Original Research
Endodontic Therapy

Decision-making for dental pulp exposure: a survey in graduate programs at Brazilian universities

Paulo Augusto SCALZILLI[a]
Cynthia Mireya JARA[b]
Daniela FLORES[c]
Daniela HEINZMANN[c]
José Antônio Poli de FIGUEIREDO[a]
Roberta Kochenborger SCARPARO[a]

[a]Universidade Federal do Rio Grande do Sul – UFRGS, School of Dentistry, Department, Porto Alegre, RS, Brazil.

[b]Universidad Nacional de Asunción - UNA, School of Dentistry, Clinical Department, Asunción, Paraguay

[c]Pontifícia Universidade Católica do Rio Grande do Sul – PUCRS, School of Dentistry, Porto Alegre, RS, Brazil.

Declaration of Interests: The authors certify that they have no commercial or associative interest that represents a conflict of interest in connection with the manuscript.

Corresponding Author:
Roberta Kochenborger Scarparo
E-mail: roberta.scarparo@ufrgs.br

https://doi.org/10.1590/1807-3107bor-2022.vol36.0087

Submitted: 2020 Sep 22
Accepted for publication: 2021 Dec 1
Last revision: 2022 Jan 17

Abstract: Clinical decision-making tends to be based on what clinicians have been taught during undergraduate and graduate programs. The aim of the present study was to assess the clinical approach and to identify the factors that influence the decision-making for dental pulp exposure among graduate students and coordinating professors in endodontics programs offered at Brazilian universities. The study used a mail-out survey developed in the Qualtrics platform, based on seven clinical reports in which dental pulp exposure was evidenced. Descriptive statistics showing vital pulp therapy (VPT) and root canal treatment (RCT) were calculated for each clinical report. Data on the participants' (n = 113) profile and variables related to clinical and radiographic characteristics of the cases were evaluated as to their potential to affect decision-making and analyzed by logistic regression ($p < 0.05$). VPT was likely to be indicated in cases of patients with immature teeth (OR = 0.017; 95%CI = 0.004 -0.073). RCT indications were related to the presence of symptoms (OR = 5.326; 95%CI = 1.429–19.852) and old age (OR = 21.057; 95%CI=6.809–65.120). In pulp exposure secondary to trauma, time of pulp exposure was significantly associated with RCT indication (OR=3.267; 95%CI=1.332–8.012). The present study demonstrated that patient age, root development, and symptom features were the main factors affecting participants' decision-making.

Keywords: Endodontics; Education, Dental; Clinical Decision-Making; Dental Pulp; Pulpotomy; Dental Pulp Capping.

Introduction

Diagnosis and treatment planning are the basis for successful clinical dentistry. The treatment strategy is considered ideal when the best possible outcomes are achieved over the long term, with minimal intervention, considering the current scientific evidence and patients' problems and concerns. However, developing these skills is challenging, especially if there is no consensus on the accuracy of the available diagnostic methods and on the best treatment options.[1] Currently, there has been a debate on symptomatic or asymptomatic pulpitis secondary to deep caries or to dental trauma with pulp involvement. Indication of vital pulp therapy (VPT) as a definitive treatment, instead of pulpectomy followed by root

canal treatment (RCT), has been surrounded by controversy in the scientific literature.[2]

VPT comprises treatment modalities aimed at preserving pulp vitality, such as direct pulp capping, partial pulpotomy, and full pulpotomy. VPT follows a biological concept of reducing inflammation and allowing root development. This maintains the defensive and proprioceptive functions of the dental pulp and reduces the risk of tooth fracture.[3] Calcium hydroxide ($Ca(OH)_2$) has been widely used as a pulp capping material since histological studies demonstrated its ability to induce the formation of dentin-like barriers.[4]

Over the past decades, improved understanding of pulp biology and the development of alternative pulp capping materials presenting sealing ability – such as mineral trioxide aggregate (MTA)[5] – have renewed the researchers' interest in treatment alternatives to RCT and encouraged the adoption of VPT.[6] In a randomized clinical trial, MTA had higher success rates (85%) than $Ca(OH)_2$ (52%) when used for capping carious exposures.[7] Favorable outcomes were demonstrated for partial pulpotomies using MTA-based materials[8] and recent findings of a systematic review and meta-analysis have suggested clinical advantages of MTA over $Ca(OH)_2$ in full pulpotomies.[9] However, another meta-analysis[10] showed differences in pulp capping materials do not significantly affect success rates (around 90%) of full pulpotomy in permanent posterior teeth with closed apices.

VPT is more cost-effective and less technically sensitive than RCT,[9,11] which could be explored in order to increase accessibility to treatments in cases of dental pulp involvement. The global prevalence of caries in adult patients has remained high over the past 25 years, with greater prevalence among patients from economically underprivileged social groups.[12] The prevalence of untreated carious permanent teeth is 34.1%, and 2.5 billion people are affected annually.[12] Untreated deep caries frequently result in pulpal inflammation and intervention needs. However, access to endodontic treatment is still a long way from meeting the population's demand, and many teeth are extracted because of the delay or lack of specialized care.[13]

All in all, the aforementioned topics have pointed to the need to revise the indication of minimally invasive treatment strategies instead of RCT or tooth extraction. However, some issues may be a hindrance to changing teaching practices and might lead to clinician's insecurity to indicate VPT. Although recent systematic reviews and meta-analyses demonstrated similar success rates for RCT and VPT, high risk of bias and low quality of the included studies were reported.[2,9,10]

Moreover, the distinction between irreversible and reversible pulp inflammation still poses a challenge. The routine methods for determining whether dental pulp is reversibly or irreversibly inflamed, and thus to define treatment decision, are based on the patient's history of pain or discomfort and on clinical and radiographic examinations.[14] However, it is well established that a proper histopathological diagnosis of the dental pulp cannot be precisely established through clinical tests and symptoms.[15,16] Also, there is insufficient evidence to clinically assess biological markers of pulp inflammation, infection, or other damage that could predict VPT outcomes.[16]

When conservative approaches are intended, the limitations of the diagnostic methods mentioned above may also give rise to controversies surrounding VPT. Criteria such as the etiology of pulp exposure and the extent of exposure, as well as subjective data such as macroscopic features of pulp tissue and bleeding control, have been employed for the selection of cases of direct pulp capping and partial or full pulpotomy,[17] but further investigation is needed to support decision-making.

There are no studies that clearly demonstrate the current attitude of professors and students towards dental pulp exposure. Given this scenario, the aim of the present study was to assess the clinical approach adopted by Brazilian graduate students and coordinating professors in cases of pulp tissue exposure, identifying the factors that influence their decision-making for indicating or not VPT.

Methodology

This study was approved by the local ethics committee (#3.782.318). The sampling frame was created by using students and coordinating professors of graduate programs in endodontics at Brazilian universities. The existing programs were identified by accessing the registries of the Brazilian Federal Board of Dentistry (CFO) (http://website.cfo.org.br/) and of the Brazilian Ministry of Education (MEC), issued on April 5, 2019 (https://www.mec.gov.br/). A total of 25 graduate programs were considered eligible for the study.

All students and coordinating professors enrolled in these programs were mailed a package that included a cover letter outlining an introduction and aims of the research and a survey containing seven clinical reports and related questions developed in the Qualtrics platform (Qualtrics, Provo, USA). A follow-up postcard reminder with the survey instrument was sent twice to all participants over a period of 2 months.

The study sample (n) was calculated based on population size, i.e., total number of eligible participants enrolled in graduate programs in endodontics offered by Brazilian universities (N), the proportion of the participants expected to choose between VPT and other treatment option (endodontic treatment or tooth extraction) (P = .5 to allow for the maximum variance), the assumed sampling error (C = 0.05), and a Z-score of 1.96 for the 95% confidence interval:[20] $n = [(N)(P)(1-P)] / [(N-1)(C/Z)^2 + (P)(1-P)]$. Considering the 25 registered graduate programs and assuming a mean of 8 participants in each program, the N was estimated at 160. Accordingly, the required sample size (n) should include 114 participants.

Survey Instrument

The survey instrument was pilot tested by four endodontists to review the design, level of understanding, face validity, and feasibility of the planned data analysis. After adjustments, the questionnaire was finalized. The following data were collected from the participants: age, academic qualifications, and the theoretical background on which their treatment decisions were based. The applied questionnaire was based on seven reports that included the description of clinical cases in which dental pulp was vital and presented direct exposure to the oral environment. For cases 1-4, radiographic and/or clinical images were also provided (Figure A-D). The information contained in each of the reported cases is summarized in Table 1.

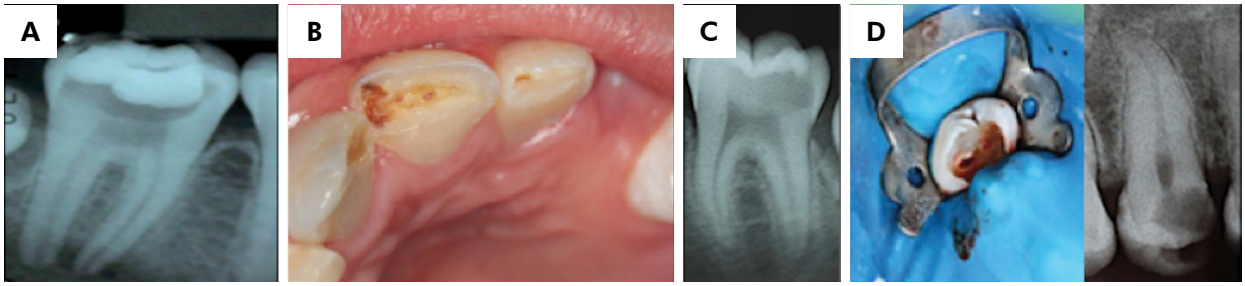
Participants were asked about their treatment decision about each reported case, *i.e.*, VPT (direct pulp capping and partial or full pulpotomy), RCT, or tooth extraction. Moreover, multiple choice questions were applied to verify the factors considered by them in their decision-making, including patients' systemic disorders, dental clinical history, and clinical/radiographic characteristics.

To define the factors that affect decision-making, the variables collected from the seven reported cases were grouped and correlated to the indication of VPT (Yes/No) for each of the clinical situations described. It was hypothesized that the participants' decision-making might be influenced by three main components:

a. Variables related to the participants' profiles: completion of graduate education (years), graduate level (first year, second year, completed), type of graduate school (private or public), and basis for decision-making (undergraduate learning, graduate learning, or clinical experience).
b. Variables related to patients: systemic disorders and patient age.
c. Variables related to clinical and radiographic characteristics: symptoms, dental root (mature/immature), tooth restorability, etiology of pulp exposure (caries/dental trauma/mechanical exposure), time of exposure, extent of exposure, and pulp macroscopic characteristics.

Data analysis

Data from the mail-out surveys were analyzed using Statistical Package for Social Sciences version 17.0 (SPSS Inc, Chicago, USA). Descriptive statistics were performed. To assess factors associated with the indication of VPT versus RCT/tooth extraction, a binary logistic regression was used with significance



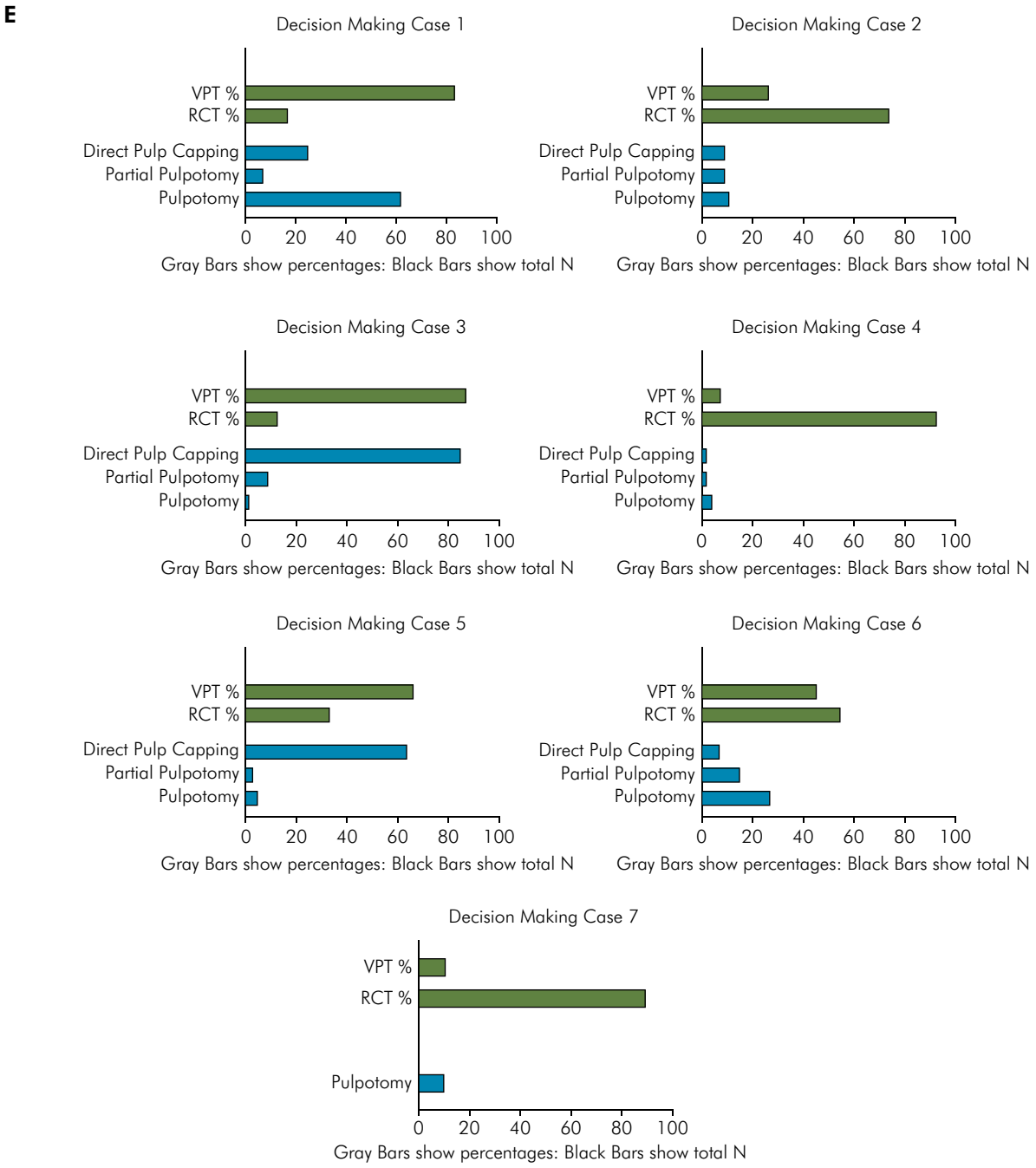


Figure. Clinical and radiographic images provided to participants for cases 1(A), 2(B), 3(C), and 4(D) and vital pulp therapy (VPT) and root canal treatment (RCT) indication rates and total N of VPT indications for the seven clinical cases of the study (E).

Table 1. Information provided in the simulated clinical case reports.

Case	Systemic disorders	Age (years)	Tooth	Symptoms	Dental Root	Tooth restorability	Etiology	Time of exposure	Extent of exposure	Pulp macroscopic aspects
1	Allergy to ASA	12	37	Intense and continuous pain	Immature Nolla's stage 9	Deep caries not affecting surrounding walls	Caries	During procedure	Involving the entire coronal pulp	Normal bleeding and consistency
2	Epilepsy	18	21	Provoked and mild pain	Mature	Mesiodistal tooth fracture involving incisal and middle third of crown	Trauma	5 days	± 2 mm	Normal bleeding and consistency
3	Not reported	14	46	Absent	Mature	Deep caries not affecting surrounding walls	Caries	During procedure	0.5 mm	Normal bleeding and consistency
4	Family history of cardiovascular disease	26	15	Spontaneous pain	Mature	Deep caries affecting occlusal surface and mesial dental wall	Caries	Unknown	3 mm	Normal bleeding and consistency
5	Smoking	40	46	Absent	Mature	Tooth needing indirect restoration	Mechanical	During procedure	0.5 mm	Normal bleeding and consistency
6	Asthma	16	36	Provoked sensitivity during chewing	Mature	Deep caries not affecting surrounding walls	Caries	Unknown	Involving the entire coronal pulp	Hyperplastic pulpitis
7	Autism	16	Unknown	Spontaneous intense pain	Mature	Deep carious lesion not affecting surrounding walls	Caries	During procedure	Involving the entire coronal pulp	Normal consistency; long-lasting and darkened bleeding

of the model established by the Wald chi-square test. Odds ratio and significance values were obtained either from logistic models or Fisher's exact test.

Results

Participants from 19 out of the 25 eligible graduate programs answered the questionnaire, totaling 76% of the universities and 70.6% of the eligible participants. Most of the eligible graduate programs (78%) were either from southeast or south regions. The average age of the 113 participants was 30.6 years and 70.8% of the respondents were from private universities.

The participants' treatment decisions for each case report are shown in Figure E. The influence of variables related to the participants' profiles and patient characteristics, in addition to clinical and radiographic characteristics, on the decision-making of the reported cases are described in Tables 2, 3, and 4, respectively.

Participants based their treatment decisions mostly on graduate or undergraduate learning. In Case 1, immature root development influenced the participants' decision for VPT, while symptom features were determining factors for participants who opted for RCT.

The time of pulp exposure to the oral environment (5 days) was a determinant for most of the participants (73.6%) who decided for RCT in a tooth with a 2-mm pulp exposure caused by trauma (Case 2). In this case report, indication of VPT was associated with having graduated more than 11 years ago.

Table 2. Participant's profile: Bivariate logistic regression model showing significant predictors ($p < 0.05$), odds ratio (OR), and 95% confidence interval (95%CI) for the preference of root canal treatment (RCT) over vital pulp therapy (VPT).

No.	Treatment decision n(%)		Factor		Influence on		OR (95%CI)	p-value
	VPT	RCT			VPT indication n (%)	RCT indication n (%)		
Simulated Clinical Case 1								
113	94 (83.1)	19 (16.9)	Completion of undergraduate education	0–2 years	45 (47,9)	10 (52,6)	1	
				3–10 years	22 (23,4)	5 (26,3)	1.023 (0.312–3.357)	
				11+ years	27 (28,7)	4 (21,1)	0.667 (0.190–2.336)	0.793
			Graduate level	First year	55 (58,5)	10 (52,6)	1	
				Second year	21 (22,3)	4 (21,1)	1.048 (0.296–3.707)	
				Completed	18 (19,1)	5 (26,3)	1.528 (0.461–5.063)	0.736
			Type of Graduate school	Private	63 (71,6)	13 (72,2)	1	
				Public	25 (28,4)	5 (27,8)	0.969 (0.313 –3.002)	1.000
			Decision based on	Undergraduate learning	37 (39,4)	5 (26,3)	1	
				Graduate learning	34 (36,2)	7 (36,8)	1.524 (0.442–5.257)	
				Clinical experience	23 (24,5)	7 (36,8)	2.252 (0.639–7.941)	0.450
Simulated Clinical Case 2								
110	29 (26.4)	81 (73.6)	Completion of undergraduate education	0–2 years	10 (34,5)	44 (54,3)	1	
				3–10 years	5 (17,2)	20 (24,7)	0.909 (0.275–3.008)	
				11+ years	14 (48,3)	17 (21)	0.276 (0.103–0.740)	0.010
			Graduate level	First year	12 (41,4)	52 (64,2)	1	
				Second year	7 (24,1)	16 (19,8)	0.527 (0.175–1.565)	
				Completed	10 (34,5)	13 (16)	0.300 (0.106–0.846)	0.070
			Type of Graduate school	Private	17 (65,4)	56 (72,7)	1	0.467
				Public	9 (34,6)	21 (27,3)	0.708 (0.274–1.833)	
			Decision based on	Undergraduate learning	12 (41,4)	24 (29,6)	1	
				Graduate learning	8 (27,6)	40 (49,4)	2.500 (0.894–6.987)	
				Clinical experience	9 (31)	17 (21)	0.944 (0.326–2.738)	0.136
Simulated Clinical Case 3								
109	95 (87.2)	14 (12.8)	Completion of undergraduate education	0–2 years	47 (49,5)	7 (50)	1	
				3–10 years	21 (22,1)	4 (28,6)	1.279 (0.338–4.845)	
				11+ years	27 (28,4)	3 (21,4)	0.746 (0.178–3.127)	0.805
			Graduate level	First year	57 (60)	7 (50)	1	
				Second year	19 (20)	3 (21,4)	1.286 (0.302–5.474)	
				Completed	19 (20)	4 (28,6)	1.714 (0.452–6.506)	0.728
			Type of Graduate school	Private	62 (70,5)	11 (78,6)	1	
				Public	26 (29,5)	3 (21,4)	0.650 (0.168–2.524)	0.752

Continue

Continuation

109	95 (87.2)	14 (12.8)	Decision based on	Undergraduate learning	41 (43,2)	3 (21,4)	1	
				Graduate learning	34 (35,8)	7 (50)	2.814(0.675–11.721)	
				Clinical experience	20 (21,1)	4 (28,6)	2.733(0.558–13.397)	0.325
Simulated Clinical Case 4								
108	8 (7.4)	100 (92.6)	Completion of undergraduate education	0–2 years	3 (37,5)	50 (50)	1	
				3–10 years	3 (37,5)	22 (22)	0.440 (0.082–2.354)	
				11+ years	2 (25)	28 (28)	0.840 (0.132–5.332)	0.853
			Graduate level	First year	5 (62,5)	58 (58)	1	
				Second year	1 (12,5)	21 (21)	1.810(0.200–16.409)	
				Completed	2 (25)	21 (21)	0.905 (0.163–5.025)	0.909
			Type of Graduate school	Private	5 (71,4)	67 (71,3)	1	1.000
				Public	2 (28,6)	27 (28,7)	1.007 (0.184–5.513)	
			Decision based on	Undergraduate learning	2 (25)	22 (22)	1	
				Graduate learning	3 (37,5)	49 (49)	1.485 (0.231–9.524)	
				Clinical experience	3 (37,5)	29 (29)	0.879 (0.135–5.719)	0.892
Simulated Clinical Case 5								
108	72 (66.7)	36 (33.3)	Completion of undergraduate education	0–2 years	35 (48,6)	18 (50)	1	
				3–10 years	20 (27,8)	5 (13,9)	0.486 (0.157–1.509)	
				11+ years	17 (23,6)	13 (36,1)	1.487 (0.593–3.728)	0.198
			Graduate level	First year	45 (62,5)	18 (50)	1	
				Second year	16 (22,2)	6 (16,7)	0.938 (0.317–2.777)	
				Completed	11 (15,3)	12 (33,3)	2.727 (1.020–7.295)	0.046
			Type of Graduate school	Private	43 (66,2)	29 (80,6)	1	
				Public	22 (33,8)	7 (19,4)	0.472 (0.178–1.247)	0.169
			Decision based on	Undergraduate learning	34 (47,2)	9 (25)	1	
				Graduate learning	22 (30,6)	16 (44,4)	2.747 (1.034–7.299)	
				Clinical experience	16 (22,2)	11 (30,6)	2.597 (0.897–7.516)	0.043
Simulated Clinical Case 6								
106	48 (45.3)	58 (54.7)	Completion of undergraduate education	0–2 years	21 (43,8)	31 (53,4)	1	
				3–10 years	11 (22,9)	14 (24,1)	0.862 (0.329–2.262)	
				11+ years	16 (33,3)	13 (22,4)	0.550 (0.220–1.378)	0.439
			Graduate level	First year	29 (60,4)	33 (56,9)	1	
				Second year	6 (12,5)	15 (25,9)	2.197 (0.753–6.406)	
				Completed	13 (27,1)	10 (17,2)	0.676 (0.258–1.772)	0.177
			Type of Graduate school	Private	29 (64,4)	42 (76,4)	1	
				Public	16 (35,6)	13 (23,6)	0.561 (0.235–1.341)	0.194
			Decision based on	Undergraduate learning	16 (33,3)	22 (37,9)	1	
				Graduate learning	18 (37,5)	26 (44,8)	1.051 (0.435–2.535)	
				Clinical experience	14 (29,2)	10 (17,2)	0.519 (0.184–1.464)	0.349

Continue

Continuation								
Simulated Clinical Case 7								
104	11 (10.6)	93 (89.4)	Completion of undergraduate education	0–2 years	5 (45,5)	46 (49,5)	1	
				3–10 years	3 (27,3)	21 (22,6)	0.761 (0.166–3.484)	
				11+ years	3 (27,3)	26 (28)	0.942 (0.208–4.264)	0.938
			Graduate level	First year	5 (45,5)	56 (60,2)	1	
				Second year	4 (36,4)	16 (17,2)	0.357 (0.086–1.488)	
				Completed	2 (18,2)	21 (22,6)	0.938 (0.169–5.208)	0.938
			Type of Graduate school	Private	8 (80)	61 (69,3)	1	
				Public	2 (20)	27 (30,7)	1,770 (0.352–8.896)	0.488
			Decision based on	Undergraduate learning	3 (27,3)	24 (25,8)	1	
				Graduate learning	6 (54,5)	42 (45,2)	0.875 (0.200–3.820)	
				Clinical experience	2 (18,2)	27 (29)	1.687 (0.260-10.968)	0.742

In pulp exposure secondary to trauma (Case 3), time of pulp exposure and complete root development were significantly associated with RCT indication, whereas age (14 years) was related to VPT indication.

Family history of cardiovascular disease was significantly associated with VPT indication (Case 4).

In Case 5, need for indirect restoration, mechanical exposure of the dental pulp, patient age (40 years), participant's graduate degree completion, and decision based on undergraduate or graduate learning were significantly associated with RCT indication, while the extent of pulp exposure (0.5 mm) influenced those participants who opted for VPT.

Case 6, describing hyperplastic pulpitis, showed lack of consensus amongst the participants, and 45.3% of them opted for VPT.

The presence of symptoms and complete root development were determinants for the indication of VPT in Case 7.

Discussion

The current study assessed the clinical approach for dental pulp exposure among graduate students and coordinating professors in endodontics programs offered at Brazilian universities and identified factors such as root development, symptoms, age, and time of pulp exposure after trauma amongst the main variables that influence decision-making. Decisions made by the participants were frequently not supported by the available scientific evidence, and RCT was preferred over VPT in four out of the seven reported cases.

Although there have been significant advances in biomaterials used for VPT[21,22] and results of clinical trials have demonstrated comparable success rates for VPT and RCT,[22] the dissemination of evidence frequently lags behind scientific findings. In this regard, surveys providing participants' perceptions of treatment options are important for estimating knowledge and acceptability of study outcomes.[22,23] VPT is apparently scarcely indicated by traditional schools of thought,[18] which could lead clinician's to opt for RCT. As a matter of fact, in a recent study evaluating treatments performed by private dentists in Finland, pulp capping, pulpotomies, and root canal fillings comprised 19.2%, 0.8%, and 80% of teeth subjected to endodontic treatment, respectively.[19] Nevertheless, to the best of the authors' knowledge, this is the first investigation about the factors that have currently influenced the decision-making for dental pulp exposure. In the present survey, clinical cases were preferred over questionnaires for assessing participant's knowledge, since the indication of VPT as a definitive treatment is still very controversial.

Immature root development was associated with the participants' decision for VPT. This was expected, considering that even those authors who contraindicate VPT make exceptions for immature teeth, given the

Table 3. Patient's systemic conditions: bivariate logistic regression model showing significant predictors ($p < 0.05$), odds ratio (OR), and 95% confidence interval (95%CI) for the preference of root canal treatment (RCT) over vital pulp therapy (VPT).

No	Treatment decision n (%)		Factor		Influence on		OR (95%CI)	p-value
	VPT	RCT			VPT indication n (%)	RCT indication n (%)		
Simulated Clinical Case 1								
113	94 (83.1)	19 (16.9)	Age	No	46 (49.1)	14 (74.7)	1	0.056
				Yes	48 (51.1)	5 (26.3)	0.342 (0.114–1.026)	
			Sistemic disorders	No	94 (100.0)	19 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 2								
110	29 (26.4)	81 (73.6)	Age	No	22 (75.9)	65 (80.2)	1	
				Yes	7 (24.1)	16 (19.8)	0.774 (0.281–2.127)	0.619
			Sistemic disorders	No	29 (100.0)	81 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 3								
109	95 (87.2)	14 (12.8)	Age	No	43 (55.8)	13 (92.9)	1	
				Yes	42 (44.2)	1 (7.1)	0.097 (0.012–0.772)	0.028
			Sistemic disorders	No	94 (100.0)	19 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 4								
108	8 (7.4)	100 (92.6)	Age	No	6 (75.0)	79 (79.0)	1	0.791
				Yes	2 (25.0)	21 (21.0)	0.797 (0.150–4.241)	
			Sistemic disorders	No	4 (50.0)	85 (85.0)	1	0.023
				Yes	4 (50.0)	15 (15.0)	0.176 (0.040–0.784)	
Simulated Clinical Case 5								
108	72 (66.7)	36 (33.3)	Age	No	19 (65.5)	63 (77.8)	1	
				Yes	5 (6.9)	22 (61.1)	21.057 (6.809–65.120)	< 0.001
			Sistemic disorders	No	29 (100.0)	81 (100.0)	1	0.551
				Yes	0 (0.0)	0 (0.0)	-	
Simulated Clinical Case 6								
106	48 (45.3)	58 (54.7)	Age	No	19 (65.5)	63 (77.8)	1	< 0.001
				Yes	10 (34.5)	18 (22.2)	0.053 (0.016–0.170)	
			Sistemic disorders	No	94 (100.0)	19 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 7								
104	11 (10.6)	93 (89.4)	Age	No	7(65.6)	81 (76.5)	1	0.053
				Yes	4 (36.4)	12 (12.9)	0.259 (0.066–1.020)	
			Sistemic disorders	No	7(65.6)	65 (69.9)	1	0.672
				Yes	4 (36.4)	28 (30.1)	0.754 (0.204–2.783)	

Table 4. Clinical and radiographic characteristics: Bivariate logistic regression model showing significant predictors ($p < 0.05$), odds ratio (OR), and 95% confidence interval (95%CI) for the preference of root canal treatment (RCT) over vital pulp therapy (VPT).

No.	Treatment decision n (%)		Factor		Influence on		OR (95%CI)	p-value
	VPT	RCT			VPT indication n (%)	RCT indication n (%)		
Simulated Clinical Case 1								
113	94 (83.1)	19 (16.9)	Symptoms	No	77 (81.9)	3 (17.6)	1	< 0.001
				Yes	17 (18.1)	16 (82.4)	24.157 (6.323–92.285)	
			Root development	No	8 (8.5)	16 (84.2)	1	
				Yes	86 (91.5)	3 (15.8)	0.017 (0.004–0.073)	< 0.001
			Tooth restorability	No	81 (86.2)	18 (94.7)	1	
				Yes	13 (13.8)	1 (5.3)	0.346 (0.043–2.819)	0.321
			Etiology of exposure	No	94 (100.0)	19 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Time of exposure	No	94 (100.0)	19 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Extent of exposure	No	93 (98.9)	19 (100.0)	1	
				Yes	1 (1.1)	0 (0.0)	-	1.000
			Pulp macroscopic aspect	No	86 (91.5)	19 (100.0)	1	
				Yes	8 (8.5)	0 (0.0)	-	0.348
Simulated Clinical Case 2								
110	29 (26.4)	81 (73.6)	Symptoms	No	19 (65.5)	63 (77.8)	1	0.197
				Yes	10 (34.5)	18 (22.2)	0.543 (0.215–1.373)	
			Root development	No	29 (100.0)	81 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Tooth restorability	No	22 (75.9)	71 (87.7)	1	0.138
				Yes	7 (24.1)	10 (12.3)	0.443 (0.151–1.301)	
			Etiology of exposure	No	12 (41.4)	48 (59.3)	1	0.100
				Yes	17 (58.6)	33 (40.7)	0.485 (0.205–1.149)	
			Time of exposure	No	14 (49.3)	18 (22.2)	1	0.010
				Yes	15 (51.7)	63 (77.8)	3.267 (1.332–8.012)	
			Extent of exposure	No	28 (96.6)	81(100.0)	1	
				Yes	1 (3.4)	0 (0.0)	-	0.264
			Pulp macroscopic aspect	No	29 (100.0)	81 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 3								
109	95 (87.2)	14 (12.8)	Symptoms	No	85 (89.5)	14 (100.0)	1	0.355
				Yes	10 (10.5)	0 (0.0)	-	
			Root development	No	92 (96.8)	5 (35.7)	1	
				Yes	3 (3.2)	9 (64.3)	55.200 (11.295-269.773)	< 0.001
			Tooth restorability	No	81 (85.3)	14 (100.0)	1	
				Yes	14 (14.7)	0 (0.0)	0.853 (0.784–0.927)	0.208

Continue

Continuation

109	95 (87.2)	14 (12.8)	Etiology of exposure	No	20 (21.1)	1 (7.1)	1	
				Yes	75 (78.9)	13 (92.9)	3.467 (0.428–28.109)	0.244
			Time of exposure	No	95 (100)	14 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Extent of exposure	No	95 (100.0)	14 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Pulp macroscopic aspect	No	95 (100.0)	14 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 4								
108	8 (7.4)	100 (92.6)	Symptoms	No	1 (12.5)	19 (19.0)	1	
				Yes	7 (87.5)	81 (81.0)	0.609 (0.071–5.249)	0.652
			Root development	No	8 (100.0)	100 (100.0)	1	
				Yes	-	-	-	-
			Tooth restorability	No	7 (87.5)	82 (82.0)	1	
				Yes	1 (12.5)	28 (28.0)	2.722 (0.320–23.144)	0.359
			Etiology of exposure	No	8 (100.0)	96 (96.0)	1	
				Yes	0 (0)	4 (4.0)	-	1.000
			Time of exposure	No	8 (100.0)	100 (100.0)	1	-
				Yes	0 (0)	0 (0.0)	-	
			Extent of exposure	No	8 (100.0)	91 (91.0)	1	
				Yes	0 (0.0)	9 (9.0)	0.919 (0.867 – 0.974)	1.000
			Pulp macroscopic aspect	No	8 (100)	100 (100)	1	-
				Yes	0.0	0.0	-	
Simulated Clinical Case 5								
108	72 (66.7)	36 (33.3)	Symptoms	No	70 (97.2)	36 (100.0)	1	
				Yes	2 (2.8)	0 (0.0)	-	0.551
			Root development	No	72 (100.0)	36 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Tooth restorability	No	68 (94.4)	23 (63.9)	1	
				Yes	4 (5.6)	13 (36.1)	9.609 (2.847–32.426)	0.001
			Etiology of exposure	No	70 (97.2)	28 (81.8)	1	
				Yes	2 (2.8)	8 (22.2)	10.000 (1.998–50.042)	0.005
			Time of exposure	No	72 (100.0)	36 (100.0)	1	-
				Yes	0 (0.0)	0 (0.0)	-	
			Extent of exposure	No	1 (1.4)	17 (47.2)	1	
				Yes	71 (98.6)	19 (52.8)	0.016 (0.002–0.126)	0.001
			Pulp macroscopic aspect	No	70 (97.2)	36 (100)	1	
				Yes	2 (2.8)	0 (0)	-	0.551
Simulated Clinical Case 6								
106	48 (45.3)	58 (54.7)	Symptoms	No	48 (100.0)	57 (98.3)	1	
				Yes	0 (0)	1 (1.7)	-	1.000

Continue

Continuation

106	48 (45.3)	58 (54.7)	Root development	No	48 (100.0)	58 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Tooth restorability	No	13 (27,1)	9 (15,5)	1	
				Yes	13 (27,1)	9 (15,5)	0.495 (0.190–1.284)	0.148
			Etiology of exposure	No	9 (19.7)	7 (12.1)	1	
				Yes	39 (81,3)	51 (87,9)	1.681 (0.575–4.912)	0.342
			Time of exposure	No	48 (100.0)	58 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Extent of exposure	No	48 (100.0)	58 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Pulp macroscopic aspect	No	48 (100.0)	58 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
Simulated Clinical Case 7								
104	11 (10.6)	93 (89.4)	Symptoms	No	7 (63.6)	23 (24.7)	1	
				Yes	4 (36.4)	70 (75.3)	5.326 (1.429–19.852)	0.013
			Root development	No	9 (71.8)	92 (98.9)	1	
				Yes	2 (18.2)	1 (1.1)	0.049 (0.004–0.594)	0.029
			Tooth restorability	No	11 (100.0)	80 (86.0)	1	
				Yes	0 (0)	13 (14.0)	-	0.351
			Etiology of exposure	No	11 (100.0)	93 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Time of exposure	No	11 (100.0)	93 (100.0)	1	
				Yes	0 (0.0)	0 (0.0)	-	-
			Extent of exposure	No	11 (0)	91 (97.8)	1	
				Yes	0 (0)	2 (2.2)	-	1.000
			Pulp macroscopic aspect	No	4 (36.4)	27 (29.0)	1	
				Yes	7 (63.6)	66 (71.0)	1.397 (0.378–5.164)	0.616

importance of keeping the pulp alive for promoting root development and tooth strengthening.[18] On the other hand, RCT was preferred over VPT in most of the cases with mature teeth. Probably, the lower vascularity of mature teeth compared to immature permanent teeth was considered to infer that host immune system responses and healing capacity were deficient. However, the limited capacity of healing of teeth with complete root development has not been supported by recent findings.[29]

Symptom were also determining factors for participants who opted for RCT. A limited correlation between clinical and histological conditions has been previously demonstrated,[15] but the terminology commonly used for classifying pulp diseases seems to suggest that reversibility of pulp inflammation depends on symptom characteristics. The European Society of Endodontology (ESE) recognizes that clinical information is not accurate enough to determine the characteristics of pulpal inflammation or to determine the potential for its repair. Nevertheless, ESE recommends a pulpal disease terminology based on symptom features. In this regard, irreversible damage to the vital pulp should be characterized by episodes of spontaneous radiating pain that lingers on after removal of the stimulus, while reversible pulpitis should be considered either in symptomless teeth or in case of episodes of less intense, shorter-

lasting pain.[26] Similarly, the American Association of Endodontists (AAE)[27] endorsed the currently accepted classification of pulpal disease in 2013, describing pulpitis as either reversible or irreversible depending on clinical signs and symptoms.

Conversely, recent randomized clinical trials[22] have confirmed that VPT is viable in teeth with intense and spontaneous pain. Therefore, there is an urgent need for a revision of pulpal disease terminology, focusing on the available evidence of the healing potential of the dental pulp.[28] The inference that observing symptoms would be effective in establishing dental pulp prognosis leads to uncertainty in clinical practice when a rational treatment plan needs to be established and that might have contributed to decreasing the indication of VPT in the present survey.

The time of pulp exposure to the oral environment was determinant for most of the participants who decided for RCT after a dental trauma. However, there is no clear evidence that corroborates the time of pulp exposure as an impediment to VPT. As a matter of fact, the study published by Cvek[30] reported 96% success rates in partial pulpotomies performed up to 90 days after pulp exposure. Accordingly, Borkar and Ataide[31] suggest the interval between trauma and treatment is not critical for pulp recovery if superficial tissue is removed and the procedure is performed with biocompatible materials and asepsis. Interestingly, in the current study, the option for VTP after dental trauma was significantly associated with graduate education completion, which demonstrates that recently graduated professionals have limited knowledge of dental trauma and VPT. A recent survey in southern Brazil has revealed moderate level of knowledge among dentists about the management of dental trauma, which corroborates the present findings.[24] Thus, it is paramount that teaching methods be revised, and more emphasis be given to these topics in undergraduate and graduate curricula.

Patient age was also a key factor for participants' decisions about treatment, probably due to the assumption that the histological features of pulp tissue in young patients – including the greater number of cells, the blood supply, and the content of collagen fibers[32] – would produce a favorable outcome. However, recent clinical studies have suggested VPT could be applied regardless of patient age[21,33]. In this respect, age-related alterations in the dental pulp complex have been previously discussed, emphasizing that, besides the inherent age-related changes due to physiological defensive processes, pathologic irritant-induced changes must affect the dental pulp.[32] Clinical difficulties in assessing these modifications make age *per se* an unreliable predictor of successful VPT.

In the presence of small carious exposure, direct pulp capping was chosen by most participants as the VPT modality. The literature has been driven by controversy over the indication of this treatment modality for this situation. While some authors have observed similar results by comparing direct pulp capping and partial pulpotomies,[21] others have concluded partial and full pulpotomies are more predictable, emphasizing the need of further observational studies that investigate the factors influencing treatment outcomes.[34] Although selective caries removal was not within the scope of this survey, recent consensus reports have pointed out it should be considered when pulp exposure is avoidable.[26]

In most of the case reports, the patient's systemic conditions did not affect the participants' decision-making, even when it could hinder patient management, leading to an increase in technical difficulties, as in patients with autism spectrum disorder.[35] Conversely, family history of heart disease was considered by those participants who opted for VPT over RCT for the treatment of a symptomatic tooth presenting dental pulp with normal bleeding and consistency. A positive association between apical periodontitis and coronary heart disease has been previously observed[36]. However, there is no scientific evidence that confirms the effects of coronary heart diseases on the outcomes of RCT of vital teeth. These outcomes evidence limited knowledge of the participants about the influence of the patient's systemic conditions on clinical practice. In this respect, Moskona et al.[1] highlight the importance of interdisciplinary approaches in dental education aiming to enhance oral diagnosis and treatment planning skills, which should be considered in order to improve teaching strategies.

A small extent of pulp mechanical exposure was significantly associated with the decision for VPT,

and direct pulp capping was the treatment modality chosen by most of the participants in this situation. The non-infectious nature of pulp exposure endorses this decision, given that previous investigations have shown teeth with traumatic or mechanical pulp exposure have higher success rates than teeth with cariously exposed pulps, which are often severely inflamed.[37] On the other hand, variables related to the participants' profiles, such as having completed their graduate program and basing their treatment decision on undergraduate or graduate learning, have played a role in the decision of those participants who opted for RCT after pulp mechanical exposure. Those participants were also influenced by the etiology of pulp exposure, patient age, and the need for indirect restoration, which is not supported by the available literature. With regard to the type of tooth restoration, a previous observational study has revealed that the quality of coronal sealing, rather than the type of dental restoration, affects the success rates of pulpotomy.[33] As a matter of fact, the presence of prosthetic crown following pulpotomy presented the most favorable outcomes in this study. Interestingly, amongst the simulated reports presented herein, this was the only one in which decision-making was significantly affected by coronal destruction.

Decisions about the treatment of hyperplastic pulpitis showed lack of consensus amongst the participants, and 45.3% of them opted for VPT. A study on pulp polyps revealed that cells isolated from this granulation tissue fulfill the criteria for multipotent mesenchymal stromal cells,[38] which could result in greater capacity of hyperplastic tissue to heal. Calişkan, Öztop, and Calişkan[39] assessed 24 permanent teeth with hyperplastic pulpitis in which pulpotomies were performed and observed clinical and radiographic healing in 91.6%. Clinical studies with larger samples and longer-term follow-up should be performed. However, the current available evidence suggests favorable perspectives for the indication of VPT for teeth with chronic hyperplastic pulpitis.

In a recent histopathologic and histobacteriologic study of treated teeth with pulp exposure,[16] the authors have proposed that more predictable treatment can be provided if the clinician takes into account the examination of the deepest part of dentin and the clinical aspects of the exposed pulp tissue. Nonetheless, the macroscopic aspects of pulp tissue were not significantly relevant to the participants' decision-making in any of the simulated cases in the present study.

Most of the participants based their decisions on undergraduate or graduate learning, confirming the suggestion of a previous study.[40] Considering the treatment decisions made by the study participants, the criteria adopted for VPT indication are not in line with the current scientific evidence. The teaching approach at Brazilian universities might not be stimulating the indication of VPT, which certainly has an impact on clinical practices.

Conclusion

The present study demonstrated that decision-making for pulp exposure is frequently not supported by the available scientific evidence, suggesting the need to revise the content and emphasis given to VPT in undergraduate and graduate programs. Patient age, root development, and symptom features were the main factors affecting the participants' decision-making.

References

1. Moskona D, Kaplan I, Leibovich P, Notzer N, Begleiter A. A three-year programme in oral diagnosis and treatment planning. A model using an interdisciplinary teaching team. Eur J Dent Educ. 1999 Feb;3(1):27-30. https://doi.org/10.1111/j.1600-0579.1999.tb00063.x
2. Zanini M, Hennequin M, Cousson PY. A review of criteria for the evaluation of pulpotomy outcomes in mature permanent teeth. J Endod. 2016 Aug;42(8):1167-74. https://doi.org/10.1016/j.joen.2016.05.008
3. 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. https://doi.org/10.3109/00016358609004733

4. Holland R, de Souza V, de Mello W, Nery MJ, Bernabé PF, Otoboni Filho JA. Permeability of the hard tissue bridge formed after pulpotomy with calcium hydroxide: a histologic study. J Am Dent Assoc. 1979 Sep;99(3):472-5. https://doi.org/10.14219/jada.archive.1979.0317
5. Ford TR, Torabinejad M, Abedi HR, Bakland LK, Kariyawasam SP. Using mineral trioxide aggregate as a pulp-capping material. J Am Dent Assoc. 1996 Oct;127(10):1491-4. https://doi.org/10.14219/jada.archive.1996.0058
6. Bjørndal L. Is pulpotomy preferable to root treatment where there is pulp exposure? Evid Based Dent. 2019 Dec;20(4):117-8. https://doi.org/10.1038/s41432-019-0057-y
7. 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 Oct;50(10):924-32. https://doi.org/10.1111/iej.12719
8. Kang CM, Sun Y, Song JS, Pang NS, Roh BD, Lee CY, et al. A randomized controlled trial of various MTA materials for partial pulpotomy in permanent teeth. J Dent. 2017 May;60:8-13. https://doi.org/10.1016/j.jdent.2016.07.015
9. Li Y, Sui B, Dahl C, Bergeron B, Shipman P, Niu L, et al. Pulpotomy for carious pulp exposures in permanent teeth: A systematic review and meta-analysis. J Dent. 2019 May;84:1-8. https://doi.org/10.1016/j.jdent.2019.03.010
10. Alqaderi H, Lee CT, Borzangy S, Pagonis TC. Coronal pulpotomy for cariously exposed permanent posterior teeth with closed apices: A systematic review and meta-analysis. J Dent. 2016 Jan;44:1-7. https://doi.org/10.1016/j.jdent.2015.12.005
11. Brodén J, Davidson T, Fransson H. Cost-effectiveness of pulp capping and root canal treatment of young permanent teeth. Acta Odontol Scand. 2019 May;77(4):275-81. https://doi.org/10.1080/00016357.2018.1538536
12. Kassebaum NJ, Smith AG, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al.; GBD 2015 Oral Health Collaborators. Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990-2015: a systematic analysis for the global burden of diseases, injuries, and risk factors. J Dent Res. 2017 Apr;96(4):380-7. https://doi.org/10.1177/0022034517693566
13. Carrer FC, Cavetano MH, Gabriel M, Melani AC, Martins JS, Araujo ME. Situation of endodontics in the public health service in brazil through the Access and Quality Improvement Program (PMAQ-CEO). Pesqui Bras Odontopediatria Clin Integr. 2018;18(1):1-12. https://doi.org/10.4034/PBOCI.2018.181.54
14. 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. https://doi.org/10.1111/j.1365-2591.2012.02016.x
15. Seltzer S, Bender IB, Ziontz M. The Dinamics of pulp inflamations: correlations between diagnostic and actual histologic findings in the pulp. Oral Surg Oral Med Oral Pathol. 1963 Aug;16(8):969-77. https://doi.org/10.1016/0030-4220(63)90201-9
16. Ricucci D, Siqueira JF Jr, Li Y, Tay FR. Vital pulp therapy: histopathology and histobacteriology-based guidelines to treat teeth with deep caries and pulp exposure. J Dent. 2019 Jul;86:41-52. https://doi.org/10.1016/j.jdent.2019.05.022
17. Mass E, Zilberman U. Clinical and radiographic evaluation of partial pulpotomy in carious exposure of permanent molars. Pediatr Dent. 1993 Jul-Aug;15(4):257-9.
18. Langeland K. Management of the inflamed pulp associated with deep carious lesion. J Endod. 1981 Apr;7(4):169-81. https://doi.org/10.1016/S0099-2399(81)80231-2
19. Vehkalahti MM, Palotie U, Valaste M. Age-specific findings on endodontic treatments performed by private dentists in Finland in 2012 and 2017: a nationwide register-based observation. Int Endod J. 2020 Jun;53(6):754-63. https://doi.org/10.1111/iej.13284
20. Armstrong JS, Overt TS. Estimating nonresponse bias in mail surveys. J Mark Res. 1977;14(3):396-402. https://doi.org/10.1177/002224377701400320
21. Awawdeh L, Al-Qudah A, Hamouri H, Chakra RJ. Outcomes of vital pulp therapy using mineral trioxide aggregate or biodentine: a prospective randomized clinical trial. J Endod. 2018 Nov;44(11):1603-9. https://doi.org/10.1016/j.joen.2018.08.004
22. Taha NA, Abdulkhader SZ. Full pulpotomy with Biodentine in symptomatic young permanent teeth with carious exposure. J Endod. 2018 Jun;44(6):932-7. https://doi.org/10.1016/j.joen.2018.03.003
23. Asgary S, Eghbal MJ, Fazlyab M, Baghban AA, Ghoddusi J. Five-year results of vital pulp therapy in permanent molars with irreversible pulpitis: a non-inferiority multicenter randomized clinical trial. Clin Oral Investig. 2015 Mar;19(2):335-41. https://doi.org/10.1007/s00784-014-1244-z
24. Hartmann RC, Rossetti BR, Siqueira Pinheiro L, Poli de Figueiredo JA, Rossi-Fedele G, S Gomes M, et al. Dentists' knowledge of dental trauma based on the International Association of Dental Traumatology guidelines: A survey in South Brazil. Dent Traumatol. 2019 Feb;35(1):27-32. https://doi.org/10.1111/edt.12450
25. Goldfarb MB, Maupomé G, Hirsh AT, Carvalho JC, Eckert GJ, Hara AT. Dentists clinical decision-making for erosive tooth wear: an online pilot study. J Dent. 2020 Sep;100:103424. https://doi.org/10.1016/j.jdent.2020.103424
26. 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. https://doi.org/10.1111/iej.13080
27. American Association of Endodontists. Guide to clinical endodontics. 6th ed. Baltimore: American Association of Endodontists; 2013.

28. Wolters WJ, Duncan HF, Tomson PL, Karim IE, McKenna G, Dorri M, et al. Minimally invasive endodontics: a new diagnostic system for assessing pulpitis and subsequent treatment needs. Int Endod J. 2017 Sep;50(9):825-9. https://doi.org/10.1111/iej.12793
29. Tan SY, Yu VS, Lim KC, Tan BC, Neo CL, Shen L, et al. Long-term pulpal and restorative outcomes of pulpotomy in mature permanent teeth. J Endod. 2020 Mar;46(3):383-90. https://doi.org/10.1016/j.joen.2019.11.009
30. Cvek M. A clinical report on partial pulpotomy and capping with calcium hydroxide in permanent incisors with complicated crown fracture. J Endod. 1978 Aug;4(8):232-7. https://doi.org/10.1016/S0099-2399(78)80153-8
31. Borkar SA, Ataide I. Biodentine pulpotomy several days after pulp exposure: four case reports. J Conserv Dent. 2015 Jan-Feb;18(1):73-8. https://doi.org/10.4103/0972-0707.148901
32. Morse DR. Age-related changes of the dental pulp complex and their relationship to systemic aging. Oral Surg Oral Med Oral Pathol. 1991 Dec;72(6):721-45. https://doi.org/10.1016/0030-4220(91)90019-9
33. Kunert GG, Kunert IR, Costa Filho LC, Figueiredo JA. Permanent teeth pulpotomy survival analysis: retrospective follow-up. J Dent. 2015 Sep;43(9):1125-31. https://doi.org/10.1016/j.jdent.2015.06.010
34. Aguilar P, Linsuwanont P. Vital pulp therapy in vital permanent teeth with cariously exposed pulp: a systematic review. J Endod. 2011 May;37(5):581-7. https://doi.org/10.1016/j.joen.2010.12.004
35. Chandrashekhar S, Bommangoudar JS. Management of autistic patients in dental office: a clinical update. Int J Clin Pediatr Dent. 2018 May-Jun;11(3):219-27. https://doi.org/10.5005/jp-journals-10005-1515
36. Costa TH, Figueiredo Neto JA, Oliveira AE, Maia MFL, Almeida AL. Association between chronic apical periodontitis and coronary artery disease. J Endod. 2014 Feb;40(2):164-7. https://doi.org/10.1016/j.joen.2013.10.026
37. Bjørndal L, Reit C, Bruun G, Markvart M, Kjaeldgaard 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. https://doi.org/10.1111/j.1600-0722.2010.00731.x
38. Attar A, Eslaminejad MB, Tavangar MS, Karamzadeh R, Dehghani-Nazhvani A, Ghahramani Y, et al. Dental pulp polyps contain stem cells comparable to the normal dental pulps. J Clin Exp Dent. 2014 Feb;6(1):e53-9. https://doi.org/10.4317/jced.51305
39. Calişkan MK, Öztop F, Calişkan G. Histological evaluation of teeth with hyperplastic pulpitis caused by trauma or caries: case reports. Int Endod J. 2003 Jan;36(1):64-70. https://doi.org/10.1046/j.1365-2591.2003.00590.x
40. Loch C, Liaw Y, Metussin AP, Lynch CD, Wilson N, Blum IR, et al. The teaching of posterior composites: A survey of dental schools in Oceania. J Dent. 2019 May;84:36-43. https://doi.org/10.1016/j.jdent.2019.01.005