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Knowledge of Vital Pulp Therapy in Primary Teeth Among Dental Interns in Riyadh, Saudi Arabia

Omar Saleh, Ebtissam Murshid, Ahmed Alzahrani*, Hisham Aqeel, Mona Alsaykhan, Sarah Alsougi, Oula Tashkandi

College of Dentistry, King Saud University, Riyadh, Saudi Arabia

ABSTRACT

Purpose: To assess the knowledge and practices regarding different approaches of vital pulp therapy in deciduous teeth among dental interns in Riyadh, Saudi Arabia.

Methods: 268 Randomly selected dental interns from 5 different universities in Riyadh participated in the study. A self-designed, close-ended questionnaire was distributed to each participant. Responses were coded in a spreadsheet software and statistically analyzed using chi-square tests.

Results: Majority of the participants were females, from Riyadh Elm University and treated pediatric patients on a weekly basis. No significant difference was found in knowledge with respect to gender of participants but a significant difference in knowledge was found with respect to university they studied in.

Conclusion: Knowledge of dental interns in most areas of VPT like; choice of treatment in different clinical scenarios and choice of materials for each therapy was found adequate in this study.

Key words: Primary Vital pulp, Pulp therapy deciduous, knowledge of pulp, Riyadh dental universities.

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Corresponding author: Ahmed Alzahrani

e-mail✉: ksu.alzahrani@gmail.com

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INTRODUCTION

Dental caries is a disease of the oral cavity caused by dysfunction of plaque biofilm that forms on the teeth with prolonged periods of low oral pH and results in a net mineral loss in teeth [1]. Despite advancements in diagnosis and treatment modalities, dental caries is still a major health problem in developed countries affecting 60-90% of school aged children and as much as 100% of adults in majority of the countries [2]. It is also the most common chronic disease affecting children [3] and while dental caries rate in children is higher in developed countries, developing countries are catching up due to increasing consumption of fermentable carbohydrates and inaccessibility to fluorides [2]. In addition, dental caries advances to the deeper dental tissues affecting pulp vitality and leads to abscess, pain, and even premature tooth loss [4]. Therefore, in most developed nations, child dental caries puts a significant burden on the healthcare system in addition to affecting the quality of life and school attendance in children [5]. A child had a tooth removed due to caries decay every ten minutes in England from 2016 to 2017 with most hospital admissions of children between 1998 and 2006 being due to dental caries [6]. Similarly, non-capital costs of treating primary oral diseases for children in Ireland cost €127 million of which more than €100 million is spent in treating dental caries [7]. These studies suggest that it is best to try and prevent caries altogether but once detected, early intervention can go a long way in saving the tooth and related problems in children. Studies suggest that between primary and permanent teeth, the former have a higher tendency of invasion into the dental pulp [8]. Extraction

is the least favorable option to manage a deciduous tooth with caries as premature loss can lead to space problems and malocclusions in the permanent dentition which needs to be avoided [9]. Endodontic procedures are the best conservative option in this regard but require a different approach than permanent teeth due to anatomic and morphologic differences in primary and permanent teeth [10]. It becomes even more challenging to choose a suitable technique when there is a deep carious lesion is close to the pulp. Many factors such as rate of caries progression, depth of the lesion, quality of residual dentin, clinical symptoms, and the dentist's skills and judgments help shape the treatment plan [11]. A good prognosis depends as much on choosing the right therapy as on the existing root canal morphology, presence of root resorption, instrumentation technique, and choice of materials used for obturation and canal irrigation [12].

Vital Pulp Therapy (VPT) is one such procedure recommended for deciduous teeth in which pulpitis is reversible, no periapical pathologies are present and pulp procedure is either mechanical or recently traumatic [13,14]. According to the American Academy of Pediatric Dentistry, three types of VPT options are present which include indirect pulp treatment (IPT) also known as indirect pulp cap, direct pulp cap (DPC), and pulpotomy [15]. All three procedures differ in indications and the choice of restorative material used. IPT is performed on deep carious lesions without signs of pulp degeneration where the lowermost infected dentin surrounding the pulp is left intact to avoid pulp exposure and sealed with a biocompatible material [16]. This material could be a radiopaque liner such as a dent in bonding agent, resin modified glass ionomer, calcium hydroxide, zinc oxide-eugenol or glass ionomer cement and the tooth is then restored with a permanent restoration that prevents microleakage and further bacterial contamination [17-20]. On the other hand, a direct pulp cap is indicated when a pinpoint exposure of a non-carious pulp occurs during cavity preparation or due to a traumatic injury [16]. The tooth is then lined with a radiopaque base such as MTA or calcium hydroxide and restored with a material that prevents microleakage [21]. When a primary tooth has a large carious lesion involving coronal pulp without evidence of radicular pathology and when caries removal results in large mechanical exposure in a carious pulp, pulpotomy should be the treatment of choice [16]. In this scenario, the coronal pulp is amputated, and the remaining pulp tissue is treated with a medicament such as Buckley's solution, formocresol, or ferric sulphate [16]. A meta-analysis conducted by Coll et al. [22] reported the success rates of different VPT options and assessed whether one of them is superior to the rest. They reported a 24-month combined success rate of 94.4% for IPT, 88.8% for DPC and 82.6% for pulpotomies with no significant effect of the liner material, capping agent, or restorative material on any of the VPT options.

With variable indications, restorative options and success rates, the choice of VPT is an important decision for the dental practitioner. It is therefore imperative that there should be adequate knowledge about these therapies among dental interns who will soon graduate to become future dentists and treat patients on their own. There is a growing prevalence of dental caries among pre-school and school going children worldwide, especially in Saudi Arabia. A study by Alshiha et al. conducted on schoolgirls in Riyadh showed a high prevalence of dental caries with majority of children having untreated caries [23]. Another study conducted by Alamri et al. in Riyadh among male schoolchildren also reported a high caries prevalence [24]. Al Agili, et al. [25] in a systematic review, reported a nationwide prevalence of dental caries in primary teeth in Saudi Arabia to be 80%. These high numbers necessitate that dentists have adequate knowledge of treatment options of dental caries in primary teeth especially VPT. A study conducted by Togoo et al. assessed the knowledge and practice of pulp therapy among dental practitioners in Saudi Arabia and reported that general dentists were regularly performing pulp therapy procedures in deciduous teeth [26]. However, to the best of the authors' knowledge, no study exists that assesses the knowledge of dental interns about VPT in the kingdom of Saudi Arabia. Our present study aims to fill this gap in knowledge and assess the knowledge of dental interns regarding vital pulp therapies in Riyadh, Saudi Arabia.

METHODS

Study design and ethical considerations: the present study is a cross-sectional, observational

study conducted in the city of Riyadh. Approval for this study was obtained from the IRB of King Saud University with approval. This study has been reported according to the STROBE guidelines.

Sample size: A stratified random sampling method was used to select participants from among interns in Riyadh, Saudi Arabia. The rationale for choosing dental interns rather than general dental practitioners was to make the study sample fairly uniform in their level of practical experience which is not possible while choosing a sample of general dental practitioner whose work experience can range from "recently graduated" to many years.

Participants were randomly selected from total interns (n) present in these five different universities; King Saud University (KSU, n=128), Riyadh Elm University (REU, n=200), Princess Nourah bint Abdulrahman University (PNU, n=36), King Saud bin Abdulaziz University for Health Sciences (KSAU-HS, n=45) and AlFarabi Colleges of Medicine Dentistry and Nursing (n=289) between November and December of 2018.

Sample size was estimated using the following formula: $n=Z1-\alpha/22[p(1-p)]/d2$ Where, n is the sample size, $Z1-\alpha/22$ is the standard normal variate (at 5% Type 1 error and 95% CI [$p<0.05$] it is 1.96), p is the expected proportion in population based on previous studies and, d is the absolute error or precision.

According to this formula, with a present knowledge level of 20% based on previous studies and a precision of 5%, a minimum sample of 245 dental interns were needed to produce statistically accurate results.

The total number of interns in all five universities was 689 out of which, 280 were randomly selected to participate in the survey. The survey was returned by 268 out of the 280 participants.

Questionnaire design and distribution: A self-designed, close-ended questionnaire was developed which consisted of 14 items (table 1). Questions were divided into divided into, demographic data, knowledge and use of pulp therapy in terms of identifying the problem, diagnosing, and suggesting treatment options. Informed consent was obtained from participants verbally and data was collected and recorded anonymously.

Statistical analysis: Data were coded and entered a spreadsheet using Microsoft Excel 16.0. Descriptive statistics were used to obtain frequency distribution of data. Inferential analysis was performed using Statistical Package for Social Sciences (SPSS, IBM Version 22.0). Contingency tables and chi square test (χ^2) were used to determine whether there were any correlations between correct responses to the knowledge variables and participant demographics as well as treatment of patients. All p values below an alpha level of 0.05 at 95% confidence interval (CI) were considered statistically significant.

RESULTS

Out of the randomly chosen 689 participants, 268 interns participated in this study. Frequency distribution of demographic variables is depicted in Figures 1 and 2. Majority of the respondents were females (55.2%) and the rest (44.8%) were males (Figure 1). Similarly, majority of the respondents were from Riyadh Elm University (40.7%) while least number of respondents were from PNU (7.8%, Figure 2). Table 1 depicts frequency distribution of responses of all respondents. Most of them (52.2%) treated pediatric patients on a weekly basis while 47.8% did not.

When asked if the participants would recommend complete excavation of carious dentin in case of a deep caries lesion, majority of them (80.6%) responded with a "yes". Majority of the participants (98.9%) used a liner on pulp surface of deep cavities with majority among them (37.3%) using calcium hydroxide. When asked what the participants recommended as a suitable treatment option in case of deep carious lesion in a vital primary tooth with high probability of pulp exposure and symptoms of pulp degeneration, 68.3% of them selected "pulpotomy/pulpectomy" whereas 6.3% and 9.3% them want to recommend indirect and direct pulp therapy respectively. However, when given the same scenario without symptoms of pulp degeneration, 40.7% interns opted to recommend indirect pulp therapy, 17.5% direct pulp therapy and 31% opted for pulpotomy/pulpectomy as a suitable choice of pulp treatment.

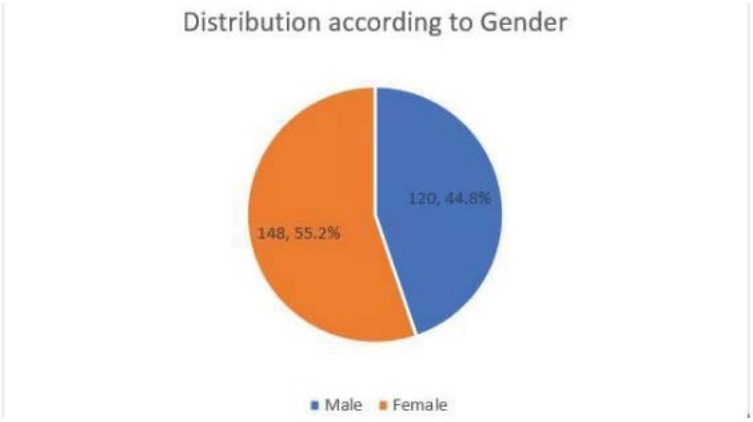

Figure 1: Frequency distribution of participants according to gender.

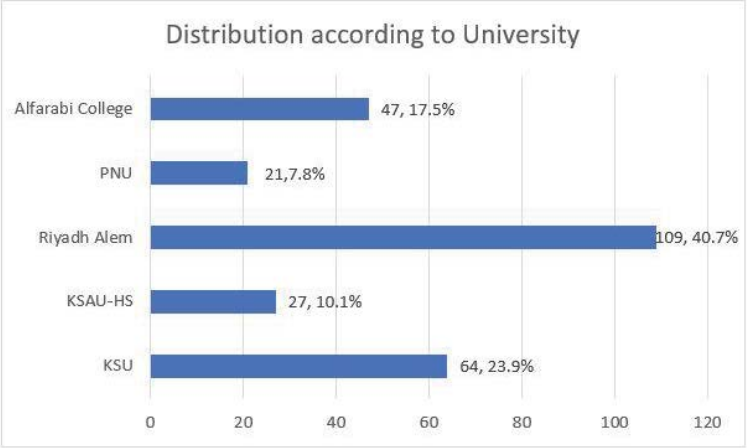

Figure 2: Frequency distribution of participants according to university.

Calcium hydroxide was the preferred material for majority (35.1%) of our participants for indirect pulp capping of primary teeth while 23.5% preferred GIC/RMGIC and 9.7% & 6.3% of them preferred MTA and Zinc oxide/eugenol, respectively. In case of direct pulp capping of primary teeth, most interns' preferred MTA (27.2%) and Calcium hydroxide (20.1%) as their preferred material while 14.6% preferred zinc oxide-eugenol and the rest (9.3%) preferred GIC/RMGIC. Majority of the participants (44.8%) preferred form cresol as the material for pulp fixation while 9.7%, 8.6% and 3.7% preferred zinc oxide-eugenol, MTA and ferric sulphate respectively. Very few participants preferred GIC/RMGIC (2.6%) and calcium hydroxide (2.2%). There were similar variable responses in the preferred obturation material among interns with majority of them (29.5%) selecting zinc oxide-eugenol. Majority of the respondents preferred stainless steel crowns (60.8%) as the final restoration post pulpotomy/ pulpectomy. When participants were asked regarding their preferred follow-up period after pulp therapy, majority of the respondents (43.3%) preferred to recall the patient 3 months after therapy, 22.4% preferred 6 months after therapy while the rest (34.3%) thought it depends on caries risk assessment. Lastly, most of the participants (77.2%) preferred to receive additional information about vital pulp therapy in primary teeth.

Tables 2 and 3 depict frequency distribution of responses with respect to gender and university, respectively. Chi-square tests were performed to assess whether any association existed between knowledge of participants and their gender as well as the university they study in. None of the questions showed any significant association with gender (Table 2) except Question 1 ($p=0.009$) and Question 10 ($p=0.02$). On the contrary, when association of knowledge with university was analyzed, a significant difference was found between responses from different universities to all the questions ($p<0.002$) except Question 12 ($p=0.83$, Table 3).

Table 1: Frequency distribution of participant responses.

Items of knowledge and practice			
		n	%
Do you treat pediatric patients on daily basis	Yes	128	47.8
	No	140	52.2
Regarding a case of deep caries lesion in a vital primary tooth, do you recommend a complete excavation of carious dentine?	Yes	216	86
	No	51	19.4
Do you use protective liner (for example, calcium hydroxide) on pulp surface of deep cavity preparations ?	Yes (Calcium hydroxide)	100	37.3
	Yes (GIC)	60	22.4
	Yes (Calcium hydroxide & GIC)	41	15.3
	Yes (Other)	64	23.9
	No	3	1.1
Regarding a case of deep carious lesion in vital primary tooth with high probability of carious pulp exposure and symptoms of pulp degradation, what do you recommend as a suitable choice/ choices of pulp treatment?	Indirect pulp therapy	40	12.9
	Direct pulp therapy	46	14.8
	Pulpotomy/Pulpectomy	224	72.3
Regarding a case of deep carious lesion in vital primary tooth with high probability of carious pulp exposure and with out symptoms of pulp degradation, what do you recommend as a suitable choice/choices of pulp treatment?	Indirect pulp therapy	132	44.6
	Direct pulp therapy	65	22
	Pulpotomy/Pulpectomy	99	33.4
Preferred material/materials of choice in indirect pulp capping in primary teeth?	MTA	47	13.9
	GIC/RMGIC	104	30.4
	Calcium Hydroxide	149	43.6
	Zinc-oxide Eugenol	40	11.7
	Dentine Bonding Agent	2	0.6
Preferred (Fixation material/pulppotomy medicament) during pulpotomy procedure in primary teeth?	MTA	40	11.2
	GIC/RMGIC	15	4.2
	Calcium Hydroxide	20	5.6
	Zinc-oxide/Eugenol	59	16.6
	Formcresol	182	51.1
	Ferric sulfate	37	10.4
	Other	3	0.8
Preferred material/materials of choice in obturation of primary teeth?	Gutta percha	22	6
	Calcium Hydroxide	76	20.9
	Zinc-oxide/Eugenol	125	34.3
	IRM	90	24.7
	Idoform	43	11.8
	KRI paste	8	2.3
Preferred final restoration post-pulpotomy/pulpectomy	Composite resin restoration	39	11.8
	GIC/RMGIC	71	21.5
	Stainless steel crown	211	63.7
	Amalgam	6	1.6
	Other	4	1.2
Preferred to follow up period after pulp therapy?	After 3 months	116	43.3
	After 6 months	60	22.4
	Depend on caries risk assessment	92	34.3

Table 2: Comparison of participant responses based on gender.

Items of knowledge and practice		Males		Females		Pearsons X2	P Value
		n	%	n	%		
Do you treat pediatric patients on a weekly basis?	Yes	68	56.7	60	40.5	6.9	0.009
	No	52	43.3	88	59.5		
Regarding a case of deep caries lesion in a vital primary tooth, do you recommend a complete excavation of carious dentine?	Yes	103	85.8	113	76.4	3.8	0.051
	No	17	14.2	35	23.6		
Do you use a protective liner (for example, calcium hydroxide) on pulp surface of deep cavity preparations?	Yes (Calcium Hydroxide)	44	36.7	56	37.8	5.25	0.2
	Yes (GIC)	24	20	36	24.3		
	Yes (Calcium Hydroxide and GIC)	15	12.5	26	17.6		
	Yes (Other)	36	30	28	18.9		
	No	1	0	2	1.4		

Regarding a case of deep carious lesion in vital primary tooth with high probability of carious pulp exposure and symptoms of pulp degradation, what do you recommend as a suitable choice/ choices of pulp treatment	Indirect pulp therapy	42	35	67	45.3	7.5	0.057
	Direct pulp therapy	27	22.5	20	13.5		
	Pulpotomy/ Pulpectomy	34	28.3	49	33.1		
Preferred material/materials of choice in indirect pulp capping in primary teeth?	MTA	10	8.3	16	10.8	2.2	0.69
	GIC/RMGIC	28	23.3	35	23.6		
	Calcium hydroxide	47	39.2	47	31.8		
	Zinc-oxide Eugenol	6	5	11	7.4		
Preferred (Fixation material/pulpotomy medicament) during pulpotomy procedure in primary teeth?	MTA	13	10.8	10	6.8	7.57	0.271
	GIC/RMGIC	1	0.8	6	4.1		
	Calcium hydroxide	3	2.5	3	2		
	Zinc-oxide Eugenol	11	9.2	15	10.1		
	Formcresol	49	40.8	71	48		
	Ferric sulfite	7	5.8	3	2		
Preferred material/materials of choice in obturation of primary teeth?	Gutta percha	7	5.8	10	6.8	10.84	0.054
	Calcium hydroxide	24	20	20	13.5		
	Zinc-oxide/ eugenol	32	26.7	47	31.8		
	Iodoform paste	10	8.3	20	13.5		
	KRI paste	1	0.8	9	6.1		
Preferred final restoration post-pulpotomy/pulpectomy	Composite resin restoration	3	2.5	4	2.7	11.36	0.023
	GIC/RMGIC	22	18.3	18	12.2		
	Satinless steel crown	62	51.7	101	68.2		
	Amalgam	4	3.3	0	0		
Preferred to follow up period after pulp therapy?	After 3 months	54	45	62	41.9	3.1	0.212
	After 6 months	21	17.5	39	26.4		
	Depend on caries risk assessment	45	37.5	47	31.8		

Table 3: Comparison of participant responses based on university.

Items of Knowledge and Practice		KSU		KSU-HS		Riyadh Elm		PNU		Al-Farabi College		Pearson's X2	P value
		n	%	n	%	n	%	n	%	n	%		
Do you treat pediatric patients on a weekly basis	Yes	35	54.7	17	63	36	33	14	66.7	26	55.3	17.3	0.002
	No	29	45.3	10	37	73	67	7	33.3	21	44.7		
Regarding a case of deep caries lesion in a vital primary tooth, do you recommend a complete excavation of carious dentine	Yes	40	62.5	21	77.8	100	91.7	15	71.4	40	85.1	23.9	0
	No	24	37.5	6	22.2	6	8.3	6	28.6	7	14.9		
Do you use a protective liner (for example, Calcium Hydroxide) on pulp surface of deep cavity preparatons?	Yes (Calcium hydroxide)	18	28.1	8	29.6	46	42.2	4	19	24	51.1		
	Yes (GIC)	14	21.9	6	22.2	20	18.3	7	33.3	13	27.7		
	Yes (Calcium hydroxide & GIC)	23	35.9	6	22.2	5	4.6	6	28.6	1	2.1		
	No	9	14.1	7	25.9	35	32.1	4	19	9	19.1		
	Yes (Other)	0	0	0	0	3	2.8	0	0	0	0		

Regarding a case of deep carious lesion in vital primary tooth with high probability of carious pulp exposure and symptoms of pulp degradation, what do you recommend as a suitable choice/choices of pulp treatment?	Indirect Pulp Therapy	2	3.1	0	0	9	8.3	0	0	6	12.8	30.4	0.002
	Direct Pulp Therapy	3	4.7	2	7.4	12	11	0	0	8	17		
	Pulpotomy/ Pulpectomy	54	84.4	19	70.4	63	57.8	20	95.2	27	57.4		
	Two or more responses	5	7.8	6	22.2	25	22.9	1	4.8	6	12.8		
Regarding a case of deep carious lesion in vital primary tooth with high probability of carious pulp exposure and without symptoms of pulp degradation, what do you recommend as a suitable choice/choices of pulp treatment ?	Indirect Pulp Therapy	30	49.6	8	29.6	53	48.6	6	28.6	12	25.5	31.3	0.002
	Direct Pulp Therapy	10	15.6	2	7.4	18	16.5	3	14.3	14	29.8		
	Pulpotomy/ Pulpectomy	19	29.7	9	33.3	25	22.9	11	52.4	19	40.4		
	Two or more responses	5	7.8	8	29.6	13	11.9	1	4.8	2	4.3		
Preferred material/materialss of choice in Indirect pulp capping in primaary teeth?	MTA	7	10.9	1	3.7	6	5.5	5	23.8	7	14.9	61.2	0
	GIC/RMGIC	12	18.8	18	66.7	14	12.8	9	42.9	10	21.3		
	Calcium hydroxide	22	34.4	4	14.8	48	44	2	9.5	18	38.3		
	Zinc oxide Eugenol	3	4.7	0	0	13	11.9	0	0	1	2.1		
	Two or more responses	20	31.3	4	14.8	28	25.7	5	23.8	11	23.4		
7. Preferred material/materials of choice in direct pulp capping in primary teeth?	MTA	31	48.4	8	29.6	15	13.8	8	38.1	12	25.5	69.8	0
	GIC/RMGIC	6	9.4	0	0	7	6.4	4	19	8	17		
	Calcium hydroxide	12	18.8	7	25.9	19	17.4	2	9.5	14	29.8		
	Zinc oxide Eugenol	0	0	0	0	33	30.3	2	9.5	4	8.5		
	Two or more responses	15	23.4	12	44.4	35	32.1	5	23.8	9	19.1		
Preferred (fixation material/pulpotomy medicament) during pulpotomy procedure in primary teeth?	MTA	11	17.2	6	22.2	0	0	0	0	6	12.8	103.7	0
	GIC/RMGIC	1	1.6	0	0	3	2.8	3	14.3	0	0		
	Calcium hydroxide	0	0	0	0	3	2.8	1	4.8	2	4.3		
	Zinc oxide/ eugenol	4	6.3	0	0	21	19.3	0	0	1	2.1		
	Formocresol	35	54.7	4	14.8	43	38.4	8	38.1	30	63.9		
	Ferric sulfite	1	1.6	5	18.5	0	0	2	9.5	2	4.3		
	Two or more responsed	12	18.8	12	44.4	39	35.8	7	33.3	6	12.8		
Preferred material/materials of choice in obturation of primary teeth?	Gutta Percha	3	4.7	0	0	11	10.1	1	4.8	2	4.3	45.6	0.001
	Calcium hydroxide	13	20.3	4	14.8	7	6.4	7	33.3	13	27.7		
	Zinc oxide/ eugenol	19	29.7	6	22.2	31	28.4	9	42.9	14	29.8		
	Iodoform paste	13	20.3	0	0	12	11	1	4.8	4	8.5		
	KRI paste	0	0	2	7.4	5	4.6	0	0	3	6.4		
	Two or more responsed	16	25	15	55.6	43	39.4	3	14.3	11	23.4		
Preferred final restoration post-pulpotomy/pulpectomy?	Composite Resin Restoration	0	0	0	0	6	5.5	0	0	1	2.1	64.7	0
	GIC/RMGIC	8	12.5	0	0	10	9.2	1	4.8	21	44.7		
	Stainless steel crown	45	70.3	18	18	68	62.4	17	81	15	31.9		
	Amalgam	0	0	0	0	1	0.9	0	0	3	6.4		
	Two or more responses	11	17.2	9	33.3	24	22	3	14.3	7	14.9		

Preferred to follow up period after pulp therapy?	After 3 months	23	35.9	8	29.6	45	41.3	13	61.9	27	57.4	66.8	0
	After 6 months	5	7.8	1	3.7	46	42.2	3	14.3	5	106		
	Depend on caries risk assessment	36	56.3	18	66.7	18	16.5	5	23.8	15	31.9		

DISCUSSION

This paper assessed the knowledge regarding vital pulp therapies among dental interns in Riyadh, Saudi Arabia. The questionnaire was designed such that it evaluated knowledge on case-based scenarios and generic knowledge on VPT. As mentioned before, there is a high prevalence of dental caries in the primary dentition in Saudi Arabia [25] which necessitates investigations on the population as well as health-care providers to try and explain the possible causes of this high caries prevalence and take appropriate measures. Dental interns of today are tomorrow's care-givers and assessing their knowledge and practices helps fulfill two purposes: (1) To assess and introspect on the existing pattern of dental education and (2) Predict the quality of care we can expect them to provide to the population. The results of this present study suggested that most dental interns do not treat pediatric patients on a weekly basis which means they do not have enough opportunities to apply knowledge to practice. Dental literature is replete with research on preventive and interventional strategies for caries in primary teeth, especially VPT, recommendations for scenario-based treatment, and material choices have been reported based on observational studies and randomized clinical trials.

In the present study, interns were assessed on treatment and material choices that reflected knowledge of best practices in VPT. Majority of the interns in this study had a very radical approach to deep caries lesion in a vital primary tooth and preferred complete excavation. This is in contradiction to studies that report that complete excavation presents a greater risk of pulp exposure with more signs and symptoms of pulpal disease than does incomplete excavation. Following a more conservative approach with partial caries removal has demonstrated a higher success rate in maintaining pulp vitality [26]. Our findings also do not coincide with other studies, for example, a study conducted in India that evaluated the knowledge of VPT among pediatric dentists in India [11].

It found that less than half (48%) of the respondents elected complete excavation as the treatment of choice for deep carious lesions in a vital primary tooth11. Similarly, a study [27] conducted on general dental practitioners in Saudi Arabia found that only 30% of the practitioners recommended pulpectomy/complete excavation, while the rest recommended other less radical procedures like pulpotomy (64%) or even referring the case to a pediatric dentist (6%) for a specialist opinion.

Furthermore, the participants in this research were given two case scenarios, both cases involved deep carious lesions in vital teeth with a high probability of pulp exposure, but one case presented with symptoms of pulp degeneration and the other did not. Participants were asked what VPT they would prefer in each case. Most of them chose pulpotomy/pulpectomy (72.3%) for the case with symptoms of pulp degeneration and indirect pulp capping (44.6%) for the one without symptoms of pulp degeneration. These choices reflect that majority of the respondents possess sound clinical decision making with regards to type of VPT as they are following AAPD guidelines [15].

Knowledge about which materials to use in each case is crucial to achieving clinical success. Our participants were evaluated for their knowledge of material choices commonly used in VPT. When asked if participants used a cavity liner while restoring pulp surfaces of deep cavity preparations, total of (81.1%) responded in the affirmative with most of them (37.3%) using calcium hydroxide liner. Also, most participants preferred to use calcium hydroxide (43.6%) as the material when performing indirect pulp capping followed by RMGIC (30.4%) and MTA (13.9%). Because of its biocompatibility and alkaline pH, calcium hydroxide has been used traditionally as a liner in deep cavities while performing VPTs but some questions have been raised with regards to its clinical performance

in lieu of its high solubility and lack of adhesion to dentin [28]. This has shifted the focus from calcium hydroxide to more adhesive liners like GIC or resin modified GIC (RMGIC) in terms of liner choices. However, a systematic review that compared the pulp response to calcium hydroxide vs RMGIC liners in deep cavities found that there can be no definitive verdict on which material is superior to the other [29]. Similarly, a trial conducted to compare the efficacy of MTA and calcium hydroxide reported that after 6 months, both materials displayed the same average dentin thickness and success rate [30]. It has also been reported in a systematic review that there was no statistically significant difference in success rates of IPT when either calcium hydroxide (Dycal) was used as opposed to adhesive cements [31]. This same review also recommended that calcium hydroxide cements should be covered with an adhesive material like GIC or reinforced zinc-oxide eugenol for better results. With regards to material of choice for pulp fixation and obturation, Many of the participants in this study chose form cresol as their preferred fixation material while opinions were mixed with regards to the obturation material with the highest number of participants choosing zinc-oxide eugenol cement. A meta-analysis conducted in 2014 by Marghalani et al. [32] to compare the clinical and radiographic success of MTA versus form cresol for pulpotomy in primary molars revealed that both materials produced comparable results. However, another meta-analysis conducted later in 2018 by Ghajari et al. [33] comparing the results of pulpotomy done on primary molars with form cresol and MTA concluded that primary molar pulpotomy done with MTA has better clinical and radiographic success rates than form cresol. Only 11.2% of participants in our study chose MTA as their preferred fixative material. In primary teeth, zinc-oxide eugenol has always been the material of choice for obturation and numerous studies testify to its success. A recent meta-analysis conducted by Najjar et al. [34] compared between calcium hydroxide/iodoform paste and zinc-oxide eugenol as obturation materials in primary teeth and found that long term success rate (at 18-month follow-up) of zinc-oxide eugenol was significantly better than calcium hydroxide/iodoform paste. It further recommended that zinc oxide eugenol or ZOE/ iodoform mixed with calcium hydroxide is a better option if teeth are not nearing exfoliation.

Stainless steel crowns were the preferred final restoration of our respondents after pulpotomy/pulpectomy procedures. Primary and permanent teeth restored with crowns after pulpotomy/pulpectomy procedures have shown higher survival rates than those restored with other materials. A long term (1-29 years) retrospective analysis done by Kunert et al. reported that prosthetic crown restorations after pulpotomy had the lowest failure rates while resin restorations significantly increased the risk of failure [35].

Finally, when asked about the appropriate follow-up period, most of the respondents preferred to recall patients based on caries risk assessment protocol. But in the study conducted by Nayak et al. majority of the participants (51%) chose to follow-up after 3 months. Studies [36] have recommended long term follow-up of patients until the successor teeth erupt into the oral cavity. All these findings indicate that knowledge of dental interns in this study is adequate with respect to most items. However, a significant difference has been noted in the level of knowledge among the interns from different universities. Difference in curriculum and method of training in universities could be one of the reasons for this significant difference in knowledge. Al-Shalan, et al. [37] has noted that dental curriculum in Saudi universities is not standardized and is highly dependent on the bias of experts in the panel that develops these curricula. These biases favor specialties that the experts on this panel belong to which means that only those specialties are developed properly in the curriculum while others tend to get ignored. In the context of our study, this implies that one university may have an extraordinarily strong curriculum in pediatric dentistry while another may not. Furthermore, Al-Shalan also noted that panels tend to follow previous work/curriculum from older universities with minor variations which means curricula are neither updated nor compared with benchmarks set by eminent institutions and shortcomings of the curriculum in existing universities are repeated. These lead to variations in learning outcomes among students in different universities and differences in knowledge and practice. Differences in

patient influx in university hospitals could lead to differences in clinical experience among interns. Many interns in this study do not get the opportunity to treat patients on a weekly basis and this varied across the five universities.

A limitation of this study was that it was not designed to correlate knowledge with confounding factors like GPA of the dental interns while in dental school which could have an impact on knowledge and practice skills.

CONCLUSION

The present study evaluated the knowledge of dental interns regarding vital pulp therapies. It was found that knowledge of dental interns in most areas of VPT like a choice of treatment in different clinical scenarios and the preferred materials for each therapy was adequate. This implies that the curriculum in dental schools in Saudi Arabia provides a good foundation for students to develop their knowledge about VPT and put it to practice as future dentists. Knowledge was found to be more significantly different between universities across items than among males and females which was probably due to a difference in curriculum or a difference in patient influx across universities.

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