

# The Vital Pulp Therapy of Permanent Teeth: A Dental Practitioner's Perspective from Saudi Arabia

Mazen D. Doumani<sup>1</sup>, Waod A. Arnous<sup>1</sup>, Malak F. Alsafadi<sup>1</sup>, Heba A. Alnazer<sup>1</sup>, Salman M. Alanazi<sup>1</sup>, Khaled S. Alotaibi<sup>1</sup>, AbdulAziz I. Al-Ammari<sup>2</sup>

<sup>1</sup>Department of Restorative Dental Sciences, AlFarabi Colleges of Medicine, Dentistry, Nursing, <sup>2</sup>Private dental practice, Riyadh city, Saudi Arabia

ABSTRACT

**Aims and Objectives:** The aim of this study was to determine the levels of knowledge and attitude of dental practitioners (DPs) toward vital pulp therapy (VPT) of young permanent teeth in Riyadh city, Saudi Arabia. **Materials and Methods:** A descriptive cross-sectional study was carried out by taking convenient sample of general DPs and specialist attending Saudi International Dental Conference, Riyadh, Saudi Arabia. A total of 200 DPs administered a structured, self-administered questionnaire to evaluate their knowledge and attitude toward VPT. The questionnaire comprised four parts: Part I: Characteristics of the study participants; Part II: Items related to indications and diagnosis of VPT; Part III: Questions related to the different VPTs for immature permanent teeth; and Part IV: Dental materials used in VPT and restoration. All the data were entered into the statistical analysis software Statistical Package for the Social Sciences version 21.0 (IBM, Armonk, NY) and analyzed by using descriptive statistics of frequency distribution and percentages for the categorical variables. **Results:** A total of 193 (men = 57% [110] and women = 43% [83]) DPs participated in this study with a response rate of 96.5%. Less than half of correct responses were observed with (Item 1) related to the duration of complete closure of root apex (43%) and (Item 14) use of sodium hypochlorite to serve as an excellent diagnostic tool to differentiate irreversible from reversible pulpitis. A high percentage of correct responses were seen with the (Item 9) indirect pulp capping—a procedure performed in a tooth with a deep carious lesion without signs or symptoms of pulp degeneration (75%). All other item responses ranged in between 52% and 72%. **Conclusion:** DPs showed fair-to-good knowledge and attitude toward VPT of young permanent teeth. In general, there is a need to improve knowledge and attitude of dental professionals about the VPT by attending continuing dental educational programs.

**KEYWORDS:** Attitude, dental practitioners, knowledge, permanent teeth, vital pulp therapy

Received : 07-02-19.  
Revised : 17-06-19.  
Accepted : 25-09-19.  
Published : 15-06-20.

## INTRODUCTION

Coronal and radicular pulp tissue is very sensitive to a wide range of factors including invasion of microorganisms and/or mechanical/chemical insult during dental procedures. This pulp insult to the tooth may result due to the invasion of microorganisms through dental caries or through chemical or mechanical irritations

of restorative materials and trauma from occlusion.<sup>[1-4]</sup> A complete understanding of the pulpal inflammatory

**Address for correspondence:** Dr. Salman Mohammed Alanazi, AlFarabi Colleges of Medicine, Dentistry, Nursing, Al Khaleej, P.O. Box 2528. King Abdullah Bin Abdulaziz Road, Riyadh 11514, Saudi Arabia.  
Email: dr-salman12@hotmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

**For reprints contact:** reprints@medknow.com

**How to cite this article:** Doumani MD, Arnous WA, Alsafadi MF, Alnazer HA, Alanazi SM, Alotaibi KS, *et al.* The vital pulp therapy of permanent teeth: A dental practitioner's perspective from Saudi Arabia. J Int Soc Prevent Communit Dent 2020;10:300-8.

### Access this article online

#### Quick Response Code:



Website: [www.jispcd.org](http://www.jispcd.org)

DOI: 10.4103/jispcd.JISPCD\_69\_19

process is indispensable in the formulation dental procedures and development immunotherapeutic agents.<sup>[5]</sup>

The dental pulp is a living part of the tooth and its vitality is indispensable for prolonged survival of the tooth. Vital pulp therapy (VPT) is intended to preserve the vitality and function of the coronal or remaining radicular pulp in reversible pulp injury to promote root development and apical closure.<sup>[6,7]</sup> VPTs include procedures such as direct pulp capping, partial pulpotomy, and/or full pulpotomy. VPT is indicated only in teeth with reversible pulpitis in the absence of any periapical pathologies or in teeth with mechanical exposure of pulp or recent traumatic pulp exposure.<sup>[8]</sup> Immature permanent tooth has the potential to recover after traumatic pulp exposure, and conservative pulp therapies increase the chance of saving pulp vitality and continued root formation. The pulp status and the level of root development are very important factors in governing the treatment plan.<sup>[9]</sup> VPT is still a contentious in judgment criteria, condition of the pulp at the time of treatment, best technique, and treatment outcomes. In majority of cases, inadequate knowledge of the dentist is a key factor in improper treatment of pulp disease.<sup>[10]</sup>

In Saudi Arabia, dental caries is highly prevalent (83%) among children aged 6–8 years,<sup>[11]</sup> leading to early loss of first permanent molars at young age. This early loss of first permanent molars has an adverse effect on skeletal and dental development.<sup>[12]</sup> In addition, 33% of children aged 5–6 years showed traumatic dental injuries that may involve pulp exposure.<sup>[13]</sup> The decision by dental practitioners (DPs) to select appropriate VPT to save the tooth is critical in view high rate of dental caries and incidence of traumatic dental injuries in young permanent tooth with incomplete root closure. The prevalence of immature permanent posterior teeth with pulpal involvement was reported to be 36.9% in Saudi Arabia.<sup>[14]</sup>

Currently, various VPTs are available to the DPs for the treatment of immature permanent teeth. VPT is still an argued subject with regard to diagnostic criteria and the pulpal condition at the time of treatment, best way of treatment and the prognosis.<sup>[15]</sup> Several recommendations were made regarding the VPT by American Association of Pediatric Dentistry (AAPD), European Endodontic Society, and Saudi Endodontic Society in order to achieve successful outcomes. In view of the above-mentioned recommendations, how far the DPs are aware of the VPT of immature permanent teeth is not fully reported from Saudi Arabia. Hence, this study aimed to determine the overall levels of

knowledge and attitude of VPT of young permanent teeth among DPs and specialists attending 29th Saudi International Dental Conference held in Riyadh city, Saudi Arabia.

## MATERIALS AND METHODS

This was a descriptive cross-sectional study carried out in a convenient sample of general DPs and specialist attending Saudi International Dental Conference, Riyadh, Saudi Arabia.

### SAMPLE SIZE CALCULATION

Sample size was calculated based on the following formula:

$$n = \frac{z^2 p(1-P)}{d^2},$$

where  $n$  is the required sample size,  $Z$  is the  $Z$ -statistic for a level of confidence,  $P$  is the expected knowledge (14.7%,  $P = 0.147$ ), and  $d$  is the precision (in proportion of one; if 5%,  $d = 0.05$ ).  $Z$ -statistic ( $Z$ ) is for the level of confidence of 95%, and  $z$ -value is 1.96. The sample size achieved was 193 subjects. While calculating the sample size of dental students, dental interns and other dental auxiliaries were excluded from the study. Moreover, the DPs and specialists attending hands on program and workshops during the Saudi International Dental Conference responded poorly to the questionnaire. Sample size remained small due to the fact that dental specialists and DPs attending workshop and hands on courses responded poorly to the questionnaire. Hence, we could able to achieve minimum required sample for the study.

This study was carried out in collaboration with AlFarabi Colleges of Medicine, Dentistry, Nursing, Riyadh city, Saudi Arabia. The initiatives of the study started between December 2017 and January 2018 in full accordance with an approval from the ethics committee by AlFarabi Colleges of Medicine, Dentistry, Nursing. The data were collected between January 9 and 11, 2018 at the Riyadh International Convention and Exhibition Center in Riyadh, Saudi Arabia.

### Inclusion and exclusion criteria

The inclusion criteria of the study were general DPs and specialists attending Saudi International Dental Conference. The exclusion criteria of the study included the dental students, dental interns, and dental ancillaries, and those not willing to participate.

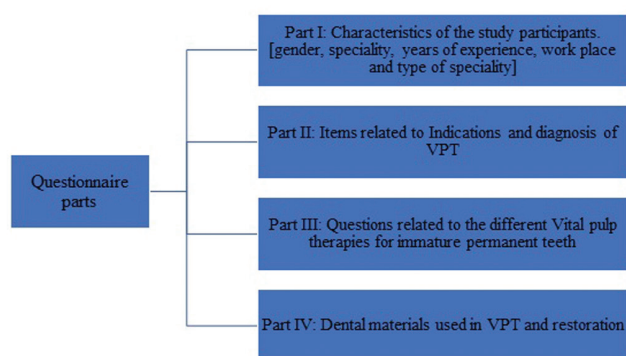
### Questionnaire development

The questionnaire used in this study was constructed after reviewing the information on VPT based on

AAPD, European Endodontic Association, and Saudi Endodontic Society. The first section of the questionnaire comprises personal information section [gender, specialty, years of experience, and work place] and the second section of the questionnaire comprises 17 items that investigated the knowledge and practice of the VPT indication, diagnosis, technique, materials, and prognosis among general DPs and specialists [Figure 1].

**Validity and reliability of the questionnaire**

After the construction of the questionnaire, it was evaluated by two general dental practitioners (GDPs), two pediatric dentists, and four endodontists attached with academics to ensure validity of the questionnaire.



**Figure 1: Parts of the questionnaire**

Furthermore, reliability of the questionnaire was established by distributing the questionnaire to the 15 general DPs and 5 specialists, and a Cronbach's  $\alpha$  was found to be 0.79. The questionnaire responses were recorded as yes, no, and I don't know, as shown in Table 1.

**Questionnaire administration**

A total of 200 questionnaires were printed and distributed to the GDPs and specialists attending Saudi International Dental Conference, Riyadh, Saudi Arabia. It took 7–10min for completing each questionnaire by the study participants. Of the 200 questionnaires, 193 were filled and returned back to the investigator. A single investigator distributed and collected all the questionnaires. A response rate of 96.5% was obtained as seven questionnaires discarded due to incomplete information. Consequently, 193 questionnaires of 200 were used for the purpose of statistical analysis.

**Statistical analysis**

All the data were entered into the statistical analysis software Statistical Package for the Social Sciences version 21.0 (IBM, Armonk, NY). Descriptive statistics of frequency distribution and percentages were calculated for all questionnaire responses, and most appropriate answers were noted to assess the overall knowledge of VPT among the study

**Table 1: Questionnaire items**

1.	The closure of root apex is completed approximately
2.	After traumatic injuries electric and thermal pulp tests may be unreliable
3.	VPT should only be performed in teeth with reversible pulpitis
4.	The main objective in VPT is to initiate the formation of tertiary reparative dentin or calcific bridge formation
5.	Apexogenesis is a VPT procedure to encourage the physiological development and formation of the root end
6.	Apexogenesis maintains pulp vitality, thus allows continued deposition of dentin
7.	Apexogenesis allows generating Dentine Bridge at the site of pulpotomy
8.	Apexification is a method to induce a calcified barrier in a root with open apex
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
10.	In indirect pulp capping, the patient returns in 8 to 12weeks for placement of a permanent coronal restoration.
11.	The drawbacks of Ca(OH) <sub>2</sub> include weak marginal adaptation to dentin, and dissolution over time
12.	The unique physiochemical properties of MTA promote a superior environment for pulpal repair and bridge formation, compared to Ca(OH) <sub>2</sub> products
13.	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.
14.	Sodium hypochlorite serves as an excellent diagnostic tool to differentiate irreversible from reversible pulpitis and to help determine whether to proceed with partial pulpotomy, complete pulpotomy, or pulpectomy.
15.	Successful outcomes for VPT decrease as the patient's age increases.
16.	Caries detector dyes can be considered a valuable tool in caries excavation when attempts are made to preserve mineralizable dentin and to minimize trauma to the pulp
17.	If MTA is substituted for Ca(OH) <sub>2</sub> in VPT procedures, similar time periods for apical maturation can be anticipated

participants. Table and graphs were generated to display the information.

**RESULTS**

A total of 193 (men = 57% [110] and women = 43% [83]) DPs participated in this study. Majority 63% [122] of the study participants were GDPs having 0-5 years 59% [114] of experience. Most 72% [139] of the dental practitioners worked in clinics while 11% (21) were in academics and 17% (33) worked in both [Table 2].

Among the dental specialists participated in the study, prosthodontists were in the highest percentages 18 (9%) followed by endodontists 14 (7%), periodontists 9 (5%), pedodontists 9 (5%), oral and maxillofacial surgeons 9 (5%), and others [Figure 2].

When enquired among the study participants about the complete closure of the root apex, the majority (43%) of the subjects mentioned 2–3 years. However, 36% and 21% participants mentioned 1–2 years and 3–4 years, respectively [Figure 3].

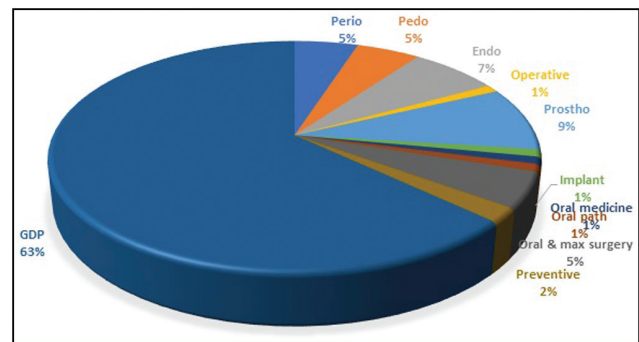
To assess the knowledge of the indications and diagnosis of VPT, the study participants were asked about three items. Item 2, after traumatic injuries electric and thermal pulp tests may be unreliable was correctly answered by 133 (69%) of the dental health professionals (DHPs). Item 3, VPT should only be performed in teeth with reversible pulpitis was agreed by 110 (57%) of the participants. Item 4, the main objective in VPT is to initiate the formation of tertiary reparative dentin or calcific bridge was answered by 135 (70%) of the DHPs [Table 3].

A total of six items (5–10) assessed the different VPTs for immature permanent teeth. Nearly, 137 (71%) of the DHPs mentioned that apexogenesis is a VPT procedure to encourage the physiological development and formation of the root end (Item 5). However, 128 (66%) of the DHPs said that apexogenesis maintains pulp vitality, thus allowing continued deposition of dentin (Item 6). More than half of (100 [52%]) of the participants mentioned that apexogenesis allows generating dentine bridge at the site of pulpotomy (Item 7). Most of the participants (139 [72%]) viewed that apexification is a method to induce a calcified barrier in a root with open apex (Item 8). Three-fourth (144 [75%]) of the DHPs agreed that 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 (Item 9) and around 123 (64%) of the DHPs mentioned that in indirect pulp capping, the patient returns in 8–12 weeks for placement of a permanent coronal restoration (Item 10) [Table 4].

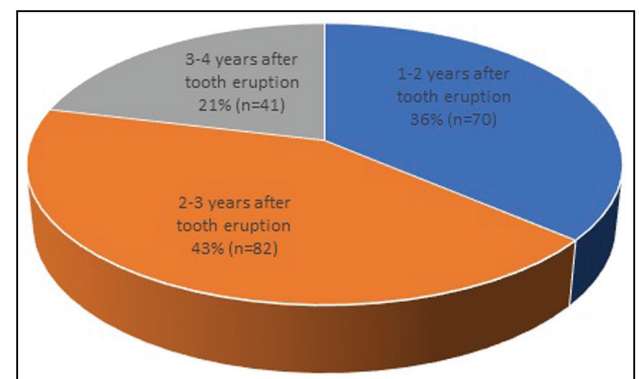
Items 11–17 assessed the knowledge of the participants regarding the materials used in VPT and restoration. Nearly, 133 (69%) of them knew about the drawbacks of calcium hydroxide (Ca(OH)<sub>2</sub>) such as weak marginal adaptation to dentin and dissolution over time (Item 11). The similar percentages (133 [69%]) of the DHPs

**Table 2: Characteristics of the study participants**

Variables		n	%
Gender	Male	110	57
	Female	83	43
	Total	193	100
Specialty	General dental practitioners (GDPs)	122	63
	Specialists	71	37
	Total	193	100
Experience (years)	0–5	114	59
	6–10	50	26
	11–15	22	11
	Above 15	7	4
	Total	193	100
Work place	Clinical	139	72
	Academic	21	11
	Both	33	17
	Total	193	100



**Figure 2: Dental specialist participated in the study (%)**



**Figure 3: The closure of root apex (Item 1)**

were aware of the unique physiochemical properties of mineral trioxide aggregate that promotes a superior environment for pulpal repair and bridge formation, as compared with Ca(OH)<sub>2</sub> products (Item 12). Nearly, 135 (70%) of participants preferred complete removal of the coronal pulp to the floor in case of bleeding cannot be controlled after 10min of direct exposure to sodium hypochlorite (NaOCl) after removal of unhealthy tissue (Item 13). Less than half (81 [42%]) of the DHPs mentioned that NaOCl serves as an excellent diagnostic tool to differentiate irreversible and reversible pulpitis and help in determining whether to proceed with partial pulpotomy, complete pulpotomy, or pulpectomy (Item 14). Nearly, two-thirds (124 [65%]) of the study participants acknowledged that successful outcomes of VPT decrease as the patient's age increases (Item 15). The majority (138 [72%]) of the DHPs said that caries detector dyes can be considered a valuable tool in caries excavation when attempts are made to preserve mineralizable dentin and to minimize trauma to the pulp (Item 16). More than half (102 [53%]) of the participants agreed that if MTA is substituted for Ca(OH)<sub>2</sub> in VPT procedures, similar time periods for apical maturation can be anticipated (Item 17) [Table 5].

On the basis of 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 study participants showed fair knowledge of VPT toward Items 14 and 1. However, with regard to remaining all other items, the study participants showed good knowledge of VPT, as shown in Figure 4.

### DISCUSSION

The main aim of VPT is to maintain pulpal health in teeth that have been exposed to caries, trauma, restorative procedures, and anatomic abnormalities by stimulating pulpal cells to produce dentin to provide durable seal that protects the pulp.<sup>[16-20]</sup> VPT plays an important role in preserving the affected immature permanent teeth with incomplete root development. Recent advancement in various materials and techniques in the treatment of the VPT have increased the clinical success rate of VPT.<sup>[21,22]</sup> The primary objective of this study was to determine the level of knowledge and attitude of the GDPs and specialists toward VPT of young permanent teeth in Riyadh city, Saudi Arabia.

**Table 3: Questions related to the indications and diagnosis of VPT**

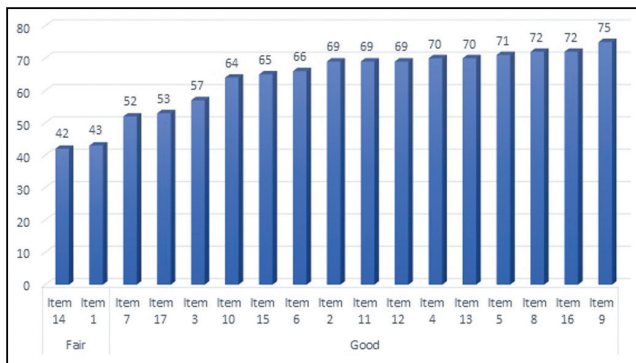
Items	Indications and diagnosis		Yes	No	I don't know
Item 2	After traumatic injuries electric and thermal pulp tests may be unreliable	<i>n</i>	133	42	18
		%	69	22	9
Item 3	VPT should only be performed in teeth with reversible pulpitis	<i>n</i>	110	68	15
		%	57	35	8
Item 4	The main objective in VPT is to initiate the formation of tertiary reparative dentin or calcific bridge	<i>n</i>	135	46	12
		%	70	24	6

**Table 4: Questions related to the different vital pulp therapies for immature permanent teeth**

Items	Vital pulp therapies for immature permanent teeth		Yes	No	I don't know
Item 5	Apexogenesis is a VPT procedure to encourage the physiological development and formation of the root end	<i>n</i>	137	43	13
		%	71	22	7
Item 6	Apexogenesis maintains pulp vitality thus allows continued deposition of dentin	<i>n</i>	128	46	19
		%	66	24	10
Item 7	Apexogenesis allows generating dentine bridge at the site of pulpotomy	<i>n</i>	100	67	26
		%	52	35	13
Item 8	Apexification is a method to induce a calcified barrier in a root with open apex	<i>n</i>	139	42	12
		%	72	22	6
Item 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	<i>n</i>	144	38	10
		%	75	20	5
Item 10	In indirect pulp capping, the patient returns in 8 to 12weeks for placement of a permanent coronal restoration	<i>n</i>	123	53	17
		%	64	27	9

**Table 5: Dental materials used in VPT and restoration**

Items	Materials used in VPT and restoration		Yes	No	I don't know
Item 11	The drawbacks of Ca(OH) <sub>2</sub> include weak marginal adaptation to dentin, and dissolution over time	<i>n</i>	133	44	16
		%	69	23	8
Item 12	The unique physiochemical properties of MTA promote a superior environment for pulpal repair and bridge formation, compared to Ca(OH) <sub>2</sub> products	<i>n</i>	133	42	18
		%	69	22	9
Item 13	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.	<i>n</i>	135	42	16
		%	70	22	8
Item 14	Sodium hypochlorite serves as an excellent diagnostic tool to differentiate irreversible from reversible pulpitis and to help determine whether to proceed with partial pulpotomy, complete pulpotomy, or pulpectomy.	<i>n</i>	81	69	42
		%	42	36	22
Item 15	Successful outcomes for VPT decrease as the patient's age increases	<i>n</i>	124	51	18
		%	65	26	9
Item 16	Caries detector dyes can be considered a valuable tool in caries excavation when attempts are made to preserve mineralizable dentin and to minimize trauma to the pulp	<i>n</i>	138	37	18
		%	72	19	9
Item 17	If MTA is substituted for Ca(OH) <sub>2</sub> in VPT procedures, similar time periods for apical maturation can be anticipated	<i>n</i>	102	57	34
		%	53	29	18



**Figure 4: Knowledge categories across different items (%)**

The knowledge and attitudes were assessed by using reliable and valid questionnaire.

Root completion is an important factor in successful endodontic treatment of young permanent tooth. Holland *et al.*<sup>[23]</sup> reported that apical root closure is completed approximately 2–3 years after tooth eruption. Our findings suggested that less than half of the study participants were aware about this fact indicating fair knowledge in this area and require further improvement.

Thermal and electric pulp sensibility tests have been used to indirectly evaluate the condition of the pulp

tissue by judging nerve supply of pulp. However, false results are commonly observed with these tests especially with immature and injured teeth. In contrast, Algaithy and Qualtrough<sup>[24]</sup> reported that the laser Doppler flowmetry (LDF) and pulse oximetry (PO) are apparently able to evaluate direct blood flow within the dental pulp. In our study, 69% of the practitioners were aware of the fact that after traumatic injuries electric and thermal pulp test may be unreliable.

American Dental Association recommends VPT for teeth diagnosed with a normal pulp or reversible pulpitis.<sup>[25]</sup> The main idea behind VPT is to avoid exposure of the pulp and tooth retention for long-term thereby evading potentially painful, costly, and invasive root canal treatments.<sup>[26]</sup> Our findings suggested that more than half (57%) of the DPs know about the indications of the VPT and 70% agreed that the main objective in VPT is to initiate the formation of tertiary dentin or calcific bridge.

Apexogenesis is a histological notation that refers to the continual physiologic development and formation of the root's apex. Formation of the root apex in vital young permanent teeth can be achieved by performing suitable VPTs such as indirect pulp treatment, direct pulp capping, and partial pulpotomy.<sup>[25]</sup> In this study, dental professionals showed variable knowledge of

apexogenesis-related items. Nearly, 71% of the study participants were aware of the VPT of apexogenesis that encourages the physiological development of formation of the root end. Although 66% knew about continued deposition of dentin in apexogenesis, more than half (52%) knew that apexogenesis allows the formation of dentine bridge.

Necrosis of the dental pulp of young permanent teeth before root completion has many bad consequences such as insufficient crown-root ratio, short root, and thin-walled roots. All these issues compromise the long-term survival of the tooth. At present, there are numerous therapies to treat immature permanent teeth with infected pulp. Apexification procedure induces a calcified apical barrier in the apical area of an incompletely formed root with necrotic pulp. Since many years,  $\text{Ca}(\text{OH})_2$  has been used in the treatment of apexification.<sup>[27]</sup> In our study, 72% of the practitioners had knowledge about the apexification procedure.

Deep carious lesions can be managed by indirect pulp capping involving incomplete removal of carious dentin and then application of a well-sealed permanent restoration.<sup>[28]</sup> In this study, three-fourth of the study participants agreed that 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. This finding is higher than that reported by Rabi,<sup>[29]</sup> in which 59.7% of the dentists know about the indirect pulp capping with a survival rate of 80–100%. Similarly, studies have shown that more than half of the dentists preferred complete removal of carious lesion in single step, even though there is a risk of pulp exposure.<sup>[30]</sup> More than two-thirds of the participants agreed that in indirect pulp capping patient returns after 8–12 weeks for receiving final restoration.

$\text{Ca}(\text{OH})_2$  had been considered the “gold standard” for years because of its good clinical results. Currently, MTA cements showed higher success rate and more predictable hard dentin formation as compared with the  $\text{Ca}(\text{OH})_2$  cements. However,  $\text{Ca}(\text{OH})_2$  has several drawbacks when used as cavity liner in pulp capping treatments. One of the disadvantages is the high solubility and water sorption. Hence, it should be avoided in the margins of prepared cavity.<sup>[22,31]</sup> In our study, 69% of the study participants agreed with the drawbacks of the  $\text{Ca}(\text{OH})_2$  cement. Similarly, 69% the DPs were in favor of superior physicochemical properties of the MTA in repairing pulp and formation of the dentin bridge as compared with the  $\text{Ca}(\text{OH})_2$ . Only 53% of the professionals knew that the MTA is a

substitute material for  $\text{Ca}(\text{OH})_2$  in VPT and has similar apical maturation period.

NaOCl is an effective nonspecific proteolytic and antimicrobial agent commonly used during the root canal therapy.<sup>[32]</sup> Moreover, NaOCl is an effective hemostatic agent as well as diagnostic tool in differentiating between reversible and irreversible pulp inflammation. When bleeding cannot be stopped after 10 min of direct exposure to NaOCl, there is high probability of coronal pulp being irreversibly inflamed and needs removal. Hence, knowledge of using NaOCl as a diagnostic tool is important for the dental professionals.<sup>[33]</sup> In this study, only 42% of the study participants were aware of the diagnostic importance of the NaOCl in deciding treatment of options of partial pulpotomy, complete pulpotomy, or pulpectomy. This result is suggestive of lacunae in the knowledge of VPT among the study participants.

Caries detector dyes play an important role in caries removal when efforts are made to retain remineralized dentin. It has been reported that the sclerotic dentin and tissues can be stained by caries detector dye in a viscosity ranging between 263 and 332 mm/s<sup>2</sup>.<sup>[34]</sup> In our study, 72% of the study participants knew that the caries detector dyes are valuable tool in caries excavation when attempts are made to preserve mineralizable dentin and to minimize trauma to the pulp.

This study, we consider, is the first to report the knowledge and attitude of DHPs toward VPT of permanent teeth in Saudi Arabia. It has pointed out the knowledge gaps in VPT among the dental health professionals. In spite of favorable study findings, we confess some limitations. It was impractical to conduct clinical study in order to obtain information about VPT among the practitioners and specialists attending Saudi International Dental Conference. Hence, knowledge and attitude toward VPT was assessed by conducting questionnaire study rather than by conducting clinical study. Furthermore, care must be taken before generalizing the results of the study because of the convenient sampling technique, limited sample size, and absence of comparative analysis within and between specialists and general DPs. Only descriptive statistical analysis was performed to evaluate the overall knowledge and attitude of the participants toward VPT to obtain an insight.

However, further studies are warranted with a large number of dental professionals with different category of qualification representing different regions of Saudi Arabia to confirm the findings of this study. Clinical studies should be part of the inquiry into the knowledge

and attitude of DHPs toward VPT of permanent teeth from Saudi Arabia.

## CONCLUSION

The DPs participated in this study showed fair-to-good knowledge and attitude toward VPT of young permanent teeth in Riyadh city, Saudi Arabia. The main knowledge deficiencies were observed in regards to closure of root apex and use of NaOCl as a diagnostic tool to differentiate between reversible and irreversible pulpitis. In general, there is a need to improve knowledge and attitude of dental professionals about the VPT by attending continuing dental educational programs.

## ACKNOWLEDGEMENTS

Nil.

## FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

## CONFLICTS OF INTEREST

There are no conflicts of interest.

## AUTHOR CONTRIBUTIONS

MDD, WAA conceived the study. MFA, HAA and SMA composed the initial data analysis plan, which was revised following feedback from KSA. AIA cleaned the data and SMA performed the analysis.

MFA and AIA wrote the first draft of this paper, HAA, SMA and KSA revised and approved the final version. All authors have read and approved the final manuscript.

## ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

The study was approved by the research center of Alfarabi colleges of dentistry. All the procedures have been performed as per the ethical guidelines laid down by Declaration of Helsinki (2000).

## PATIENT DECLARATION OF CONSENT

Not directly related to the patients.

## DATA AVAILABILITY STATEMENT

The data used to support the findings of this study are available from the corresponding author upon request.

## REFERENCES

- Heyeraas KJ, Kvinnsland I. Tissue pressure and blood flow in pulpal inflammation. *Proc Finn Dent Soc* 1992;88: 393-401.
- Van Hassel HJ. Physiology of the human dental pulp. *Oral Surg Oral Med Oral Pathol* 1971;32:126-34.
- Yu C, Abbott PV. An overview of the dental pulp: Its functions and responses to injury. *Aust Dent J* 2007;52:S4-16.
- Sen BH, Piskin B, Demirci T. Observation of bacteria and fungi in infected root canals and dentinal tubules by SEM. *Endod Dent Traumatol* 1995;11:6-9.
- Park SH, Ye L, Love RM, Farges J-C, Yumoto H. Inflammation of the dental pulp. *Mediators Inflamm* [Internet]. 2015. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4736221/>. [Last accessed on 2018 Dec 7].
- Cohenca N, Paranjpe A, Berg J. Vital pulp therapy. *Dent Clin North Am* 2013;57:59-73.
- Ghoddusi J, Forghani M, Parisay I. New approaches in vital pulp therapy in permanent teeth. *Iran Endod J* 2014;9:15-22.
- Makowiecki P, Trusewicz M, Tyszler L, Buczkowska-Radlińska J. [The vital pulp therapy in permanent teeth]. *Ann Acad Med Stetin* 2014;60:80-8.
- Rosenberg PA, Schindler WG, Krell KV, Hicks ML, Davis SB. Identify the endodontic treatment modalities. *J Endod* 2009;35:1675-94.
- Aguilar P, Linsuwanont P. Vital pulp therapy in vital permanent teeth with cariously exposed pulp: A systematic review. *J Endod* 2011;37:581-7.
- Alhabdan YA, Albeshr AG, Yenugadhathi N, Jradi H. Prevalence of dental caries and associated factors among primary school children: A population-based cross-sectional study in Riyadh, Saudi Arabia. *Environ Health Prev Med* 2018;23:60.
- Saber AM, Altoukhi DH, Horaib MF, El-Housseiny AA, Alamoudi NM, Sabbagh HJ. Consequences of early extraction of compromised first permanent molar: A systematic review. *BMC Oral Health* 2018;18:59.
- Al-Majed I, Murray JJ, Maguire A. Prevalence of dental trauma in 5-6- and 12-14-year-old boys in Riyadh, Saudi Arabia. *Dent Traumatol* 2001;17:153-8.
- Al-Madi EM, Al Saleh SA, Bukhary SM, Al-Ghofaily MM. Endodontic and restorative treatment patterns of pulpally involved immature permanent posterior teeth. *Int J Dent* 2018;2018:2178535.
- Pishbin L, Sajadi FS, Mahmoudi M, Shahabinejad H. Knowledge and practice of VPT in young permanent teeth among general dental practitioners in Kerman, Iran. *Int J Dent Res* 2018;6:29-34.
- Brizuela C, Ormeño A, Cabrera C, Cabezas R, Silva CI, Ramírez V, *et al.* Direct pulp capping with calcium hydroxide, mineral trioxide aggregate, and biodentine in permanent young teeth with caries: A randomized clinical trial. *J Endod* 2017;43:1776-80.
- Kundzina R, Stangvaltaite L, Eriksen HM, Kerosuo E. Capping carious exposures in adults: A randomized controlled trial investigating mineral trioxide aggregate versus calcium hydroxide. *Int Endod J* 2017;50:924-32.
- Linu S, Lekshmi MS, Varunkumar VS, Sam Joseph VG. Treatment outcome following direct pulp capping using bioceramic materials in mature permanent teeth with carious exposure: A pilot retrospective study. *J Endod* 2017;43:1635-9.
- Wang G, Wang C, Qin M. Pulp prognosis following conservative pulp treatment in teeth with complicated crown fractures: A retrospective study. *Dent Traumatol* 2017;33:255-60.
- Alex G. Direct and indirect pulp capping: A brief history, material innovations, and clinical case report. *Compend Contin Educ Dent* 2018;39:182-9.
- Asgary S, Hassanizadeh R, Torabzadeh H, Eghbal MJ. Treatment outcomes of 4 vital pulp therapies in mature molars. *J Endod* 2018;44:529-35.
- da Rosa WLO, Cocco AR, Silva TMD, Mesquita LC, Galarça AD, Silva AFD, *et al.* Current trends and future perspectives of dental pulp capping materials: A systematic review. *J Biomed Mater Res B Appl Biomater* 2018;106:1358-68.
- Holland GR, Trowbridge HO, Rafter M. Protecting the pulp, preserving the apex. In, Torabinejad M, Walton RE,



- eds. Endodontics, Principles and Practice, 4th edn. Philadelphia, Saunders, 2009. p. 26–34.
24. Alghaithy RA, Qualtrough AJ. Pulp sensibility and vitality tests for diagnosing pulpal health in permanent teeth: A critical review. *Int Endod J* 2017;50:135-42.
  25. ADA. Pulp therapy for primary and immature permanent teeth. *Pediatr Dent* 2017;39:325-33.
  26. Schwendicke F. Contemporary concepts in carious tissue removal: A review. *J Esthet Restor Dent* 2017;29:403-8.
  27. Guerrero F, Mendoza A, Ribas D, Aspiazu K. Apexification: A systematic review. *J Conserv Dent* 2018;21:462-5.
  28. Alsadat FA, El-Housseiny AA, Alamoudi NM, Alnowaiser AM. Conservative treatment for deep carious lesions in primary and young permanent teeth. *Niger J Clin Pract* 2018;21:1549-56.
  29. Rabi T. Knowledge, attitude, and practice survey of dentists in Palestine toward deep dentin caries removal. *Cons Dent Endod J* 2016;1:28-32.
  30. Crespo-Gallardo I, Martín-González J, Jiménez-Sánchez MC, Cabanillas-Balsera D, Sánchez-Domínguez B, Segura-Egea JJ. Dentist's knowledge, attitudes and determining factors of the conservative approach in teeth with reversible pulpitis and deep caries lesions. *J Clin Exp Dent* 2018;10:e1205-15.
  31. Arandi NZ. Calcium hydroxide liners: A literature review. *Clin Cosmet Investig Dent* 2017;9:67-72.
  32. Mohammadi Z. Sodium hypochlorite in endodontics: An update review. *Int Dent J* 2008;58:329-41.
  33. Demir T, Cehreli ZC. Clinical and radiographic evaluation of adhesive pulp capping in primary molars following hemostasis with 1.25% sodium hypochlorite: 2-year results. *Am J Dent* 2007;20:182-8.
  34. Kobayashi M, Inagaki R, Ichikawa K, Niizuma Y, Morisaki H, Kuwata H, *et al.* Effect of kinematic viscosity on the staining performance of caries detector dyes. *Dent Mater J* 2018;38:120-26.