Health. 2023;4:1147884. doi:10.3389/froh.2023.1147884.

41. Nagendrababu V, Dutta A, Arias A, et al. A multi-national questionnaire-based analysis of dental students' knowledge of the management of deep caries and the exposed pulp. Int Dent J. 2025;75(4):100844. doi:10.1016/j.identj.2025.100844.

42. Gadallah LK, Elbardissy A, Elyazeed MA, et al. Pulpotomy versus pulpectomy in carious vital pulp exposure in primary incisors: a randomized controlled trial. BMC Oral Health. 2024;24:354. doi:10.1186/s12903-024-04116-w.

43. Chawla S, Singhal R, Namdev R, Kumar A, Chhanna K, Kumari C. Effectiveness of pulpotomy compared with pulpectomy for irreversible pulpitis in primary teeth: a systematic review and meta-analysis. J Dent. 2026;166:106329. doi:10.1016/j.jdent.2026.106329.

44. Maldupa I, Al-Yaseen W, Giese J, et al. Recommended procedures for managing carious lesions in primary teeth with pulp involvement-a scoping review. BDJ Open. 2024;10:74. doi:10.1038/s41405-024-00259-8.

45. Fuks AB. Pulp therapy for the primary and young permanent dentitions. Dent Clin North Am. 2000;44(3):571-vii.

46. Igna A. Vital pulp therapy in primary dentition: pulpotomy-a 100-year challenge. Children. 2021;8(10):841. doi:10.3390/children8100841.

47. Togoo R, Nasim V, Zakirulla M, Yaseen S. Knowledge and practice of pulp therapy in deciduous teeth among general dental practitioners in Saudi Arabia. Ann Med Health Sci Res. 2012;2(2):119-123. doi:10.4103/2141-9248.105657.

48. American Academy of Pediatric Dentistry. Pulp therapy for primary and immature permanent teeth. In: The Reference Manual of Pediatric Dentistry. Chicago: American Academy of Pediatric Dentistry; 2025. p. 487-496.

49. Rodd HD, Waterhouse PJ, Fuks AB, Fayle SA, Moffat MA; British Society of Paediatric Dentistry. Pulp therapy for primary molars. Int J Paediatr Dent. 2006;16 Suppl 1:15-23.

50. Patil PD, Katge AF, Rusawat DB. Knowledge and attitude of pediatric dentists, general dentists, postgraduates of pediatric dentistry, and dentists of other specialties toward the endodontic treatment of primary teeth. J Orofac Sci. 2016;8(2):96-101. doi:10.4103/0975-8844.195917.

51. Nayak UA, Wadhwa S, Kashyap N, Prajapati D, Mahuli AV, Sharma R. Knowledge and practice of, and attitudes toward, pulp therapy in deciduous teeth among pediatric dentists in India. J Investig Clin Dent. 2017;9(1):e12284. doi:10.1111/jicd.12284.

52. Madarati AA. Why dentists don't use rubber dam during endodontics and how to promote its usage? BMC Oral Health. 2016;16:24. doi:10.1186/s12903-016-0175-2.

53. Ahmad IA. Rubber dam usage for endodontic treatment: a review. Int Endod J. 2009;42(11):963-972. doi:10.1111/j.1365-2591.2009.01623.x.

54. Harford S, Sharpling J, Williams C, et al. Guidelines relevant to paediatric dentistry-do foundation dentists and general dental practitioners follow them? Part 2: treatment and recall. Br Dent J. 2018;224:803-808. doi:10.1038/sj.bdj.2018.355.

55. Caplan DJ, Reams G, Weintraub JA. Recommendations for endodontic referral among practitioners in a dental HMO. J Endod. 1999;25(5):369-375. doi:10.1016/S0099-2399(06)81174-X.

56. Guo J, Guo J, Yuan G. Impact of multimodal electronic follow-up systems on postoperative complications in pediatric dentistry under general anesthesia: a retrospective study. J Clin Pediatr Dent. 2025;49(4):120-127.

57. Gharechahi M, Rouhani A, Ahmadi AK, Davaji M. The necessity and reasons for referrals to endodontists among general dentists in Mashhad: a cross-sectional study. Saudi Endod J. 2024;14:75-79.

58. Kaur H, Singhal S, Glogauer M, Azarpazhooh A, Quiñonez C. General dentists' perceptions about their relationship with specialists. Int Dent J. 2022;72(4):463-469. doi:10.1016/j.identj.2021.08.052.

59. Rosenman R, Tennekoon V, Hill LG. Measuring bias in self-reported data. Int J Behav Healthc Res. 2011;2(4):320-332. doi:10.1504/IJBHR.2011.043414.