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Original Article

The Knowledge and Information of Vital Pulp Therapy by Libyan Internship Dentists and Dental Students: A Survey Study

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Abstract
The dental pulp is a specialized connective tissue that maintains tooth vitality. Excessive wear or bacterial infiltration can cause irreversible pulp inflammation, often requiring pulpectomy or tooth extraction. Vital pulp therapy is considered a pulp-conserving treatment for permanent teeth. This study aims to evaluate the knowledge of Libyan dental interns and clinical-level students regarding vital pulp therapy (VPT) for permanent teeth, while also examining its correlation with their sociodemographic characteristics. A comprehensive survey consists of two parts: demographic and general information, followed by 22 questions assessing the understanding of vital pulp therapy's indications, procedures, and materials. The questionnaire was mailed (as a soft copy) and distributed by hand (as hard copies) to internship dentists and clinical dental students from two Libyan academic centers in Benghazi. Descriptive statistics and the Chi-square test were used to analyze the responses to the questions. 71% of the 224 respondents were final year dental students, and 28.6% were internship dentists. (76.8%) Of the respondents were females; 23.2% were males. Only 36.2% of respondents knew that (VPT) may be successfully applied in teeth with signs and symptoms of irreversible pulpitis. 72.8% of respondents were familiar with the definition of indirect pulp capping. About 73.7% knew that any leakage to the capping materials would cause failure in VPT. 33.5% reported that Biodentine and TheraCal can be used as direct pulp capping agents. This study found that dental clinical-level students and interns possess a good understanding of the various types and procedural steps involved in Vital Pulp Therapy (VPT).
Keywords. Vital Pulp Therapy, Survey, Libyan Dental Students, Apexogenesis.

Introduction

The dental pulp is a highly specialized connective tissue surrounded by a mineralized covering with a limited blood supply. The important functions of pulp tissue are the maintenance of tooth vitality, supplying nutrients and oxygen, providing innervation, pain sensation, immune response, and promoting the formation of reparative dentin after injury [1]. However, excessive wear or infiltration of cariogenic oral bacteria can lead to acute, irreversible inflammatory events and the destruction of pulp tissue. The morbidity associated with untreated pulp infection often requires root canal treatment or tooth extraction with further replacement, which may involve multiple appointments and significant expenses [2,3].

Pulpal diseases are clinically classified by the criteria of the American Association of Endodontists (AAE) [4,5]. Pulpal inflammation is commonly referred to as either 'reversible' or 'irreversible' pulpitis. Reversibility means that the process is controlled well enough that it can be stopped and then aid in healing. Inflammatory processes are considered "irreversible" when inflammation has progressed beyond control. For irreversible pulpitis, root canal treatment remains the therapy of choice because the pulp is too inflamed to heal. Studies have shown that root canal treatment of teeth with vital pulp yields reliable results [6,7]. However, the survival rate of endodontically treated teeth is not as high as that of living teeth [8]. Possible reasons for this may include the loss of proprioceptive function [9], damping properties, and tooth sensitivity provided by vital pulp as a defense mechanism against harmful stimuli [10]. Therefore, the vitality pulp should be preserved as much as possible.

Although the management of deep caries and the exposed pulp has been carried out for many years, it has been considered to have poor outcomes [11,12]. It has been recommended that vital pulp therapy should be performed only in teeth with reversible pulpitis, with no periapical pathologies, or in teeth with recent mechanical or traumatic pulp exposure [13,14]. However, recent studies have reported successful VPT outcomes utilizing selective removal techniques to avoid pulp exposure in one or two visits, as well as carious exposures treated by pulp capping, partial pulpotomy, and full/coronal pulpotomy [2,15–17]. These techniques have shown success even in cases with signs and symptoms indicative of irreversible pulpitis [17,18]. The improved success rates of VPT in teeth with deep carious lesions can be attributed to the implementation of enhanced protocols [19], including disinfectant lavage of the pulpal wound, magnification, and the use of hydraulic calcium silicate cements (HCSCs) [2,15,20].

Pulp capping and pulpotomy of the pulp chamber are methods that prevent bacterial penetration merely by placing a material directly in contact with the pulp tissue. This material helps seal the lesion within a few minutes/hours and provides a double protective effect by inducing the formation of a mineralized barrier between the material and the pulp tissue. Thus, partial and full chamber pulpotomies, followed by pulp capping, are considered to be minimally invasive endodontic treatments [21]. Recent research advancements have shown that the dentin–pulp complex has the ability to repair and regenerate mineralized tissue. This

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offers hope for new endodontic treatment approaches that can protect the vital pulp, promote reactionary dentinogenesis, and stimulate revascularization [22]. Because surveys are an indicator of the knowledge and awareness level of dental students, the purpose of this study was to assess the knowledge of Libyan internship dentists and dental students at clinical levels regarding different types of vital pulp therapy (VPT) for permanent teeth. Additionally, this study seeks to understand how the knowledge relates to the sociodemographic data of the internship dentists and dental students

Methods

The survey was conducted in Benghazi, Libya, in 2022. This descriptive cross-sectional study aimed to assess the knowledge of Libyan internship dentists and dental students regarding vital pulp therapy. The study followed the guidelines outlined in the Declaration of Helsinki and received approval from the Ethics Committee of the University of Benghazi, Libya (Protocol 0116). Participants were informed about the purpose of the questionnaire and assured of the anonymity of their responses.

The questionnaire used in this study was developed based on a previous study by Doumani [23], with permission from the authors. Minor modifications were made to the questionnaire, including adding items 7, 12, 14, 20, 21, and 22. The questionnaire consisted of two main parts. The first part collected demographic data and general information, such as university, gender, and academic level.

The second part contained 22 questions divided into three sections. The first section (items 1-6) assessed participants' knowledge of the indications, objectives, and diagnosis of vital pulp therapy. The second section (items 7-15) evaluated participants' understanding of the different procedures involved in vital pulp therapy for permanent teeth. Finally, the third section (items 16-22) assessed participants' knowledge of the materials used in vital pulp therapy and restoration. All questions in the questionnaire were closed-ended, requiring participants to choose from the options "true," "false," or "I do not know."

The sample for this study was a convenience sample. The questionnaire was mailed (as a soft copy) and distributed by hand (as hard copies) to 300 participants from two Libyan academic centers in Benghazi: The University of Benghazi and Libyan International Medical University. We received 220 responses in both types of questionnaires. Incomplete or non-compliant questionnaires were excluded.

Results

160 out of 224 (71.4.2%) respondents participating in the survey were final-year dental students, and 64 out of 224 (28.6%) internship dentists, who were the minority of respondents participating in the survey. The majority of respondents were female (76.8%), whereas a minority of participants were male (23.2%). Regarding the university, 163 respondents (72.8%) were from a governmental school, and the rest (27.2%) were from a private school. Descriptive statistics of the participants are shown in Table 1.

Table 1. Descriptive statistics of the participants

Variables	Classification	Number of respondents	Percentage
Educational Level	Final year dental student	160	71.4
	Internship dentist	64	28.6
	Total	**224**	100.0%
Gender	Female	172	76.8
	Male	52	23.2
	Total	**224**	100.0%
University	Government	163	72.8
	Private	61	27.2
	Total	**224**	100.0%

As shown in Table 2, the descriptive responses from the participants regarding the survey items related to Vital Pulp Therapy (VPT) for permanent teeth are summarized. Items 1- 6 assessed the knowledge of the participants about the indications, objectives, and diagnosis of VPT. Item 1, less than half, 36.2% of respondents knew that Vital pulp therapy may be successfully applied not only in permanent teeth diagnosed with reversible pulpitis, but also with signs and symptoms of irreversible pulpitis. For item 2, More than half (56.7%) of respondents were aware that the main objective in VPT is to initiate the formation of tertiary reparative dentin or calcific bridge formation.

Item 3, The majority, 75.4 % of respondents, agreed that after traumatic injuries, electric and thermal pulp tests may be unreliable. Item 4, a high percentage, 76.3% of respondents, were aware that the closure of the root apex is completed approximately 2–3 years after tooth eruption. Item 5, More than half, 67% of respondents identified that the use of CBCT provides more accurate information about the root formation compared to conventional radiographs. Item 6, more than half, 54.5% of respondents agreed that Successful outcomes for VPT decrease as the patient's age increases. Items 7-16 assessed the knowledge of the

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participants regarding the different procedures of VPTs for permanent teeth. Item 7, almost half (46%) of respondents reported that the Apexification is not one form of VPT for permanent teeth

Table 2. The descriptive responses of the participants to the survey items related to VPT of permanent teeth

Survey items related to Vital pulp therapy of permanent teeth.		Answers, Number (%)			
		No. %	Yes	No	I don't know
Items (1-6) related to the indications, objectives, and diagnosis of VPT	1. Vital pulp therapy should only be performed in teeth with reversible pulpitis.	n %	*123* *54.9*	*81* *36.2*	20 8.9
	2. The main objective in VPT is to initiate the formation of tertiary reparative dentin or calcific bridge formation.	n %	*127* *56.7*	58 25.9	39 17.4
	3. After traumatic injuries, electric and thermal pulp tests may be unreliable.	n %	*169* *75.4*	34 15.2	21 9.4
	4. The closure of the root apex is completed approximately 2–3 years after tooth eruption	n %	*171* *76.3*	27 12.1	26 11.6
	5. The use of CBCT provides more accurate information about the root formation compared to conventional radiographs.	n %	*150* *67.0*	36 16.1	38 17.0
	6. Successful outcomes for VPT decrease as the patient's age increases.	n %	*122* *54.5*	61 27.2	41 18.3
Items (7-15) related to the different procedures of VPTs for permanent teeth.	7. Apexification is one form of VPT for permanent teeth.	n %	78 34.8	*103* *46.0*	43 19.2
	8. Apex genesis is a vital pulp therapy procedure to encourage the physiological development and formation of the root end.	n %	*172* *76.8*	14 6.3	38 17.0
	9. Indirect pulp capping is a procedure performed in a tooth with a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration	n %	*163* *72.8*	42 18.8	19 8.5
	10. Regarding indirect pulp capping: caries near the pulp is left in place to avoid pulp exposure and is covered with biocompatible material.	n %	*163* *72.8*	43 19.2	18 8.0
	11. In indirect pulp capping, the patient returns in 8–12 weeks for placement of a permanent coronal restoration.	n %	*110* *49.1*	61 27.2	53 23.7
	12. Regarding direct pulp capping: a tooth with exposure on the axial wall of the pulp or a tooth with calcification in the pulp chamber and root canals, both are contraindications to direct pulp capping.	n %	*117* *52.2*	37 16.5	70 31.3
	13. Regarding direct pulp capping: the size and the character of bleeding following an exposure provide a valuable diagnostic aid in prognosis.	n %	*139* *62.1*	28 12.5	57 25.4
	14.Regarding direct pulp capping, mechanical exposure has a much better prognosis than does carious exposure.	n %	*155* *69.1*	28 12.5	57 25.4
	15. In partial or shallow pulpotomy: If bleeding cannot be controlled after 10 minutes of direct exposure to NaOCl after removal of unhealthy tissue, complete removal of the coronal pulp to the pulp floor is the preferred option	n %	*139* *62.1*	28 12.5	57 25.4
Items (16- 22) related to the materials used in VPT and restoration	16. Caries detector dyes can be considered a valuable tool in caries excavation when attempts are made to preserve	n %	*139* *62.1*	30 13.4	55 24.6
	17. The drawbacks of Ca(OH)2 include weak marginal adaptation to dentin and dissolution over time	n %	*120* *53.6*	52 23.2	52 23.2
	18. The unique physiochemical properties of MTA promote a superior environment for pulpal repair and bridge formation, compared to Ca(OH)2 products	n %	*166* *74.1*	17 7.6	41 18.3
	19. If MTA is substituted for Ca (OH)2 in vital pulp therapy procedures, similar periods for apical maturation can be anticipated	n %	*74* *33.0*	67 29.9	83 37.1
	20. In VPT, if the temporary restoration is to be left for a longer time, then amalgam or composite restoration should be used.	n %	*98* *43.8*	65 29.0	61 27.2
	21. Regarding VPT, any leakage to the capping materials would cause failure in the treatment.	n %	*165* *73.7*	20 8.9	39 17.4
	22. Do you think that Biodentine, TheraCal can be used as a direct pulp capping agent?	n %	*75* *33.5*	42 18.8	107 47.8

The correct answer response is printed in italics.

Item 8, The majority, 76.8% of respondents, were familiar with the definition of Apex genesis, which is a vital pulp therapy procedure to encourage the physiological development and formation of the root end. Items 9,10,11 assessed the knowledge of the participants regarding Indirect pulp capping (IPC), the majority,

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72.8% of respondents, were aware that IPC is a procedure performed in a tooth with a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration. Item 10, The similar percentages72.8% of them agreed that in the IPC procedure, the deepest layer of the remaining carious dentine near the pulp is left and covered by a biocompatible material to prevent pulp exposure. Item 11, While half, 49.1% of respondents knew that in IPC, the patient returns in 8–12 weeks for placement of a permanent coronal restoration. Items 12, 13, and 14 assessed the knowledge of the participants regarding direct pulp capping (DPC). More than half, 52.2% of the respondents were aware that teeth with exposure on the axial wall of the pulp or teeth with calcification in the pulp chamber and root canals are contraindications to direct pulp capping. While 62.1% of them identified that the size and the character of bleeding following an exposure provide a valuable diagnostic aid in the prognosis of DPC. Whereas two-thirds (69.1%) of the respondents believe that mechanical exposure has a much better prognosis than carious exposure.

Item 15 assessed the knowledge of the respondents regarding the pulpotomy. More than half, 62.1% of the respondents, preferred complete removal of the coronal pulp to the pulp floor. If bleeding cannot be controlled after 10 minutes of direct exposure to NaOCl, after the removal of unhealthy tissue. Items 16-22 assessed the knowledge of the respondents regarding the materials used in VPT and restoration. Item 16, more than half, 62.1% of respondents were aware that Caries detector dyes can be considered a valuable tool in caries excavation when attempts are made to preserve remineralizable dentin and to minimize trauma to the pulp. Item (17), 53.6% of the respondents were aware of the drawbacks of Ca (OH)2, including weak marginal adaptation to dentin and dissolution over time. Item 18, whereas nearly three-fourths 74.1% of them reported that the unique physiochemical properties of MTA promote a superior environment for pulpal repair and bridge formation, compared to Ca (OH)2 products. Item (19), While one third, 33.0% of respondents knew that if MTA is substituted for Ca (OH)2 in vital pulp therapy procedures, similar periods for apical maturation can be anticipated. Item 20, Less than half, 43.8% of the respondents agreed that if the temporary restoration is to be left for a longer time, then amalgam or composite restoration should be used. Item 21, The majority, 73.7% of respondents, were aware that any leakage to the capping materials would cause failure in the VPT. Item 22, One-third, 33.5% of respondents reported that Biodentine, TheraCal can be used as a direct pulp capping agent.

Based on the correct responses to the questionnaire items, knowledge of the participants is divided into poor knowledge of VPT (0%–25 %), fair knowledge of VPT (26%–50%), good knowledge (51%–75%), and excellent knowledge of VPT (76%–100%). In general, the results showed that the majority of participants have excellent knowledge of VPT toward items 4 and 8, with percentages 76.3 and 76.8%, respectively. However, about all other items, the majority of participants have fair knowledge of VPT to good knowledge of VPT, with a percentage of (33% to 75%) (Figure 1).

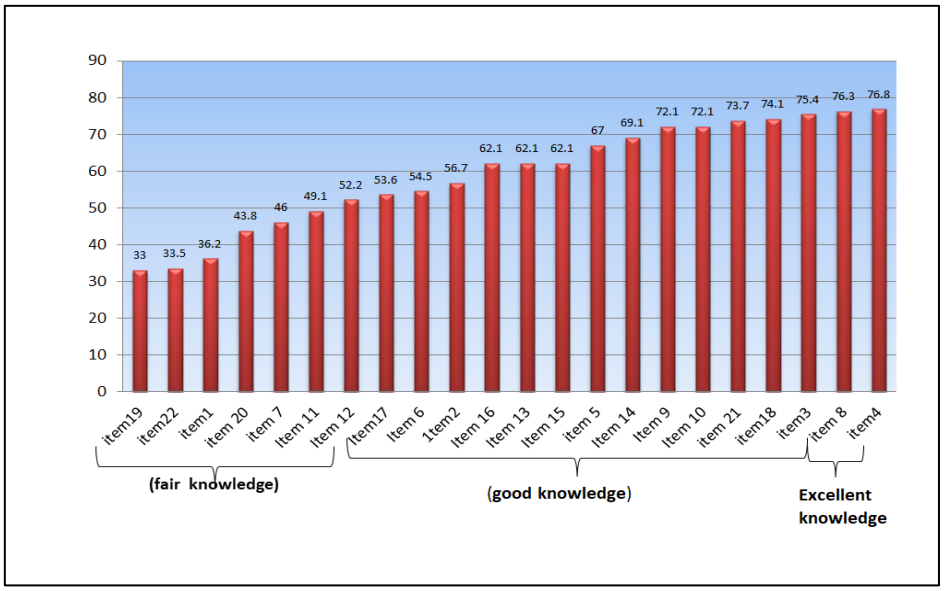

Figure 1. Knowledge level across survey items of VPT.

As shown in Table 3, the comparison mean score % of correct responses for knowledge regarding VPT of permanent teeth, about the demographic characteristics of the participants. (Educational level, gender, and university). According to educational level: the results showed that the majority of internship dentists have fair knowledge of VPT to good knowledge and excellent knowledge of VPT with a percentage of (31.1% to 85.9%), whereas the majority of final-year dental students have fair knowledge to good knowledge of VPT with a percentage of (31.3% to 75.6%). This means the intern dentist has enough knowledge than a final-year dental student. There is a statistically significant association between academic position and choosing

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the correct answer of VPT's items (Item No.12, 16, 18), the p-value of the Chi-square test (0.004, 0.049, and 0.037) is less than 0.01 and 0.05, respectively, while other Items were insignificant. According to gender: the majority of female's dentists have fair knowledge of VPT to good knowledge and excellent knowledge of VPT with a percentage of (32.0% to 79.7%), whereas the majority of male's dental students have fair knowledge of VPT to good knowledge of VPT with a percentage of (32.0% to 75.0%). This reflects that female dental students have greater knowledge of VPT than their male counterparts. There is a statistically significant association between gender and choosing the correct answer of VPT's items (Item No. 1, 11, 21), the p-value of the Chi-square test (0.043, 0.044, and 0.039) is less than 0.05, respectively, while the rest of the items were insignificant. According to university: The majority of government university of dentist's knowledge have fair knowledge of VPT to good knowledge and excellent knowledge of VPT with a percentage of (27.6% to 79.7%), whereas the majority of private university of dentist's knowledge have fair knowledge of VPT to good knowledge and excellent knowledge of VPT with a percentage of (31.1% to 77.0%).
This reflects those dental students from the government university have slightly greater knowledge of VPT for permanent teeth than those from the private university. There is a statistically significant association between the university of dentists' knowledge and choosing the correct answer of VPT's items (Item No. 10, 22), the p-value of the Chi-square test (0.049, 0.001) is less than 0.05 and 0.01, respectively, while other Items were insignificant.

Table 3. Relationship between survey items (1-22) and demographic variables.

		Educational level		Gender		University	
Items No	**Answer**	**Final year**	**internship**	**Female**	**Male**	**Government**	**Private**
Item 1	**Yes**	88 (55.0%)	35 (54.7%)	99 (57.6%)	24 (46.2%)	89 (%54.6)	34 (55.7%)
	No	58(36.3%)	23 (35.9%)	62 (36.0%)	19 (36.5%)	63 (%38.7)	18 (29.5%)
	I don't know	14 (70.0%)	6 (9.4%)	11 (6.4%)	9 (17.3%)	11 (%6.7)	9 (14.8%)
	p-value	0.989		0.043*		0.120	
Item 2	**Yes**	86 (53.8%)	41 (64.1%)	100 (58.1%)	27 (51.9%)	92 (56.4%)	35 (57.4%)
	No	45 (28.1%)	13 (20.3%)	45 (26.2%)	13 (25.0%)	41 (25.2%)	17 (27.9%)
	I don't know	29 (18.1%)	10 (15.6%)	27 (15.7%)	12 (23.1%)	30 (18.4%)	9 (14.8%)
	P-value	0.350		0.462		0.789	
Item 3	**Yes**	121 (%75.6)	48 (%75.0)	133 (77.3%)	36 (69.2%)	124 (76.1%)	45 (73.8%)
	No	26 (%16.3)	8 (%12.5)	26 (15.1%)	8 (15.4%)	27 (16.6%)	7 (11.5%)
	I don't know	13 (%8.1)	8 (%9.4)	13 (7.6%)	8 (15.4%)	12 (7.4%)	9 (14.8%)
	P-value	0.507		0.227		0.185	
Item 4	**Yes**	117 (%73.1)	54 (%84.4)	137 (79.7%)	34 (65.4%)	128 (%78.5)	43 (%70.5)
	No	23 (%14.4)	4 (%6.3)	18 (10.5%)	9 (17.3%)	18 (%11.0)	9 (%14.8)
	I don't know	20 (%12.5)	6 (%9.4)	17 (9.9%)	9 (17.3%)	17(10.4%)	9 (%14.8)
	P-value	0.162		0.105		0.450	
Item 5	**Yes**	106 (%66.3)	44 (%68.8)	111 (64.5%)	39 (75.0%)	109 (%66.9)	41 (%67.2)
	No	23 (%14.4)	13 (%20.3)	31 (18.0%)	5 (9.6%)	22 (%13.5)	14 (%23.0)
	I don't know	31 (%19.4)	7 (%10.9)	30 (17.4%)	8 (15.4%)	32 (%19.6)	6 (%9.8)
	P-value	0.227		0.285		0.083	
Item 6	**Yes**	87 (%54.4)	35 (%54.7)	29 (%16.9)	12 (23.1%)	92 (%56.4)	30 (%49.2)
	No	47 (%29.4)	14 (%21.9)	98 (57.0%)	24 (46.2%)	42 (%25.8)	19 (%31.1)
	I don't know	26 (%16.3)	15 (%23.4)	45 (26.2%)	16 (30.8%)	29 (%17.8)	12 (%19.7)
	P-value	0.327		0.365		0.987	
Item 7	**Yes**	58 (36.3%)	20 (%31.3)	55 (32.0%)	23 (44.2%)	57 (35.0%)	21 (34.4%)
	No	*68 (%42.5)*	*35 (%54.7)*	84 (48.8%)	19 (36.5%)	74 (45.4%)	29 (47.5%)
	I don't know	34 (%21.3)	9 (%14.1)	33 (19.2%)	10 (19.2%)	32 (19.6%)	11 (18.0%)
	P-value	0.219		0.219		0.948	
Item 8	**Yes**	118 (%73.8)	54 (%84.4)	134 (77.9%)	38 (73.1%)	129 (79.1%)	43 (%70.5)
	No	13 (8.1%)	1 (1.6%)	11 (6.4%)	3 (5.8%)	9(5.5%)	5(8.2%)
	I don't know	29 (18.1%)	9 (14.1%)	27 (15.7%)	11 (21.2%)	25 (%15.3)	13 (%21.3)
	P-value	0.118		0.654		0.392	

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Item 9	**Yes**	111 (69.4%)	52 (81.3%)	126 (73.3%)	37 (71.2%)	117 (%71.8)	46 (%75.4)
	No	35 (21.9%)	7 (10.9%)	35 (20.3)	7 (13.5%)	33 (%20.2)	9 (%14.8)
	I don't know	14 (8.8%)	5 (7.8%)	11 (6.4%)	8 (15.4%)	13 (%8.0)	6 (%9.8)
	P-value	0.146		0.088		0.614	
Item 10	**Yes**	118 (%73.8)	45 (%70.3)	127 (73.8%)	36 (69.2%)	125 (%76.7)	38 (%62.3)
	No	30 (%18.8)	13 (%20.3)	32 (18.6%)	11 (21.2%)	25 (%15.3)	18 (%29.5)
	I don't know	12 (7.5%)	6 (9.4%)	13 (7.6%)	5 (9.6%)	13 (%8.0)	5 (%8.2)
	P-value	0.846		0.790		0.049	
Item 11	**Yes**	80 (50.0%)	30 (46.9%)	89 (51.7%)	21 (40.4%)	78 (47.9%)	32 (52.5%)
	No	43 (26.9%)	18 (28.1%)	49 (28.5%)	12 (23.1%)	43 (26.4%)	18 (29.5%)
	I don't know	37 (23.1%)	16 (25.0%)	34 (19.8%)	19 (36.5%)	42 (25.8%)	11 (18.0%)
	p-value	0.911		0.044*		0.479	
Item 12	**Yes**	87 (54.4%)	30 (42.2%)	95 (55.2%)	22 (42.3%)	86 (52.8%)	31 (50.8%)
	No	30 (18.8%)	7 (10.9%)	28 (16.3%)	9 (17.3%)	26 (16.0%)	11(18.0%)
	I don't know	43 (26.9%)	27 (42.2%)	49 (28.5%)	21 (40.4%)	51 (31.3%)	19 (31.1%)
	p-value	0.049*		0.211		0.929	
Item 13	**Yes**	92 (57.5%)	47 (73.4%)	111 (64.5%)	28 (53.8%)	102 (62.6%)	37 (60.7%)
	No	22 (13.8%)	6 (9.4%)	21 (12.2%)	7 (13.5%)	21 (12.9%)	7 (11.5%)
	I don't know	46 (28.7%)	11 (17.2%)	40 (23.3%)	17 (32.7%)	40 (24.5%)	17 (27.9%)
	P-value	0.083		0.335		0.865	
Item 14	**Yes**	104 (65.0%)	51 (79.7%)	121 (70.3%)	34 (65.4%)	116 (71.2%)	39 (63.9%)
	No	27 (16.9%)	7 (10.9%)	27 (15.7%)	7 (13.5%)	23 (14.1%)	11 (18.0%)
	I don't know	29 (18.1%)	6 (9.4%)	24 (14.0%)	11 (21.2%)	24 (14.7%)	11 (18.0%)
	P-value	0.094		0.449		0.578	
Item 15	**Yes**	92 (57.5%)	47 (73.4%)	111 (65.4%)	28 (53.8%)	102 (62.6%)	37 (60.7%)
	No	22 (13.8%)	6 (9.4%)	21 (12.2%)	7 (13.5%)	21 (12.9%)	7 (11.5%)
	I don't know	46 (28.7%)	11 (17.2%)	40 (23.3%)	17 (32.7%)	40 (24.5%)	17 (27.9%)
	P-value	0.083.		0.335		0.865	
Item 16	**Yes**	93 (58.1%)	46 (71.9%)	109 (63.4%)	30 (57.7%)	101 (62.0%)	38 (62.3%)
	No	29 (18.1%)	1 (1.6%)	21 (12.2%)	9 (17.3%)	19 (11.7%)	11 (18.0%)
	I don't know	38 (23.8%	17 (26.6%)	42 (24.4%)	13 (25.0%)	43 (26.4%)	12 (19.7%)
	P-value	**0.004		0.610		0.339	
Item 17	**Yes**	81 (50.6%)	39 (60.9%)	92 (53.2%)	28 (53.8%)	83 (50.9%)	37 (60.7%)
	No	43 (26.9%)	9 (14.1%)	38 (22.1%)	14 (26.9%)	41 (25.2%)	11 (18.0%)
	I don't know	36 (22.5%)	16 (25.0%)	42 (24.4%)	10 (19.2%)	39 (23.9%)	13 (21.3%)
	P-value	0.119		0.648		0.390	
Item 18	**Yes**	111 (66.4%)	55 (85.9%)	132 (76.7%)	34 (65.4%)	119 (73.0%)	47 (77.0%)
	No	14 (8.8%)	3 (4.7%)	13 (7.6%)	4 (7.7%)	12 (7.4%)	5 (8.2%)
	I don't know	35 (21.9%)	6 (9.4%)	27	14	32 (19.6%)	9 (14.8%)
	P-value	0.037*		0.178		0.699	
Item 19	**Yes**	52 (32.5%)	22 (34.4%)	57 (33.1%)	17 (32.7%)	55 (33.7%)	19 (31.1%)
	No	43 (26.9%)	24 (37.5%)	55 (32.0%)	12 (23.1%)	45 (27.6%)	22 (32.8%)
	I don't know	65 (40.6%)	18 (28.1%)	60 (34.9%)	23 (44.2%)	63 (38.7%)	20 (32.8%)
	P-value	0.157		0.367		0.457	
Item 20	**Yes**	71 (44.4%)	27 (42.2%)	78 (45.3%)	20 (38.5%)	74 (45.4%)	24 (39.3%)
	No	42 (26.3%)	23 (35.9%)	51 (29.7%)	14 (26.9%)	45 (27.6%)	20 (30.8%)
	I don't know	47 (29.4%)	14 (21.9%)	43 (25.0%)	18 (34.6%)	44 (27.0%)	17 (27.9%)

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	P-value	0.29		0.388		0.672	
Item 21	**Yes**	112 (70.0%)	53 (82.8%)	133 (77.3%)	32 (61.5%)	126 (77.3%)	39 (63.9%)
	No	18 (11.3%)	2 (3.1%)	15 (8.7%)	5 (9.6%)	13 (8.0%)	7 (11.5%)
	I don't know	30 (18.8%)	9 (14.1%)	24 (14.0%)	15 (28.8%)	24 (14.7%)	15 (24.6%)
	P-value	0.083		0.039*		0.124	
Item 22	**Yes**	50 (31.3%)	25 (39.1%)	55(32.0%)	20 (38.5%)	45 (27.6%)	30 (49.2%)
	No	35 (21.9%)	7 (10.9%)	36 (20.9%)	6 (11.5%)	38 (23.3%)	4 (6.6%)
	I don't know	75 (46.9%)	32 (50.0%)	81 (47.1%)	26 (50.0%)	80 (49.1%)	27 (44.3%)
	P-value	0.146		0.293		0.001*	

To assess differences in knowledge levels on VPT of permanent teeth for the academic level, gender, and university, an independent-sample t-test was used (Table 4). There was a statistically significant difference in academic level mean scores ($t_{(df= 222)}$= -2.610, p < 0.01). A further investigation reveals that final year dental students and interns significantly differ from each other regarding their answers to items on VPT of permanent teeth. These results indicate that interns have more knowledge than final year dental students with respect to VPT of permanent teeth. There was no statistically significant difference between knowledge on VPT of permanent teeth according to gender and university ($t_{(df= 222)}$ = -1.071, p > 0.05) and ($t_{(df= 222)}$ = 0.270, p > 0.05), respectively.

Table 4. Independent sample t-test related to the mean difference in knowledge of academic level, gender, and university.

	Group	**N**	**Mean**	**Std. Deviation**	**t-test**	**df**	**Sig. (2-tailed)**
Academic level	Final year dental student.	160	2.37	0.26	-2.61	222	0.005
	Internship dentist	64	2.47	0.24			
Gender	Female	172	2.41	0.24	1.071	222	0.143
	Male	52	2.36	0.29			
University	Government	163	2.40	0.24	0.614	90.091	0.270
	Private	61	2.38	0.30			

Discussion

The health of the pulp is critical for the long-term survival of the tooth. Vital pulp therapy (VPT) aims to maintain the health of the pulp tissue by eliminating bacteria from the dentin-pulp complex. There are various treatment options available for vital pulp therapy in severely decayed or traumatized teeth, including pulp capping and pulpotomy. These procedures rely on accurately assessing the condition of the pulp and carefully managing the remaining pulp tissue [24]. To evaluate the knowledge of Libyan internship dentists and dental students regarding vital pulp therapy (the indications, objectives, diagnosis, procedures, and materials) for permanent teeth, we conducted a research study. A questionnaire was used to assess their knowledge, and the survey was designed to be easily understandable and fillable. The survey was distributed online and by hand to selected university centers representing dental faculties in Libyan universities.

Several studies have been conducted on this important topic. However, there are limited survey-based studies on vital pulp therapy among dental students and permanent teeth. We found only two similar studies in the literature for comparison [23,25]. The study by Doumani et al. indicated that Saudi dental students had an average knowledge of the different types and steps of vital pulp therapy, while Naram et al. concluded that the majority of dental students at Saveetha Dental School and Hospital had a fair knowledge regarding vital pulp therapy.

The current results found that the majority of participants were women, with 76.8% (172 out of 224) of the total sample being female. This high representation of women currently graduating from dental school in Libya suggests a significant feminization trend in the field. Similar findings of a predominantly female student population have also been reported in other studies conducted in Libya [26,27]. In (Table 3), the relationship between the respondents and participant demographics (educational level, gender, university) is illustrated. The majority of dental students from government and private universities demonstrated fair to good and excellent knowledge of VPT, ranging from 27.6% to 79.7% and 31.1% to 77.0%, respectively. Internship dentists also exhibited a fairly good to excellent understanding of VPT, with a range of percentages from 31.1% to 85.9%. On the other hand, final-year dental students showed a fair to good knowledge of VPT, ranging from 31.3% to 75.6%.

(Table 4) illustrates a significant difference between final-year dental students and interns in their ability to answer items on the VPT (Vital Pulp Test) of permanent teeth (t(df=222)= -2.610, p < 0.01). This indicates that interns have greater knowledge of VPT than final-year dental students. However, there was no

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statistically significant difference in knowledge of VPT according to gender and university (t(df= 222) = -1.071, p > 0.05) and (t(df= 222) = 0.270, p > 0.05), respectively. It is worth noting that the Libya International Medical University, the first private national medical university in Libya, has introduced a new educational strategy called problem-based learning (PBL) and offers excellent opportunities for education. On the other hand, the University of Benghazi lacks a quality teaching and research culture due to limited resources, funding, high student numbers, and the political crisis. Surprisingly, there was no difference in student knowledge of VPT in permanent teeth between the two universities, which could be explained by the fact that both universities rely on the same teaching staff and materials.

Items 1–6 assessed the participants' knowledge of the indications, objectives, and diagnosis of Vital Pulp Therapy (VPT). In item 1 in this study, around 55% of Libyan participants agree with performing vital pulp therapy only in teeth with reversible pulpitis. This is in line with the findings of Doumani et al. [23], where 60% of Saudi participants agreed, while only 40% of Indian students [25] agreed with this.

Dummer et al suggested that there is a weak connection between clinical symptoms and the histological condition of the pulp [28]. Additionally, determining whether inflamed pulp tissue can heal based solely on pulp tests and symptoms is challenging, and there is no definitive threshold to differentiate between reversible and irreversible pulpitis [29]. Asagry et al found that the most recent systematic reviews provide the best evidence for the effectiveness of VPT in treating cases of irreversible pulpitis. [30] The goal of VPT is to create an environment that promotes pulp health. This may involve removing infected or inflamed tissue and/or sealing the margins of the cavity to allow for regeneration or repair of the dentin-pulp complex, then medicament materials are applied to the dentin or pulp to stimulate the formation of mineralized dentin bridges by odontoblasts or odontoblast-like cells [31]. According to the current study, 56.7% of respondents to item (2) agreed with this approach, while 67.2% of Saudi participants and 60% of Indian participants acknowledged the same. The response to item (3) found that the majority of dental students and intern dentists in Libya (75.4%), Saudi Arabia (71.3%), and India (65%) have reported that sensibility tests yield incompatible results regarding pulp diagnosis in traumatized teeth. According to the literature, the cause of such diagnostic failures is temporary paraesthesia, leading to false-negative outcomes. This paraesthesia is caused by partial loss of the myelin sheath and swelling of axons, resulting in neurodegeneration [32].

In item (4), a considerable number of Libyan participants (76.3%) reported that root apex closure typically occurs 2–3 years after tooth eruption. This finding is consistent with the two other studies: Doumani et al. (74.4%) and Naram et al. (72%). These findings are important as they guide dental procedures. Moving on to item (5), Venkatesh et al. found that CBCT imaging provides high-quality images with a short scanning time and low radiation dose, surpassing the limitations of 2D imaging. With this equipment, practitioners can make accurate diagnoses [33]. It is worth noting that most Libyan (67%) and Saudi (78%) dental students were aware that CBCT is more accurate in providing information about root formation compared to conventional radiographs. However, only 40% of participants in the Naram et al. study agreed with this fact.

Although most studies on VPT are limited to young age groups, age does not seem to be an important factor in VPT outcomes, as demonstrated by Taha et al [29]. In contrast, the majority of Indian participants (82%), Saudi Arabian participants (63.3%), and half of Libyan participants (54.5%) responded to item (6) consistently with Mejàre et al. They stated that the response of the dental pulp in permanent teeth affected by dental caries may vary depending on whether the patient is a child or an adult. Immature permanent teeth have a well-established blood supply that can resist bacterial infection for longer periods. [34].

The participants' understanding of different procedures for treating permanent teeth, known as Vital Pulp Therapies (VPTs), was assessed through items 7-16. Item (7) discusses a dental procedure called apexification, which is used to create a calcified barrier in the root of a tooth that has an open apex or to continue apex development in a tooth with an incompletely formed root and necrotic pulp [35]. According to this study, 46% of Libyan dental students agreed with this definition. In item (8), an alternative dental procedure called "Apexogenesis" is mentioned. It involves vital pulp therapy, where the damaged pulp in the crown area is removed from the root canal of an immature permanent tooth. By removing only the superficially damaged pulp, the remaining healthy pulp can continue root maturation and natural development [36]. Notably, this definition was recognized by most dental students in this study (76.8%), as well as in previous studies conducted in Saudi Arabia (71.9%) and India (71%).

In item (9) of this study and previous studies in India and Saudi Arabia, the majority of respondents (72.8% and 75.2%, respectively) agreed with the existing literature on the use of indirect pulp capping (IPC) for deep cavity preparation. IPC is commonly employed when carious dentin is close to the pulp, but there is no visible pulp exposure [37]. Regarding item (10), approximately 73% of Libyan dental students agreed to leave the deepest layer of remaining carious dentin near the pulp during the IPC procedure. This layer is then covered with a biocompatible material to prevent pulp exposure. The latest position statement from the European Society of Endodontology (ESE) emphasizes that deep caries management should primarily focus on preventing pulp exposure. This can be achieved through selective one-stage carious tissue removal or stepwise excavation treatment. It is now considered overly aggressive to remove both soft and firm carious dentin until hard dentin is reached, as this approach may be deemed over-treatment in many cases [38].

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About 49% of respondents in Libya, as well as a similar percentage in India and Saudi Arabia, were aware that patients should return for permanent coronal restoration 8 to 12 weeks after an IPC procedure.

In the present study, the knowledge of dental students regarding direct pulp capping (DPC) was evaluated using items (12), (13), and (14). The results of item (12) revealed that 52.2% of the Libyan participants agreed with the existing literature, which states that DPC should not be performed on teeth with calcification in the pulp chamber or pulp exposure on the axial wall. This consensus is based on the fact that the therapeutic properties of capping materials may not effectively benefit the pulp tissue coronal to the axial exposure [39]. Furthermore, the size of the pulp exposure is also a crucial factor in determining the appropriate approach for vital pulp therapy (VPT), although its significance is often overestimated. Smaller exposures, up to 2.5 mm, can be successfully treated, while larger ones (greater than 2.5-5 mm) yield less predictable outcomes. However, it is important to note that achieving and maintaining hemostasis is more vital than the size of the exposure itself, as it directly affects the sealing capability of the DPC material [40].

Various indicators, such as coronal pulp calcification, darker pulp blood, or severe bleeding at the exposure site, may suggest more severe inflammation and the necessity for a pulpotomy or pulpectomy. If bleeding cannot be controlled within a reasonable period, it signifies irreversible pulp inflammation. Different authors have suggested varying timeframes for achieving hemostasis before proceeding with further tissue resection. Ricucci et al. recommend achieving bleeding cessation within 2-3 minutes, while Duncan et al. suggest approximately 5 minutes, and Bogen and Chandler advise less than 10 minutes [31]. The results of item (13) indicated that 62.1% of Libyan dental students believed that the amount and type of bleeding after a dental procedure can be used to predict the success of dental pulp capping (DPC). Our study also found that 69.1% of respondents to item (14) were aware that mechanical exposure had a better prognosis than carious exposure. This aligns with previous research, which classified pulp exposure into two types. Type 1 is caused by trauma, mechanical or iatrogenic factors, or caries exposure through healthy dentine. Type 2 occurs when deep or extremely deep carious lesions are present before treatment, requiring a modified treatment approach due to heightened inflammation and a greater microbial challenge [19,40]. The work by Yong et al. shows that partial pulpotomy is performed in cases of carious pulp exposure, aiming to remove bacteria, biofilm, and inflamed tissue. If bleeding cannot be controlled, a full pulpotomy is done until the orifice level. In cases where healthy tissue is present, bleeding can be controlled within 10 minutes by applying gentle pressure with a sterile cotton pellet soaked in NaOCl [31]. This finding aligns with the opinions of 62.1% of the respondents to item (15) in our study, as well as 64% of respondents in previous studies conducted in Saudi Arabia and India.

Items 16-22 of this study assessed respondents' knowledge of the materials used in Vital Pulp Therapy (VPT) and dental restorations. In item (16), the findings indicated that 62% of Libyan participants were aware of the benefits of using caries detector dyes during caries excavation to protect dentin and reduce pulp damage. In comparison, previous studies conducted in Saudi Arabia and India reported awareness rates of 59% and 72%, respectively, regarding this technique. The Caries detector dye method involves selectively staining the decayed dentin layer infected with acid-producing Gram-positive bacteria, allowing the removal of the outer layer while leaving the inner layer intact for remineralization. Calcium hydroxide, known for its high pH level, is widely used to eliminate bacteria, stimulate the defense mechanism, and support pulp tissue repair. However, it should be noted that this material is unstable and may degrade under permanent restorations. In addition, tunnel defects within the hard tissue bridge can potentially create pathways for microorganisms to enter vital pulp tissue, triggering the activation of circulating immune cells. Effects may include pulpal irritation, calcification, and possible canal obliteration [41]. About item (17), in Libya, 53.6% of internship dentists and dental students were aware of the disadvantages of using Ca(OH)2. Previous studies also showed that 58% of dental students in Saudi Arabia and 69% of dental students in India agreed with this.

According to the results of item (18), 67% of respondents in India, 71.1% in Saudi Arabia, and 74.1% in Libya reported that MTA provides a better environment for endodontic repair and bridging compared to Ca(OH)2 products. The existing literature supports the idea that MTA is an excellent alternative to Ca(OH)2 as it can maintain pulp vitality by inducing mineralization beneath the exposed pulp. The biocompatibility and sealing capabilities of MTA are attributed to the presence of calcium ions in the material. These ions react with phosphates in the interstitial fluid to form hydroxyapatite, which is responsible for the chemical seal between the MTA and the dentin wall [37,41].

The current study's findings regarding item (19) showed a low awareness rate of 33%, which aligns with earlier research conducted in India and Saudi Arabia that reported comparable levels of awareness. Rotstein and Ingle highlighted that if mineral trioxide aggregate (MTA) is used instead of calcium hydroxide (Ca(OH)2) in vital pulp therapy procedures, similar periods for apical maturation can be expected [41]. About item (20), less than half (43.8%) of the Libyan participants agreed that temporary restorations should be replaced with either amalgam or composite if they are left in place for a prolonged period. Additionally, Nawal et al. noted that failures in vital pulp therapy can occur either early or late. Early failures are often linked to incorrect diagnosis, while late failures are caused by bacterial leakage from poorly restored teeth. Therefore, after applying pulp capping material, the evaluation of the remaining tooth structure should guide the placement of a permanent restoration [42]. The quality and seal of the final restoration are vital for long-term

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maintenance of pulp vitality. Bacterial microleakage around restorations can lead to pulpal inflammation, so eliminating microleaks increases the chances of wound repair and survival [41].
In response to item (21) of the survey, 73.7% of respondents recognized that any leakage into the capping materials may compromise the success of vital pulp therapy. Biodentine, a calcium silicate-based biomaterial, serves as a biocompatible dentin substitute and is favored over calcium hydroxide [$Ca(OH)_2$] due to its superior properties, including reduced setting time, enhanced mechanical strength, and the ability to form a durable seal. TheraCal, a light-cured calcium silicate-based material, is also employed in both direct and indirect pulp capping. It facilitates immediate placement of definitive restorations and addresses the inadequate bonding typically observed between conventional calcium silicate materials and resin-based restorations [37]. Considering item (22), only one-third (33.5%) of participants correctly stated that TheraCal and Biodentine can be directly used as pulp capping agents.

Conclusion

Based on the findings of this study, it can be concluded that Libyan dental interns and students at clinical levels possess a good level of knowledge pertaining to the different types and steps involved in Vital Pulp Therapy (VPT). However, the survey also brought attention to certain areas where their understanding was lacking and required further attention. Specifically, their knowledge of novel materials utilized in the field of endodontics was found to be inadequate. In order to enhance their clinical skills in this domain, it is imperative to expose students to practical cases that can augment their comprehension of VPT. By incorporating such practical cases into their curriculum, students' knowledge and understanding of VPT can be bolstered.

Conflicts of Interest

The authors declare that there are no conflicts of interest that could have influenced the objectivity or outcomes of this research.

References

1. Duncan HF, Cooper PR. Clinical approaches in endodontic regeneration: current and emerging therapeutic perspectives. Cham: Springer; 2018. 197 p.
2. Marques MS, Wesselink PR, Shemesh H. Outcome of direct pulp capping with mineral trioxide aggregate: a prospective study. J Endod. 2015 Jul;41(7):1026–31.
3. Mente J, Geletneky B, Ohle M, Koch MJ, Friedrich Ding PG, Wolff D, et al. Mineral trioxide aggregate or calcium hydroxide direct pulp capping: an analysis of the clinical treatment outcome. J Endod. 2010 May;36(5):806–13.
4. Glickman GN. AAE consensus conference on diagnostic terminology: background and perspectives. J Endod. 2009 Dec;35(12):1619–20.
5. Schmidlin K, Schnell N, Steiner S, Salvi GE, Pjetursson B, Matuliene G, et al. Complication and failure rates in patients treated for chronic periodontitis and restored with single crowns on teeth and/or implants. Clin Oral Implants Res. 2010 May;21(5):550–7.
6. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature – Part 2. Influence of clinical factors. Int Endod J. 2008 Jan;41(1):6–31.
7. Kojima K, Inamoto K, Nagamatsu K, Hara A, Nakata K, Morita I, et al. Success rate of endodontic treatment of teeth with vital and nonvital pulps. A meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004 Jan;97(1):95–9.
8. Caplan DJ, Cai J, Yin G, White BA. Root canal filled versus non-root canal filled teeth: a retrospective comparison of survival times. J Public Health Dent. 2005 Spring;65(2):90–6.
9. Randow K, Glantz PO. On cantilever loading of vital and non-vital teeth: an experimental clinical study. Acta Odontol Scand. 1986 Oct;44(5):271–7.
10. Ou KL, Chang CC, Chang WJ, Lin CT, Chang KJ, Huang HM. Effect of damping properties on fracture resistance of root filled premolar teeth: a dynamic finite element analysis. Int Endod J. 2009 Aug;42(8):694–704.
11. Barthel CR, Rosenkranz B, Leuenberg A, Roulet JF. Pulp capping of carious exposures: treatment outcome after 5 and 10 years: a retrospective study. J Endod. 2000 Sep;26(9):525–8.
12. Bjørndal L, Reit C, Bruun G, Markvart M, Kjældgaard M, Näsman P, et al. Treatment of deep caries lesions in adults: randomized clinical trials comparing stepwise vs. direct complete excavation, and direct pulp capping vs. partial pulpotomy. Eur J Oral Sci. 2010 Jun;118(3):290–7.
13. Al-Hiyasat AS, Barrieshi-Nusair KM, Al-Omari MA. The radiographic outcomes of direct pulp-capping procedures performed by dental students: a retrospective study. J Am Dent Assoc. 2006 Dec;137(12):1699–705.
14. Swift EJ Jr, Trope M, Ritter AV. Vital pulp therapy for the mature tooth – can it work? Endod Top. 2003 Dec;5(1):49–56.
15. Bogen G, Kim JS, Bakland LK. Direct pulp capping with mineral trioxide aggregate: an observational study. J Am Dent Assoc. 2008 Mar;139(3):305–15.
16. Simon S, Perard M, Zanini M, Smith AJ, Charpentier E, Djole SX, et al. Should pulp chamber pulpotomy be seen as a permanent treatment? Some preliminary thoughts. Int Endod J. 2013 Jan;46(1):79–87.
17. Taha NA, Khazali MA. Partial pulpotomy in mature permanent teeth with clinical signs indicative of irreversible pulpitis: a randomized clinical trial. J Endod. 2017 Sep;43(9):1417–21.
18. Cushley S, Duncan HF, Lappin MJ, Tomson PL, Lundy FT, Cooper P, et al. Pulpotomy for mature carious teeth with symptoms of irreversible pulpitis: a systematic review. J Dent. 2019 Sep;88:103158.

Received*: 06-06-2025 -* ***Accepted****: 03-08-2025 -* ***Published****: 12-08-2025*

19. Bjørndal L, Simon S, Tomson PL, Duncan HF. Management of deep caries and the exposed pulp. Int Endod J. 2019 Jul;52(7):949–73.
20. Taha NA, Ahmad MB, Ghanim A. Assessment of mineral trioxide aggregate pulpotomy in mature permanent teeth with carious exposures. Int Endod J. 2017 Feb;50(2):117–25.
21. Simon S. Bioceramic materials for vital pulp therapy. In: Drukteinis S, Camilleri J, editors. Bioceramic materials in clinical endodontics. Cham: Springer International Publishing; 2021. p. 19–27.
22. Simon S, Smith AJ. Regenerative endodontics. Br Dent J. 2014 Mar;216(6):E13.
23. Doumani M, Almutairi S, Talal Alshammari N, Alshami A, Alharbi A, Habib A. The knowledge about vital pulp therapy of permanent teeth among Saudi internship dentists and dental students. Saudi Endod J. 2020 May;10(2):83.
24. Ghoddusi J, Forghani M, Parisay I. New approaches in vital pulp therapy in permanent teeth. Iran Endod J. 2014 Winter;9(1):15–22.
25. Naram B, J M, S D. A knowledge attitude and practice survey regarding pulp therapy among dental students. J Contemp Issues Bus Gov. 2021;27(2):2930–43.
26. Alawjali S, Elkumati I, Alfeitouri F. Knowledge of Libyan dentists about vertical root fractures (VRF): a survey study (Benghazi dentists as a case). Libyan J Sci Technol. 2023 Jan;14(2):69–78.
27. Peeran S, Naveen Kumar P, Ramalingam K, Peeran S, Elhammali NAJ, Elhassan A, et al. Knowledge and attitudes of Libyan dental students about HIV/AIDS infection and HIV-positive patients. Dent Med Res. 2015 Jan;3(1):8–14.
28. Dummer PMH, Hicks R, Huws D. Clinical signs and symptoms in pulp disease. Int Endod J. 1980 Jan;13(1):27–35.
29. Taha NA, About I, Sedgley CM, Messer HH. Conservative management of mature permanent teeth with carious pulp exposure. J Endod. 2020 Sep;46(9):33–41.
30. Asgary S, Eghbal MJ. Challenging the misnomer of irreversible pulpitis and deliberating the urgent need for reclassification of pulpal diseases based on the efficacy of vital pulp therapies: an overview of systematic reviews. Iran Endod J. 2023 Oct;18(4):202–5.
31. Yong D, Cathro P. Conservative pulp therapy in the management of reversible and irreversible pulpitis. Aust Dent J. 2021 Mar;66 Suppl 1:4–14.
32. Lima TFR, Dos Santos SL, Da Silva Fidalgo TK, Silva EJNL. Vitality tests for pulp diagnosis of traumatized teeth: a systematic review. J Endod. 2019 May;45(5):490–9.
33. Venkatesh E, Elluru SV. Cone beam computed tomography: basics and applications in dentistry. J Istanbul Univ Fac Dent. 2017;51(3 Suppl 1):102–21.
34. Mejàre IA, Axelsson S, Davidson T, Frisk F, Hakeberg M, Kvist T, et al. Diagnosis of the condition of the dental pulp: a systematic review. Int Endod J. 2012 Jul;45(7):597–613.
35. Cohenca N, Paranjpe A, Berg J. Vital pulp therapy. Dent Clin North Am. 2013 Jan;57(1):59–73.
36. Murray PE. Review of guidance for the selection of regenerative endodontics, apexogenesis, apexification, pulpotomy, and other endodontic treatments for immature permanent teeth. Int Endod J. 2023 Apr;56 Suppl 2:188–99.
37. Kunert M, Lukomska-Szymanska M. Bio-inductive materials in direct and indirect pulp capping—a review article. Materials (Basel). 2020 Mar;13(5):1204.
38. 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 Jul;52(7):923–34.
39. Kashyap N. A review of direct pulp capping: new treatment approaches and modalities. Int J Dent Oral Sci. 2020;19(2):1–11.
40. Edwards D, Stone S, Bailey O, Tomson P. Preserving pulp vitality: part two - vital pulp therapies. Br Dent J. 2021 Feb;230(3):148–55.
41. Rotstein I, Ingle JI, editors. Ingle's endodontics. 7th ed. Raleigh (NC): PMPH USA; 2019. 885-909 p.
42. Nawal RR, Logani A, Sangwan P, Ballal NV, Gopikrishna V. Indian Endodontic Society: position statement for deep caries management and vital pulp therapy procedures. Endodontology. 2023 Jul;35(3):167–94.

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