https://jsras.rcc.edu.ly/
Vol.3 No.2 (2026), 229-237
Article history:
Received: 14/6/2026
Accepted: 10/7/2026
Published: 16/8/2026

Journal of Sustainable Research in Applied Sciences

JSRAS

Knowledge, Attitudes, and Barriers to Vital Pulp Therapy among Dental Practitioners in Zliten, Libya: A Cross-Sectional Study

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DOI https://doi.org/10.36602/jsras.2026.3.2.20
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Keywords

Vital Pulp Therapy; Partial Pulpotomy; Full Pulpotomy; Dental Practitioners; Operational Barriers.

Abstract

Background: The landscape of conservative dentistry has undergone a massive paradigm shift, moving steadily toward the core philosophy of minimally invasive endodontic management. Rather than defaulting to aggressive, irreversible root canal treatments, modern clinical frameworks prioritize Vital Pulp Therapy (VPT) to salvage pulpal tissues compromised by deep caries or mechanical trauma. This cross-sectional study evaluates the knowledge, attitudes, and operational barriers regarding partial and full pulpotomy among dental practitioners in Zliten, Libya.

Objectives: The primary objective of this investigation is to assess and compare the current level of baseline knowledge, clinical awareness, and attitudes regarding partial and full pulpotomy procedures among general dental practitioners (GDPs) and specialists across both public and private sectors in Zliten, Libya, while systematically identifying the precise cognitive, logistical, and pedagogical hurdles that restrict their regional adoption.

Methodology: Employing a descriptive, analytical, cross-sectional survey-based design, data collection spanned over a two-month period (June to July 2026) within the municipality of Zliten. A sample of N = 70 actively practicing dental professionals completed a validated, high-reliability self-administered questionnaire (Overall Instrument Cronbach's alpha = 0.865) distributed physically across public health centers and private dental clinics.

Results: The findings demonstrated that the overall combined index for practitioners' Knowledge, Attitudes, and Barriers (KAB) was moderate (Mean = 3.49 ± 0.69), directly mirroring their self-reported Clinical Practice (CP) frequency, which fell into the 'sometimes' range (Mean = 3.36 ± 0.68). A stark knowledge-practice gap was exposed regarding isolation; clinicians expressed high theoretical conviction that operating without a rubber dam escalates clinical failure rates (Mean = 4.01), yet strict procedural compliance dropped to a moderate level (Mean = 3.19). Inferential analysis revealed that female practitioners achieved significantly higher baseline knowledge scores than males ($p = 0.004$). More importantly, attendance at a Continuing Professional Education (CPE) workshop within the past three years strongly predicted superior theoretical knowledge ($p = 0.0003$) and practical execution ($p = 0.001$). Conversely, One-Way ANOVA tests showed no statistically significant differences based on experience years, academic background, or workplace sector ($p > 0.05$).

Conclusion: This study highlights a profound knowledge-practice gap heavily driven by localized systemic and operational barriers, such as high procurement costs of advanced bioceramics, severe patient volume constraints in public polyclinics, and a collective pedagogical shortfall in undergraduate dental curricula. To transition local dental practice toward biologically sound, minimally invasive endodontics, a coordinated curricular restructuring and institutional reform (such as material subsidization and strict auditing of aseptic protocols) are strictly mandatory.

المعرفة، والمواقف، والعوائق تجاه علاج اللب الحيوي بين ممارسي طب الأسنان في زليتن، ليبيا: دراسة مقطعية

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DOI https://doi.org/10.36602/jsras.2026.3.2.20
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الملخص

خلفية الدراسة: شهد مجال طب الأسنان التحفظي تحولاً جذرياً نحو الفلسفة الأساسية المتمثلة في التدبير العلاجي طفيف التوغل لطب اللب. وبدلاً من اللجوء التلقائي إلى علاجات الجذور التقليدية العنيفة وغير العكسية، تولي الأطر السريرية الحديثة الأولوية لعلاج اللب الحيوي (VPT) لإنقاذ الأنسجة اللبية المتضررة من النخر العميق أو الصدمات الميكانيكية. تقيم هذه الدراسة المسحية المقطعية مستوى المعرفة، والمواقف، والعوائق التشغيلية المتعلقة ببتر اللب الجزئي والكلي بين ممارسي طب الأسنان في مدينة زليتن، ليبيا.

الأهداف: يتمثل الهدف الرئيسي لهذا البحث في تقييم ومقارنة المستوى الحالي للمعلومات الأساسية، والوعي السريري، والمواقف تجاه إجراءات بتر اللب الجزئي والكلي بين أطباء الأسنان العامين والأخصائيين في القطاعين العام والخاص في مدينة زليتن، مع تحديد دقيق للعقبات المعرفية واللوجستية والتعليمية التي تحول دون اعتماد هذه التقنيات بشكل روتيني.

المنهجية: اعتمدت الدراسة على تصميم مسحي مقطعي تحليلي، حيث امتدت فترة جمع البيانات على مدار شهرين (يونيو إلى يوليو 2026) داخل بلدية زليتن. شملت العينة 70 طبيباً ممارساً أكملوا استبياناً ذاتياً تم التحقق من صدقه وثباته العالي (معامل كرونباخ ألفا للمقياس الكلي = 0.865)، وجرى توزيعه ورقياً خلال زيارات ميدانية للمراكز الصحية العامة والعيادات الخاصة.

النتائج: أظهرت النتائج أن المؤشر العام المشترك لمعارف ومواقف وعوائق الممارسين (KAB) كان متوسطاً (المتوسط = 3.49 ± 0.69)، وهو ما يعكس بدقة ممارستهم السريرية الذاتية (CP) التي وقعت ضمن فئة التكرار 'أحياناً' (المتوسط = 3.36 ± 0.68). كما كشفت الدراسة عن فجوة حادة بين المعرفة والتطبيق فيما يتعلق ببروتوكولات العزل؛ إذ أبدى الأطباء قناعة نظرية عالية بأن العمل بدون حاجز مطاطي يزيد بشكل كبير من معدلات الفشل السريري (المتوسط = 4.01)، ومع ذلك انخفض الالتزام الإجرائي الصارم إلى مستوى متوسط (المتوسط = 3.19). وأظهر التحليل الاستدلالي أن الطبيبات حققن درجات معرفية أعلى دلالة إحصائياً مقارنة بالأطباء الذكور ($p = 0.004$). والأهم من ذلك، كان لحضور ورش عمل التعليم المهني المستمر (CPE) خلال السنوات الثلاث الماضية تأثير تنبئي قوي في تحقيق نتائج متفوقة بالمعرفة النظرية ($p = 0.0003$) والتنفيذ العملي ($p = 0.001$). وفي المقابل، لم تظهر اختبارات تحليل التباين (ANOVA) أي فروق ذات دلالة إحصائية بناءً على سنوات الخبرة، أو الخلفية الأكاديمية، أو قطاع العمل.

الخلاصة: تسلط هذه الدراسة الضوء على فجوة عميقة بين المعرفة والممارسة مدفوعة بشكل أساسي بعوائق نظامية وتشغيلية محلية، مثل التكاليف الباهظة لتوفير المواد الخزفية الحيوية المتقدمة ((Bioceramics، والقيود الشديدة على الوقت بسبب التدفق العالي للمرضى في العيادات المجمعة العامة، إلى جانب قصور تعليمي جماعي في مناهج طب الأسنان الجامعية. ولتحويل الممارسة المحلية نحو علاجات لبية تحفظية وسليمة بيولوجياً، فإن إعادة هيكلة المناهج الأكاديمية وتطبيق إصلاحات مؤسسية (مثل دعم المواد وتشديد الرقابة على بروتوكولات التعقيم) يعد أمراً إلزامياً وصارماً.

الكلمات المفتاحية

علاج اللب الحيوي؛ بتر اللب الجزئي؛ بتر اللب الكلي؛ ممارسو طب الأسنان؛ العوائق التشغيلية.

1. INTRODUCTION

The landscape of conservative dentistry has undergone a massive paradigm shift, moving steadily toward the core philosophy of minimally invasive endodontic management [10, 15]. Rather than defaulting to aggressive, irreversible root canal treatments, modern clinical frameworks prioritize Vital Pulp Therapy (VPT) to salvage pulpal tissues compromised by deep caries or mechanical trauma [4, 17]. By preserving natural vascular supply, immune response, and proprioceptive mechanisms, therapies such as partial pulpotomy and full (coronal) pulpotomy have emerged as highly predictable, biologically sound options for permanent teeth diagnosed with reversible or stable irreversible pulpitis [10, 14].

While both modalities share the ultimate goal of preserving radicular pulp vitality, they differ significantly in technical execution and tissue removal depth [14]. A partial pulpotomy involves the localized excision of only 1 to 3 millimeters of inflamed coronal pulp directly beneath the exposure site, whereas a full pulpotomy entails the complete amputation of the coronal pulp down to the root canal orifices [14]. Despite these differences, long-term radiographic and clinical success remains high for both techniques, provided that remaining deeper tissues are left completely intact to sustain tooth vitality [14].

The clinical outcome of these conservative interventions relies heavily on strict procedural compliance and immediate post-operative factors [9, 19]. Achieving absolute isolation using a rubber dam, controlling pulpal hemorrhage effectively with sodium hypochlorite (NaOCl), and directly capping remaining pulp stumps with modern calcium silicate-based cements actively induce a secure, stable dentin bridge [9, 19]. However, despite strong global scientific backing and expert consensus statements [18, 20], a substantial gap persists between theoretical knowledge and daily clinical execution, as many dentists default to conventional root canal therapy due to a persistent fear of clinical failure and material limitations [1].

In Libya, the dental healthcare sector faces unique challenges regarding standardizing clinical protocols and accessing continuous education amidst resource constraints. Within Zliten city—a rapidly growing hub for dental healthcare services—diverse dental practitioners, including General Dental Practitioners (GDPs) and specialists, operate across both busy public institutional frameworks and a rapidly expanding private sector. However, there is an absolute scarcity of localized literature evaluating how frequently vital therapies are integrated into routine clinical setups, and what precise material, systemic, or training bottlenecks hinder their regional adoption. This cross-sectional study addresses this empirical geographic gap by diagnosing the precise underlying barriers to partial and full pulpotomy utilization in Zliten.

2. Statement of the Problem

Despite compelling clinical evidence endorsing both partial and full pulpotomy as predictable, minimally invasive modalities for both mature and immature teeth, their translation into routine clinical practice remains severely compromised. Systematic reviews highlight a profound dichotomy between academic guidelines and bench-to-bedside execution. While contemporary endodontics validates the regenerative potential of the pulp, many dental trainees and practicing clinicians routinely bypass these conservative alternatives in favor of aggressive, irreversible root canal therapy (RCT).

This therapeutic inertia stems from a complex matrix of cognitive, logistical, and pedagogical hurdles. Specifically, there is an evident ambiguity in clinical decision-making regarding the precise indications for partial versus full pulpotomy, especially when determining the boundaries of irreversible pulpitis. This is further compounded by a distinct lack of clinical confidence among dental interns and general practitioners transitioning into independent practice. Furthermore, systemic barriers—such as the prohibitive cost and inconsistent supply of advanced bioceramic materials (like MTA and Biodentine) in the local Libyan market, intense institutional time constraints in busy public clinics, and poor compliance with absolute rubber dam isolation—substantially restrict the clinical adoption of both techniques.

To date, there is an absolute scarcity of localized, comparative data that systematically quantifies how these barriers evolve from the internship phase through active clinical practice within the specific dental ecosystem of Zliten city. Without identifying the precise knowledge gaps, clinical preferences, and operational bottlenecks unique to these cohorts across healthcare centers regarding partial and full pulpotomy, restructuring undergraduate curricula and continuous dental education remains ineffective. This study addresses this critical geographic and empirical gap by diagnosing the underlying impediments to both partial and full pulpotomy adoption in Zliten, thereby establishing an empirical foundation to bridge the rift between current scientific consensus and daily clinical performance.

3. Research Questions

- What is the current level of baseline knowledge and clinical awareness regarding the indications, procedural protocols, and prognostic outcomes of partial versus full pulpotomy among dental practicing clinicians (GDPs and specialists) in Zliten?
- What are the primary cognitive, procedural, and systemic barriers (e.g., availability of biomaterials like MTA/Biodentine, rubber dam compliance, institutional time limits) that significantly restrict or prevent the routine clinical execution of both partial and full pulpotomy?
- Does the clinical experience, educational background (local graduation vs. other universities), or institutional work setting (public sectors vs. private clinics in Zliten) significantly influence the decision-making matrix and willingness of dental professionals to adopt partial and full pulpotomies over conventional root canal treatments?
- How do dental practitioners in Zliten differentiate between the clinical indications of partial pulpotomy and full pulpotomy when managing teeth with deep caries or pulpal exposure?

4. Research Hypotheses

Hypothesis 1: Dental practitioners (GDPs and specialists) in Zliten possess a satisfactory baseline level of comprehensive theoretical knowledge and clinical differentiation regarding Vital Pulp Therapy (VPT) protocols and prognostic outcomes, which varies significantly based on demographic factors (e.g., gender and prior CPE attendance).

Hypothesis 2: Systemic and pedagogical barriers (such as high local procurement costs, unavailability of bioceramics like MTA/Biodentine, institutional time constraints, and a lack of undergraduate clinical training) serve as significantly more dominant impediments to the clinical adoption of VPT in Zliten than purely cognitive diagnostic barriers.

Hypothesis 3: There are statistically significant differences and correlations between a professional's background attributes (such as years of clinical experience, institutional work setting, and monthly case volumes) and their ultimate clinical decision-making matrix to practice vital pulp therapies over conventional root canal treatments.

5. Objectives of the Study

5.1. General Objective

The primary objective of this study is to assess and compare the current level of knowledge, attitudes, and perceived barriers regarding partial and full pulpotomy

procedures among dental practitioners (including, general dental practitioners, and specialists) in both public and private sectors in Zliten, Libya.

5.2. Specific Objectives

- To evaluate the baseline knowledge of dental practitioners regarding the clinical indications, diagnostic criteria, and procedural steps for partial versus full pulpotomy in mature and immature permanent teeth.
- To assess the clinical attitudes and level of confidence of the participants toward the predictability, success rates, and biological outcomes of both partial and full pulpotomies compared to conventional root canal therapy.
- To identify and rank the major cognitive, pedagogical, and systemic barriers (such as lack of training, high cost of biomaterials like MTA/Biodentine, and rubber dam compliance) that hinder the routine implementation of both procedures.
- To compare the differences in knowledge and attitudes toward partial and full pulpotomy based on the participants' demographic and professional characteristics, such as years of clinical experience, educational background, and workplace sector (public vs. private).
- To identify the preferred choice of biomaterials and diagnostic methods used by practitioners in Zliten when performing partial and full pulpotomy techniques.

6. Significance of the Study

The clinical and academic significance of this investigation lies in its capacity to provide an empirical framework for operationalizing minimally invasive endodontics within the Libyan healthcare context, specifically focusing on Zliten city. While the biological advantages of pulp preservation are well-established in literature, this study bridges the 'bench-to-bedside' rift by exposing the precise human, economic, and systemic bottlenecks that halt the clinical translation of both partial and full pulpotomy in this region.

From a pedagogical perspective, the insights generated from this research serve as a critical diagnostic tool for academic institutions in Libya, such as the Faculty of Dentistry at Asmarya University in Zliten. Quantifying specific knowledge gaps regarding the distinct indications and protocols of partial versus full pulpotomy allows dental educators to restructure undergraduate curricula and clinical training setups, shifting focus from traditional, aggressive protocols toward evidence-based vital pulp therapies.

Furthermore, by illuminating specific localized systemic barriers—such as the high procurement costs or unavailability of biomaterials like MTA/Biodentine in Libya, intense patient volume constraints in public polyclinics, and deep-seated non-compliance regarding mandatory rubber dam utilization—this study provides local healthcare administrators, dental syndicates, and policymakers with actionable data. These data are vital for optimizing institutional workflows in Zliten, modifying resource allocation, and designing targeted continuing dental education (CDE) programs necessary to standardize conservative care—specifically partial and full pulpotomies—in daily clinical practice across the city.

7. Literature Review

7.1. The Paradigm Shift and Biological Basis of Vital Pulp Therapy (VPT)

The field of conservative endodontics has undergone a significant paradigm shift, transitioning from radical root canal treatments to therapies aimed at preserving dental pulp vitality [10, 15]. Historically, a clinical presentation of irreversible pulpitis mandated complete pulpectomy. However, contemporary biological insights indicate that the dental pulp possesses a remarkable regenerative and healing capacity, provided that bacterial contamination is eliminated and local inflammation is properly modulated [4, 17].

Expanded Indications: VPT indications have successfully expanded from immature permanent teeth (apexogenesis) to mature permanent teeth diagnosed with symptomatic irreversible pulpitis [10].

Inflammation Modulation: Modern bioceramic materials interact with host tissues to downregulate destructive inflammatory biomarkers, converting a hostile microenvironment into a pro-healing matrix that supports tertiary dentin formation [17, 18].

Bibliometric Growth: Bibliometric analyses demonstrate an exponential increase in global scientific interest and high-impact publications validating conservative endodontic protocols [11].

7.2. Clinical Efficacy of Partial vs. Full Pulpotomy in Permanent Teeth

Randomized clinical trials and comprehensive meta-analyses demonstrate high clinical and radiographic success rates for both partial and full pulpotomies in carious permanent teeth [6]. However, the choice between these two technical modalities remains a subject of ongoing clinical evaluation depending on the depth of excavation and hemostasis control.

Procedural Differences: Partial pulpotomy involves removing only 1 to 3 mm of inflamed pulp tissue beneath the exposure site, preserving coronal pulp tissue to facilitate future vitality testing [14]. Conversely, full pulpotomy removes the entire coronal pulp down to the root canal orifices, offering a more extensive debridement of potentially inflamed tissue [14].

Prognostic Factors: Success is heavily dictated by immediate postoperative factors, including strict moisture control, the direct placement of a bioactive barrier material over the pulp stumps, and the immediate establishment of a definitive coronal seal to avert microleakage [9, 19].

Dentin Bridge Formation: Retrospective cohort studies confirm that successful pulpotomies consistently lead to the formation of a detectable hard tissue barrier, which isolates and protects the remaining radicular pulp tissue [16].

Management of Failures: Even in cases of initial failure, subsequent nonsurgical root canal therapy remains a viable option without significantly compromising the long-term survival of the tooth.

7.3. Advancements in Bioactive Materials and Auxiliary Agents

The clinical success of pulpotomy has been revolutionized by the development of calcium silicate-based cements (bioceramics), which have effectively replaced traditional calcium hydroxide materials due to their superior sealing properties and biocompatibility [8, 13].

Material Comparisons: Systematic reviews underscore the clinical superiority of Mineral Trioxide Aggregate (MTA), Calcium-Enriched Mixture (CEM) cement, and contemporary pre-mixed bioceramics over older materials, citing lower failure rates, enhanced legal sealing, and strong induction of dentin bridges [12, 13].

Role of Irrigation and Chelating Agents: The choice of root canal irrigants and contemporary chelating agents during the pulpotomy procedure significantly impacts pulp healing, as they help disinfect the chamber while releasing crucial dentin-bound growth factors.

7.4. Knowledge, Attitudes, and Clinical Barriers Among Dental Practitioners

Despite clear evidence, consensus statements, and expert guidelines promoting pulpotomy for mature teeth [18, 20], a substantial discrepancy persists between academic knowledge and actual clinical implementation by dental practitioners [1, 7].

Global and Regional Trends: Questionnaire-based surveys globally and regionally (e.g., Jordan, the UK, and the USA) reveal that while many dentists hold positive general attitudes toward VPT, they lack detailed knowledge regarding modern diagnostic protocols and precise clinical steps [1, 7].

Primary Clinical Barriers: Several factors hinder the routine adoption of pulpotomies in private and public clinics:

(a) Fear of Clinical Failure: Uncertainty regarding long-term prognosis makes practitioners default to safer, traditional treatments like RCT [1];

(b) Material Accessibility and Cost: High costs and limited availability of advanced bioceramic materials restrict their use [1];

(c) Educational Deficiencies: A lack of updated clinical guidelines in undergraduate curricula and a shortage of evidence-based continuing education workshops limit practitioner confidence [1, 5].

RATIONALE FOR THE STUDY IN ZLITEN, LIBYA

Currently, there is a total lack of baseline data regarding how dental practitioners in Libya view and practice vital pulp therapy. Variations in clinical behavior, combined with an over-reliance on conventional pulpectomy, suggest that modern endodontic protocols are underutilized. Therefore, this cross-sectional study is designed to assess the current levels of knowledge, attitudes, and specific institutional or material barriers among dental practitioners in Zliten, Libya. The findings will serve as a foundation for developing targeted continuing education programs and public health strategies to optimize conservative dental care across the region.

8. METHODOLOGY

Study Design and Setting

This study employed a descriptive, analytical, cross-sectional survey-based design conducted within the geographic boundaries of Zliten city, Libya. Data collection spanned over a two-month period (from June to August 2026). The clinical settings encapsulated both Health care centers and private dental centers in Zliten operating across the municipality.

Sampling and Sample Size Determination

A convenience non-probability sampling technique was utilized to recruit eligible participants operating within the municipality of Zliten, Libya. The target population comprised actively practicing dental clinicians (including General Dental Practitioners [GDPs] and specialists) operating across public institutions and private dental clinics.

Sample size calculation was performed using G*Power software (version 3.1.9.7). To detect a medium effect size (f = 0.25) for group comparisons using two-tailed Independent Samples t-tests and One-Way Analysis of Variance (ANOVA), with \alpha = 0.05 and power ($1 - \beta) = 0.80, a minimum required sample size of N = 64 was established.

To account for potential non-response or incomplete submissions, the survey was distributed to 100 eligible dental professionals across Zliten. Ultimately, N = 70 completed questionnaires were retrieved and verified for statistical analysis, yielding an effective response rate of 70%.

Validity and Reliability (Pilot Testing)

Content and Face Validity: The initial draft of the self-administered questionnaire was developed based on established indices from contemporary endodontic literature. The instrument was submitted to an expert panel comprising three senior endodontists and two academic epidemiologists. Minor textual modifications were implemented based on consensus recommendations.

Pilot Testing: A pilot study was conducted on a sample of 10 dental general practitioners in Zliten (excluded from the final cohort). The test confirmed that the instrument required approximately 5 to 7 minutes to complete, with clear comprehension reported across all domains.

Internal Consistency Reliability: Scale reliability was evaluated on the final dataset (N = 70) using Cronbach's alpha (\alpha). Both Likert-scale sections demonstrated strong internal consistency exceeding the standard academic threshold of \alpha \ge 0.70:

Part II (Knowledge, Attitudes, & Barriers - KAB): 10 items, Cronbach's \alpha = 0.806

Part III (Intent & Clinical Practice - CP): 10 items, Cronbach's \alpha = 0.735

Overall Instrument (Full 20-Item Scale): Cronbach's \alpha = 0.865

Data Collection Procedure

Data collection was executed over a two-month period (June to July 2026). The questionnaire was administered in English. A hard-copy distribution strategy was employed: printed questionnaires were physically distributed during field visits to public dental facilities and private clinics across Zliten. Completed surveys were collected in sealed envelopes to maintain anonymity. Informed consent was obtained prior to participation.

9. Results and Analysis

Table 1: Cronbach's Alpha Reliability Analysis.

Scale / Subscale	Number of Items	Cronbach's Alpha (α)	Interpretation
Part II: Knowledge, Attitudes, & Barriers (KAB)	10	0.806	Good Reliability
Part III: Intent & Clinical Practice (CP)	10	0.735	Acceptable Reliability
Overall Questionnaire (Full Scale)	20	0.865	High Reliability

Table 2: Demographic and Professional Background (N = 70)

Characteristic	Category	Frequency (N)	Percentage (%)
Gender	Male	31	44.3%
	Female	39	55.7%
Age Group	22 – 30 Years	17	24.3%
	31 – 40 Years	35	50.0%
	41 – 50 Years	17	24.3%
	Above 50 Years	1	1.4%
Clinical Experience	< 5 Years	8	11.4%
	5 – 10 Years	29	41.4%
	> 10 Years	33	47.1%
Primary Sector of Practice	Public Sector Only	19	27.1%
	Private Sector Only	8	11.4%
	Both Public and Private	43	61.4%
Highest Qualification Obtained	BDS (Bachelor of Dental Surgery)	45	64.3%
	Higher Diploma	19	27.1%
	Master's Degree (MSc)	3	4.3%
	Libyan Board / Arab Board / PhD	3	4.3%
VPT CPE Course (Last 3 Years)	Yes	35	50.0%
	No	35	50.0%
Monthly Pulpotomy Cases	None	22	31.4%
	1 – 5 Cases	25	35.7%
	6 – 10 Cases	10	14.3%
	More than 10 Cases	13	18.6%

Table 3: Part II — Knowledge, Attitudes, and Perceived Barriers (KAB)

#	Survey Statement	Mean (M)	Std. Dev. (SD)	Level / Agreement
KAB 1	Adequate clinical knowledge regarding diagnostic criteria (partial vs full)	3.50	1.14	Moderate
KAB 2	Belief in full pulpotomy as definitive treatment for mature teeth with irreversible pulpitis	3.26	1.26	Moderate
KAB 3	Recognition that bioactive materials (MTA/Biodentine) excel over \(Ca(OH)_2\)	3.76	1.23	High
KAB 4	Awareness that NaOCl bleeding control serves as an important diagnostic tool	3.61	1.11	Moderate
KAB 5	Clinical confidence to manage exposure, hemorrhage, and assess vitality	3.53	1.07	Moderate
KAB 6	Lack of continuous clinical training/ guidelines prevents confident practice	3.36	1.09	Moderate
KAB 7	Unavailability of advanced bioceramic materials in Zliten restricts practice	3.10	1.09	Moderate
KAB 8	Belief that operating without rubber dam significantly increases failure rate	4.01	1.10	High
KAB 9	High financial cost of modern materials makes VPT less acceptable to patients	3.33	1.26	Moderate
KAB 10	Fear of late clinical failures drives preference for conventional RCT over pulpotomy	3.41	1.14	Moderate
-	**Overall Combined KAB Mean Index**	**3.49**	**0.69**	**Moderate**

Table 4: Part III — Intent and Clinical Practice of Pulpotomy (CP)

#	Survey Statement	Mean (M)	Std. Dev. (SD)	Level / Frequency
CP 1	Perform partial pulpotomy when encountering carious/mechanical exposure	3.06	1.30	Sometimes
CP 2	Choose full pulpotomy as conservative alternative before pulpectomy/RCT	2.80	1.21	Sometimes
CP 3	Strictly apply rubber dam isolation for every VPT procedure	3.19	1.32	Sometimes
CP 4	Utilize standard irrigation (NaOCl) for disinfection & hemostasis	3.54	1.06	Sometimes
CP 5	Place bioactive calcium silicate materials directly over exposed pulp	3.41	1.28	Sometimes
CP 6	Place well-sealed permanent restoration in same session/shortly after	3.34	1.39	Sometimes
CP 7	Schedule follow-up appointments to evaluate symptoms and barrier formation	3.46	1.14	Sometimes
CP 8	Actively recommend dental colleagues in Zliten to adopt VPT protocols	3.37	1.17	Sometimes
CP 9	Switch immediately to RCT if pulp bleeding fails to stop within 5-10 mins	3.79	1.19	Often/ Always
CP 10	Allocate clinical time to educate patients on keeping teeth vital	3.63	1.33	Sometimes
-	**Overall Combined Clinical Practice Mean Index**	**3.36**	**0.68**	**Sometimes**

Table 5: Independent Samples T-Test (Gender & CPE Attendance)

Variable	Category	N	KAB Mean (SD)	t-statistic	p-value	Interpretation
Gender	Male	31	3.23 (0.68)	-2.962	0.004	Statistically Significant (Females Higher)
	Female	39	3.69 (0.64)			
CPE Course	Yes	35	3.77 (0.57)	3.779	0.0003	Highly Significant (With CPE Higher)
	No	35	3.20 (0.69)			

Table 6: One-Way ANOVA Across Professional Characteristics

Independent Variable	Dependent Variable	F-statistic	p-value	Interpretation
Experience Years	KAB Mean Index CP Mean Index	0.520 0.459	0.597 0.634	No Significant Difference No Significant Difference
Practice Sector	KAB Mean Index CP Mean Index	0.153 0.046	0.858 0.955	No Significant Difference No Significant Difference
Qualification	KAB Mean Index CP Mean Index	0.196 0.808	0.899 0.494	No Significant Difference No Significant Difference
Cases Per Month	KAB Mean Index CP Mean Index	1.838 3.721	0.149 0.015*	No Significant Difference **Statistically Significant Differences**

Table 7: Pearson Correlation Matrix

Bivariate correlation between practitioners' knowledge/attitudes index and their actual practice patterns.

Variables Compared	Pearson (r)	Spearman (ρ)	p-value	Significance / Interpretation
KAB Index vs. Clinical Practice (CP)	0.724	0.664	< 0.0001	Strong Positive Correlation

Table 8: Multiple Linear Regression Model

Multivariable regression analysis modeling clinical practice performance (\(R^{2}\) Predictors).

Model Predictors	Unstandardized (B)	Std. Error	t-value	p-value	95% Confidence Interval
Constant	0.645	0.481	1.342	0.184	[-0.315, 1.605]
KAB Mean Index	0.669	0.087	7.653	< 0.001*	[0.494, 0.843]
CPE Training (Yes/No)	0.046	0.104	0.432	0.700	[-0.143, 0.234]
Monthly Pulpotomy Cases	0.141	0.061	2.307	0.024*	[0.019, 0.264]

10. DISCUSSION

The results of the current study demonstrated that the overall combined index for dental practitioners' Knowledge, Attitudes, and Barriers (KAB) toward partial and full pulpotomy in Zliten was moderate, with a mean score of (3.49 \pm 0.69). This moderately developed cognitive foundation directly mirrors their self-reported clinical practice (CP) scores, which fell into the 'sometimes' frequency range with a mean of (3.36 \pm 0.68).

A critical evaluation of these findings reveals a stark knowledge-practice gap regarding isolation protocols. Clinicians expressed a high theoretical conviction that operating without a rubber dam significantly escalates clinical failure rates, yielding one of the highest agreement means in the survey (M = 4.01). However, this cognitive awareness failed to fully translate into daily clinical operations, as strict procedural rubber dam compliance dropped noticeably to a moderate level (M = 3.19). This behavioral dissonance can be interpreted as a direct consequence of localized systemic and administrative bottlenecks within the Libyan healthcare sector. In busy public polyclinics and institutional frameworks across Zliten, high patient volumes, severe clinic time constraints, and lack of immediate supply chains create environments where clinicians frequently bypass standard aseptic protocols. This structural impediment aligns with the findings of Abu Zaghlan et al. (2025) [2], who identified material inaccessibility and structural clinic limitations as primary operational barriers preventing practitioners from adopting contemporary vital pulp therapy (VPT) regimens.

Regarding diagnostic precision and advanced biomaterial awareness, the participants exhibited an encouragingly high level of knowledge (M = 3.76) respecting the clinical superiority of bioceramics like Mineral Trioxide Aggregate (MTA) and Biodentine over traditional calcium hydroxide [Ca(OH)]. This demonstrates that clinicians in Zliten are theoretically well-aligned with the global endodontic paradigm shift, acknowledging the capacity of calcium silicates to actively stimulate a secure, defect-free dentin bridge. Furthermore, practitioners showed a high, disciplined adherence to the clinical hallmark of hemostasis, exhibiting a strong intent to switch immediately to conventional root canal treatment (RCT) if pulpal bleeding failed to stabilize within 5–10 minutes (M = 3.79). This decision-making matrix represents a highly sound clinical consensus, strongly validated by Duncan et al. (2023) [9], who established that temporal hemostasis control using sodium hypochlorite (NaOCl) serves as the single most critical diagnostic marker to differentiate reversible from terminal, irreversible pulpal inflammation stages.

Inferential demographic analysis utilizing Independent Samples t-tests exposed a statistically significant variance in baseline knowledge based on gender, with female practitioners demonstrating higher KAB scores than their male counterparts ($p = 0.004$). More importantly, a profound statistical impact was observed relative to Continuing Professional Education (CPE); clinicians who had attended a structured VPT training workshop within the past three years achieved significantly superior scores in both theoretical knowledge ($p = 0.0003$) and practical execution ($p = 0.001$) compared to untrained professionals. This finding is further strengthened by

the multiple linear regression model, which demonstrated that a practitioner's clinical competence is robustly predicted by their baseline KAB index (\beta = 0.669, $p < 0.001$) and their monthly case volume (\beta = 0.141, $p = 0.024$).

Conversely, One-Way ANOVA tests failed to show any statistically significant differences in knowledge or practice across experience cohorts, academic backgrounds, or workplace sectors (public vs. private). This uniform lack of variation across career trajectories suggests a collective pedagogical shortfall. It implies that standard undergraduate curricula across local institutions remain heavily anchored to traditional, highly aggressive endodontic philosophies that favor total pulpectomy, leaving both transitioning interns and senior clinicians with insufficient hands-on confidence. This systemic educational deficiency directly corresponds with the multivariable analysis conducted by Cangül et al. (2026) [5], which criticized conservative dental education for over-focusing on conventional endodontics, thereby inducing an institutionalized 'fear of late clinical failure' that drives clinicians to default to radical therapies despite overwhelming scientific evidence supporting pulp preservation.

11. Conclusion

This cross-sectional investigation highlights a profound knowledge-practice gap among dental practitioners in Zliten, Libya, regarding the clinical adoption of partial and full pulpotomies. While clinicians demonstrate a commendable theoretical awareness of advanced biomaterials and the diagnostic value of temporal hemostasis control, their actual clinical implementation remains compromised. This hesitation is heavily driven by systemic and operational barriers, most notably a sharp disconnect between rubber dam awareness and daily compliance, high local procurement costs of advanced bioceramics, and severe institutional time constraints in public polyclinics.

12. Curricular and Policy Recommendations

1. Academic Curricular Restructuring (Faculty of Dentistry, Asmarya University)

Shift the Endodontic Paradigm: Rebalance undergraduate dental curricula by actively integrating evidence-based vital pulp therapy (VPT) guidelines for mature permanent teeth, moving away from the historical over-focus on immediate root canal therapy (RCT).

Mandatory Hands-On Pre-clinical Training: Introduce dedicated simulation laboratory modules focusing on the technical execution of partial and full pulpotomies, precise hemostasis assessment using sodium hypochlorite (NaOCl), and the handling of bioceramic materials.

Clinical Competency Requirements: Establish mandatory clinical requirements for dental interns to perform a minimum of five documented vital pulp therapies cases under absolute rubber dam isolation prior to graduation.

2. Institutional and Healthcare Policy Reforms (Zliten Health Authorities & Public Sector)

Subsidization and Supply Chain Stabilization: Optimize municipal procurement strategies to lower prohibitive costs and ensure an uninterrupted supply of advanced bioceramics (like MTA and Biodentine) across public facilities, including Health care centers in Zliten.

Enforcement of Aseptic Protocols: Implement strict institutional auditing and quality-control checklists making absolute rubber dam isolation mandatory for all deep-caries excavations and pulp-capping procedures.

Adjustment of Clinical Time Slots: Revise the administrative scheduling of patient volumes in public polyclinics to allocate dedicated, 45 minutes slots required for meticulous moisture control and multi-step bio-inductive restorations.

3. Professional Development and Community Outreach (Dental Syndicates)

Targeted Continuing Dental Education (CDE): Launch a series of regular, localized hands-on workshops and continuous training programs certified by the dental syndicate to target general dental practitioners (GDPs) and older experience cohorts who graduated prior to the bioceramic paradigm shift.

Standardization of Local Guidelines: Draft and distribute a localized, simple visual decision-making flowchart across all public and private dental clinics in Zliten, clearly defining diagnostic entry criteria and specific clinical timelines for managing irreversible vs. reversible pulpitis.

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