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Deep occlusal carious lesions clinical management by Brazilian dentists: a nationwide e-survey

Manejo clínico de lesões cariosas oclusais profundas por cirurgiões-dentistas brasileiros: uma pesquisa eletrônica nacional

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ABSTRACT

Objective: To investigate the clinical management of deep occlusal carious lesions in permanent teeth by Brazilian dentists. **Material and Methods:** This cross-sectional study included a sample of 732 Brazilian dentists who responded to an electronic questionnaire composed of 20 questions addressing socio-demographic information, training and professional activity characteristics, and clinical management of deep carious lesions. Descriptive analysis was performed, considering relative and absolute frequencies and 95% confidence intervals. The association between the dentists' variables of interest (age group, type of higher education institution, years in practice, highest academic degree completed and main sector of professional activity) and the mean number of incorrect answers regarding deep carious lesions management was analyzed by Analysis of Variance (ANOVA), followed by the Bonferroni post-test ($p<0.005$). **Results:** Stepwise removal was the strategy pointed out by most dentists (42.8%). However, 16% of the dentists selected nonselective carious tissue removal. Furthermore, 45.6% of the dentists disagreed with maintaining carious tissue over the pulp in deep lesions with a risk of pulpal exposure. When using instruments to remove carious dentine, 17% of the dentists chose a diamond burn while 13% preferred tungsten carbide burs. Dentists who graduated from public institutions had a lower mean of non-conservative decisions than those from private institutions. Dentists with master's or doctoral degrees were more conservative, as well as dentists from public service compared to those from the private sector. **Conclusion:** The dissemination of conservative approaches in the management of deep carious lesions needs to be strengthened and increasingly based on updated scientific literature.

KEYWORDS

Dental caries; Dental pulp capping; Dentists; Dentistry; Evidence-based practice.

RESUMO

Objetivo: Investigar o manejo clínico de lesões cariosas oclusais profundas em dentes permanentes por cirurgiões-dentistas brasileiros. **Material e Métodos:** Este estudo transversal incluiu uma amostra de 732 dentistas brasileiros que responderam a um questionário eletrônico composto por 20 questões abordando informações sociodemográficas, formação, características da atividade profissional e manejo clínico de lesões cariosas profundas. Foi realizada análise descritiva, considerando frequências relativas e absolutas, e intervalos de confiança de 95%. A associação entre as variáveis de interesse (faixa etária, tipo de instituição de ensino superior, anos de prática, maior titulação acadêmica concluída e principal setor de atividade profissional) dos cirurgiões-dentistas e a média de acertos no manejo de lesões cariosas profundas foi analisada pela Análise de Variância (ANOVA), seguida do pós-teste de Bonferroni ($p<0,005$). **Resultados:** A remoção seletiva foi a estratégia apontada pela maioria dos cirurgiões-dentistas (42,8%). No entanto, 16% dos dentistas selecionaram a remoção não seletiva do tecido cariado. Além disso, 45,6% dos dentistas discordaram da manutenção de tecido cariado sobre a polpa em lesões profundas com risco de exposição pulpar. Ao usar instrumentos para remover a dentina cariada, 17% dos dentistas escolheram uma broca diamantada, enquanto 13% preferiram brocas de carboneto de tungstênio. Cirurgiões-dentistas formados em instituições públicas apresentaram menor média de decisões não conservadoras do que os de instituições privadas. Os cirurgiões-dentistas com mestrado ou doutorado foram mais conservadores, assim como os cirurgiões-dentistas do serviço público em relação aos do setor privado. **Conclusão:** A disseminação de abordagens conservadoras no manejo de lesões cariosas profundas precisa ser fortalecida e cada vez mais baseada em literatura científica atualizada.

PALAVRAS-CHAVE

Cárie dentária; Capeamento da polpa dentária; Dentistas; Odontologia; Prática clínica baseada em evidências.

INTRODUCTION

The removal of carious tissue is a common procedure performed by dentists, considering that dental caries is globally one of the main public oral health problems [1]. Traditionally, for carious lesions, restorative treatment has been performed by complete and non-selective removal of carious tissue, regardless of location and hardness. This removal continues until sound tooth tissue is achieved, providing a stable substrate for subsequent restoration[2]. However, this strategy used in primary or permanent teeth with deep cavity creates a potential risk of iatrogenic pulp exposure and other post-operative complications, compromising tooth longevity [2,3].

Currently, the management of permanent teeth with deep carious lesions in asymptomatic pulps or with symptoms of reversible inflammation is based on carious tissue removal in conservative strategies, such as stepwise removal and selective removal, both encouraged by the International Caries Consensus Collaboration (ICCC) [2]. Stepwise removal advocates partial removal of carious tissue and provisional restoration followed by remineralization-inducing materials and complete removal in a second dental visit for the definitive restoration [2,4]. The initial procedure aims to provide a favourable environment for the dentin-pulpal complex physiological reactions that provide the formation of tertiary dentin and remineralization of the lesion before the complete excavation of the carious tissue, avoiding a possible pulpal exposure [2,3]. Therefore, selective removal of carious tissue supports the restricted removal of superficial, necrotic, disorganized carious tissue, with demineralized dentine remaining on the pulpal wall [2]. A frequent concern of dentists about this technique is the presence of residual bacteria in the cavity after the definitive restoration [5,6]. Nevertheless, there is no need to perform a complete elimination of microorganisms during cavity preparation given that the restorations are properly sealed [2].

Although new concepts and recommendations have been developed, neither knowledge reach dentists nor they do not practice this knowledge in their offices [7,8]. This lack of knowledge or interest can be perceived in previous questionnaire surveys that have shown a wide variation in strategies of carious tissue removal in primary or permanent teeth among dentists worldwide [8,9,10,11]. Brazilian studies regarding the clinical management of deep carious lesions in both dentitions have been conducted only in small and local samples [5,7,8,12]. For this reason, it would be of great interest to know how deep knowledge of the criteria, strategies, and methods of caries removal are established in the clinical practice of Brazilian dentists. Thus, if necessary, best practices would be recommended regarding the uniformity of the clinical procedures. Therefore, the present study investigated the knowledge and clinical management of dentists from different regions of the country regarding deep occlusal carious lesions in permanent teeth.

MATERIAL AND METHODS

Study design and ethical issues

The present observational, cross-sectional, descriptive, and quantitative study was developed using an online questionnaire applied to Brazilian dentists from October to December 2020. This study was approved by the Research Ethics Committee of the Universidade Federal do Ceará, Brazil on September 15, 2020 (protocol #4.277.387). Before the questionnaire application, all participants agreed to the Consent Form displayed on the first page of the online form, which guaranteed the confidentiality of the data and personal information collected.

Questionnaire development and pre-survey

The questionnaire was developed by a group of restorative dentistry specialists, based on information obtained from the previous studies [2,8,9], as well as additional relevant questions about the topic. During the development of the instrument, a pre-test was conducted within one week with 10 dentists not previously involved with the study, aiming to verify the clarity and objectivity of the questions, gauge the reliability of the instrument to data collection, as well as to determine the average time to complete the form. The pre-survey questionnaire was hosted in the Google Forms® (Google Corp., USA) platform and the link was sent to pre-survey participants by e-mail. Furthermore, based on the answers, small adjustments were made to adapt the questionnaire, considering the inclusion of a description of technical terms about the management of deep carious lesions that worked like a glossary. The average preview time to complete the pre-survey form was 9 minutes.

Questionnaire content, sample size, and survey application

After the pre-survey procedures, the final questionnaire consisted of 20 mandatory close-ended questions distributed in four blocks: (1) socio-demographic variables (sex, age, Brazilian regional division – states/macroregion, and main sector of professional activity) and training and professional activity characteristics (type of higher education institutions, years in practice, highest academic degree completed, dental specialty and service provision); (2) deep carious lesion treatment (criteria, strategies, and methods for deep carious tissue removal); (3) materials for protecting the pulp-dentin complex (with and without pulp exposure); (4) concepts regarding deep carious lesions (permanence of residual microorganisms from cavity preparation, maintenance of remaining demineralized dentine, and cavity sealing).

The target population for this study was Brazilian dentists, who numbered approximately 330,000 in 2020 (data provided by the Federal Council, 2022). The sample size calculation was performed in the OpenEpi Menu, web version 3.01, available online at www.OpenEpi.com. Considering the variables of interest with an unknown prevalence of 50%, a margin of error of 5 percentage points, and a 95% confidence interval, a sample size of 384 dentists was estimated.

The final questionnaire was hosted in the Google Forms® (Google Corp., USA) online platform. The participants received a link sent via e-mail and social networks - WhatsApp® (WhatsApp LLC, Meta Inc., USA), Facebook® (Meta Inc., USA), and Instagram® (Kevin Systrom, Mike Krieger, Burbn, Inc., USA). The dissemination of the link to the survey and other information was done using a profile specially developed for the survey on Instagram® (@questcarie). There were no financial or material incentives for participation in the research. All participants were volunteers. The answers were collected between October 3rd, 2020 and December 3rd, 2020. At the end of the questionnaire, the participants could enter their contact e-mail in a specific field if they desired to receive the answers to questions about the management of deep carious lesions. After the data collection period, a file with the answer key and comments on questions of blocks 2, 3 and 4, according to current scientific evidence, was sent to the dentist via e-mail using the research account (questionariocarie@gmail.com).

Data management and analysis

After the data collection period, data was imported into a Microsoft Excel 2016 (Excel 2016, Microsoft, Richmond, USA) spreadsheet. To improve data presentation the state of professional activity was categorized into Brazilian macroregions. For the variable age group, the categories "50 to 59 years old" and "60 years old or above" were grouped into "≥50 years old". Also, the variables years in practice and highest academic degree completed, respectively question 5 and 6, had their categories grouped, as presented in the results. For question 4 – The type of higher education institution had its categories "Community" and "Public" grouped into "Public" category and question 8 - The main sector of professional activity had grouped the categories "Private dental clinic" and "Private dental clinics network" into "Dentist- Private sector" and the category "Graduate program dental clinic" grouped with "Teaching". Finally, question 16 – Management of minor pulpal exposure (pinpoint exposure) with bleeding in deep carious lesions, had the answer alternatives "I do not apply the material, I perform pulpotomy" and "I do not apply material, I perform pulpectomy" grouped into "Pulpotomy or Pulpectomy".

All statistical analysis was performed using Stata®, version 14.2 (Stata Corp. College Station, TX, USA) software. For all variable missing data was treated as a loss of information and excluded from the analysis. Descriptive analysis was performed to assess frequencies of categorical variables and 95% confidence intervals. To assess the association between a dentist´s characteristics and level of knowledge about conservative management of dental caries a quantitative variable was created based on 9 questions (from questions 9 to 12 and 14 to 19). For each incorrect answer to the question, a point was attributed to the scale variable. This variable named "non-conservative" was used to evaluate the degree of responses considered incorrect concerning the current recommendations for the treatment of deep carious lesions. Thus, the questionnaire score corresponded from 0-9, where lower values corresponding to more conservative decisions. Data distribution of the "non-conservative" variable was verified by Bartlett's Test, followed by Analysis of Variance (ANOVA) and Bonferroni's Test ($p<0.05$).

RESULTS

Sample characteristics

A total of 732 dentists participated in this e-survey. The socio-demographic, training and professional activity characteristics of the dentists are presented in Table I. Females were predominant in the sample (70.1%), as well as dentists in young adulthood (20 to 29 years old – 41.4%), trained in public institutions of higher education, and with more than 5 years in practice. Approximately 30% of the sample had only an undergraduate degree in Dentistry, completed until the research period. Regarding professional activity, most of the participants worked as a dentist in the private sector (65.7%). The highest number of answers was obtained in the Northeast region of the country (39.8%), followed by the Southeast (37.3%).

Criteria for tissue removal in deep carious lesions

Table II presents the responses of the study participants regarding the criteria used for the removal of carious tissue on the pulpal wall of deep lesions. The colour was not considered a relevant criterion by 57.4% of the dentists though 12.4% of the dentists reported removing darkened dentine close to the pulp. Considering the hardness of the remaining dentine, 56.8% of the dentists used to excavate softened carious tissue, 28.4% remove dentin with a leathery aspect, and 3% did not use this criterion.

Table I - Absolute frequencies (n), relative frequencies (%), and 95% confidence intervals (95%CI) of the socio-demographic, training, and professional activity characteristics of Brazilian dentists (n=732)

Variable	n	%	95% CI
Sex			
Female	512	70.1	66.7 to 73.3
Male	218	29.9	26.6 to 33.3
Type of higher education institution			
Private	349	47.7	44.1 to 51.3
Public	383	52.3	48.7 to 56.0
Years in practice			
≤ 5 years	345	47.3	43.6 to 50.9
6 to 10 years	135	18.5	15.8 to 21.5
11 to 20 years	120	16.4	13.9 to 19.3
>20 years	130	17.8	15.1 to 20.8
Age group			
20 to 29 years old	303	41.4	37.9 to 45.0
30 to 39 years old	244	33.3	30.0 to 36.8
40 to 49 years old	103	14.1	11.7 to 16.8
≥50 years old	82	11.2	9.1 to 13.8
Highest academic degree completed			
Undergraduate degree in dentistry	226	30.9	27.6 to 34.3
Residency or advanced special training (certification)	327	44.7	41.1 to 48.3
Master's or Doctorate degrees	179	24.4	21.5 to 27.7
Main sector of professional activity			
Dentist – Private sector	468	65.7	62.1 to 69.0
Dentist – Public sector	200	28.0	24.9 to 31.5
Teaching	45	6.3	4.7 to 8.3
Brazilian regional division			
Southeast	273	37.3	33.8 to 40.9
Northeast	291	39.8	36.3 to 43.3
South	129	17.6	15.0 to 20.6
Central-West	16	2.2	1.3 to 3.5
North	23	3.1	2.1 to 4.7

Table II - Absolute frequencies (n), relative frequencies (%), and 95% confidence intervals (95% CI) for variables related to the criterion for tissue removal in deep carious lesions (n=732)

Variable	n	%	95%CI
Color of remaining dentine			
Did not use color as a criterion	420	57.4	53.7 to 60.9
Pale/Yellow dentine	221	30.2	27.0 to 33.6
Dark/Brown/Black dentine	91	12.4	10.2 to 15.0
Hardness of remaining dentine			
Did not use hardness as a criterion	22	3.0	2.0 to 4.5
Soft dentine	416	56.8	53.2 to 60.4
Leathery/Firm dentine	208	28.4	25.2 to 31.8
Hard dentine	86	11.8	9.6 to 14.3
Moisture of remaining dentine			
Did not use moisture as a criterion	374	51.1	47.5 to 54.7
Wet dentine	209	28.5	25.4 to 32.0
Moist dentine	89	12.2	10.0 to 14.7
Dry dentine	60	8.2	6.4 to 10.4

About half of dentists do not consider moisture as a parameter for dentine tissue removal. On the other hand, 8% reported removing dry dentine.

Strategies and methods for carious tissue removal and materials to protect the dentin-pulp complex

Stepwise removal was the strategy used for most of the dentist (42.8%), followed by the selective removal of remaining dentine (Table III). On the other hand, a significant percentage of dentists (16.1%) still perform nonselective removal (Table III). According to the dentists, the decision for or against a strategy was based on clinical practice guidelines, scientific evidence, and familiarity/ease of the procedure. The use of hand instruments combined or not with tungsten carbide burs was the most cited tool for excavation of carious dentin (Table III).

After the removal of carious tissue in deep lesions, about 35% of dentists reported performing only cavity-lining followed by restorative material and 7.9% reported applying the adhesive directly into the dentine (Table III). In the case of pinpoint pulpal exposure during excavation, direct pulpal capping was preferred over pulpotomy and pulpectomy (Table III). For direct pulpal capping, 81.6% of the dentists reported that they used calcium hydroxide-based powder and cement materials (Table III).

Concepts about carious tissue removal in deep lesions

Table IV presents the dentists' responses regarding the concepts related to deep lesions. The majority of participants (64.3%) disagree or strongly disagree that caries-related microorganisms should be completely removed during the cavity preparation, as the residual bacteria may form a new carious lesion. In addition, most of the participants (74.6%) agreed or strongly agreed that residual microorganisms from cavity preparation can be left in it because well-sealed restorations block the carbohydrate supply to bacteria, which stops lesion progression. However, about 20% of dentists responded to these statements incorrectly. Moreover, almost half of the dentists (45.6%) disapproved maintenance of carious tissue near the pulp to avoid pulpal exposure.

Association between dentists' socio-demographic characteristics and the mean of "non-conservative" responses

No statistically significant association was found between years in practice and the mean number of answers considered incorrect ($p=0.128$), based on the current scientific knowledge (Table V). Dentists who graduated from public institutions had a lower mean of non-conservative responses than those who graduated from private schools ($p<0.001$).

Table III - Absolute frequencies (n), relative frequencies (%), and 95% confidence intervals (95%CI) for variables related to strategies and methods for carious tissue removal, and pulp protection materials used for deep carious lesions (n=732)

Variable	n	%	95%CI
Strategies for carious tissue removal			
Stepwise removal of carious tissue	313	42.8	39.2 to 46.4
Selective removal of carious tissue	254	34.7	31.3 to 38.2
Nonselective removal of carious tissue	118	16.1	13.6 to 19.0
Other	47	6.4	4.8 to 8.4
Methods for carious tissue removal			
Hand excavators	359	49.1	45.5 to 52.7
Tungsten carbide burs	100	13.7	11.4 to 16.4
Hand excavators + Tungsten carbide burns	148	20.2	17.5 to 23.3
Diamond burs	124	17.0	14.4 to 19.9
Most used pulp protection material in deep carious lesions without pulpal exposure (considering resin composite as restorative material)			
Only cavity-lining material	258	35.2	31.8 to 38.8
Only cavity base material	100	13.7	11.3 to 16.3
Cavity-lining material + Cavity base material	316	43.2	39.6 to 46.8
Did not use, applies the adhesive directly into the dentine	58	7.9	6.2 to 10.1
Management of minor pulpal exposure (pinpoint exposure) with bleeding in deep carious lesions			
Using calcium hydroxide powder	169	23.1	20.2 to 26.3
Using calcium hydroxide paste	81	11.1	9.0 to 13.5
Using calcium hydroxide cement	35	4.8	3.4 to 6.6
Using calcium hydroxide powder + calcium hydroxide cement	258	35.2	31.8 to 38.8
Using calcium hydroxide paste + calcium hydroxide cement	54	7.4	5.7 to 9.5
Using Mineral Trioxide Aggregate (MTA)	26	3.5	2.4 to 5.2
Pulpotomy or Pulpectomy	109	14.9	12.5 to 17.7

Table IV - Absolute (n) frequencies, relative (%) frequencies, and 95% confidence intervals (95%CI) for variables related to concepts about carious tissue removal in deep carious lesions (n=732)

Variable	N	%	95% CI
"Caries-related microorganisms should be removed completely during cavity preparation, because the permanence of residual bacteria may form a new carious lesion."			
Strongly disagree	253	35.2	31.2 to 38.8
Disagree	209	29.1	25.8 to 32.5
Neither agree nor disagree	32	4.4	3.2 to 6.2
Agree	159	22.1	19.2 to 25.3
Strongly agree	66	9.2	7.3 to 11.5
"Residual microorganisms from the cavity preparation can be left in the cavity because well-sealed restorations block the carbohydrate supply to the bacteria, which interrupts carious lesion progression."			
Strongly disagree	51	7.2	5.6 to 9.4
Disagree	84	12	9.8 to 14.6
Neither agree nor disagree	43	6.1	4.6 to 8.2
Agree	240	34.2	30.8 to 37.8
Strongly agree	283	40.4	36.8 to 44.0
"The carious tissue near the pulp should not be removed in order to avoid pulpal exposure."			
Strongly disagree	152	20.9	18.1 to 24.0
Disagree	180	24.7	21.7 to 28.0
Neither agree nor disagree	32	4.4	3.1 to 6.1
Agree	255	35.0	31.6 to 38.6
Strongly agree	109	15.0	12.5 to 17.8

Table V - Association between socio-demographic, training, and professional activity characteristics of Brazilian dentists and the mean number of incorrect answers regarding the management of carious tissue removal in deep lesions. One-way ANOVA

Variable	Mean ± SD	*p-value*
Age group		
20 to 29 years old	4.76±1.56[a]	0.688
30 to 39 years old	4.77±1.62[a]	
40 to 49 years old	4.97±1.56[a]	
≥50 years old	4.76±1.43[a]	
Type of higher education institution		
Public	4.48±1.48[a]	<0.001
Private	5.13±1.59[b]	
Years in practice		
≤ 5 years	4.76±1.56[a]	0.128
6 to 10 years	4.68±1.62[a]	
11 to 20 years	5.09±1.62[a]	
< 20 years	4.68±1.45[a]	
Highest academic degree completed		
Undergraduate degree in dentistry	4.78±1.50[a]	<0.001
Residency or advanced special training (certification)	5.06±1.54[a]	
Master's or Doctorate degrees	4.32±1.59[b]	
Main sector of professional activity		
Dentist – Public sector	4.48±1.48[b]	<0.001
Dentist – Private sector	5.00±1.57[c]	
Teaching	3.84±1.36[a]	

Note: Different lower-case letters represent statistically significant difference between groups (p<0.05).

Also, dentists with post-graduate studies had more conservative responses (p<0.001), as well as those who work in the public dental service than their counterparts (p<0.001) (Table V).

DISCUSSION

The clinical management of deep carious lesions as well as changes in its paradigm have been discussed in several countries [2,3,13,14]. The present study showed that most Brazilian dentists decide on stepwise removal in cavities involving the inner third of the dentine. This result corroborates with Sales et al. (2020) [8] and diverges from the findings of Weber et al. (2011) [5], both conducted in South Brazil. The latter reported that most dentists (71%) performed complete and nonselective carious tissue removal in permanent teeth and only 17% preferred stepwise removal. This divergence of results between studies is probably due to time. In the last years, less invasive dental procedures have been encouraged to be used by dentists. More invasive approaches in primary or permanent teeth were also reported in studies conducted in Norway and Germany [6,15]. The lack of a consensus regarding the depth of excavation, strategies and appropriate diagnostic criteria for caries removal may have favoured non-conservative practices in the recent past as observed in the aforementioned studies. However, in 2016, a set of clinical recommendations (ICCC) on the management of deep carious lesions in both dentitions was developed, discouraging its complete removal, which may have favoured changes in clinical practices [2,16].

In the present study, almost half of the dentists reported that they do not keep the carious tissue close to the pulp, which may have been reflected in the choice of strategy of carious tissue removal. Although selective removal presents a lower risk of pulpal exposure when compared to stepwise removal, only 34.7% of the dentists point out it. Indeed, dentists are afraid that the remaining carious tissue into the definitive restoration - advocated in the selective removal of carious tissue - could cause postoperative pain, caries progression, and restorative failure [2,9]. However, there is no scientific evidence correlating the permanence of residual carious tissue with

postoperative complications [2]. Selective removal seems to be more advantageous because it is not necessary reopening the cavity, avoiding the possibility of pulpal damage and reducing clinical time and treatment costs [2,17].

It is important to note that there are limitations in the present study. Firstly, the sample was defined according to the availability of the participant, thus being considered a convenience sample. Thus, selection bias can be present in our results. Randomized recruitment of participants would better reflect the knowledge, attitudes and practices about the clinical management of deep carious lesions. Secondly, the questionnaire was not submitted to a previously protocolled validation process, however, a rigorous pre-testing process, described before, was carried out, besides having a language adapted to the routine of the Brazilian dentist. Finally, it is worth mentioning that this study was performed during the COVID-19 pandemic. The use of instruments with aerosols was discouraged due to the risk of the spread of the virus. Therefore, it is possible that more conservative approaches were elected by dentists also due to the reflects of the pandemic in dental practice.

When using instruments and methods to remove carious dentine, 17% of dentists decided for diamond burs while 13% preferred tungsten carbide bur. Currently, there are several methods available for removing carious tissue such as dentine excavators, and metallic polymeric, tungsten carbide, and ceramic burs, air dental abrasion, ultrasonic abrasion, chemical-mechanical method and lasers [2]. The diamond burn is not recommended, as it is ineffective in cutting softened carious tissue. During cavity preparation, its use should be employed to open the cavity accessing the carious lesion [18].

Pulp exposure is a critical point that can result in an unfavourable prognosis [19,20]. For this reason, calcium hydroxide and mineral trioxide material (MTA)-based products are indicated in cases of direct pulp capping in permanent teeth [21]. In the present study, most dentists (81.6%) decided for one of the presentation forms of calcium hydroxide, probably due to the tradition of its use in educational institutions, its low cost, and its ease of application. However, the mineral barrier produced by the calcium hydroxide is porous and does not adhere to the pulp wall, thus generating an inefficient sealing. Moreover, the high solubility generates its dissolution over time, causing spaces between the tertiary dentin and the restorative material that can be easily populated by microorganisms (tunnel defects) [22]. On the other hand, MTA produces a more homogeneous and continuous mineralized barrier, achieving an efficient pulp seal [22,23]. Despite presenting better results, MTA was chosen as a pulp capping material by only 3.5% of the dentists and the main reason for this is probably due to its high cost for most of Brazilian dentists. Besides, this material has been developed during the last twenty years which can be considered little time compared calcium hydroxide that has been used as a pulp-capping agent for over ninety years and is widespread worldwide. Thus, dentists may not be aware of the promising results of MTA.

More conservative approaches were preferred over invasive treatment in case of pulpal exposure during carious tissue removal. Nonetheless, 14.9% of dentists indicate pulpotomy or pulpectomy in the management of minor pulpal exposure. These findings are a source of concern, as according to the European Society of Endodontics statement, invasive procedures that compromise pulp vitality result in tooth loss and elevated treatment costs [21,24].

Previous studies suggest that residual bacteria in properly sealed cavities are deprived of nutrients essential for their survival, which stops lesion progression [2,17,25]. However, approximately half of French, German, and Norwegian dentists disagreed with the permanency of bacteria under restorations fearing a continuity of the lesion and loss of pulp vitality [2]. In the present study, most dentists agreed that residual microorganisms from cavity preparation can remain intothe cavity, which suggests that Brazilian dentists seem to have more conservative decision-making than Europeans regarding caries tissue removal daily in-office protocols

Dentists with post-graduate degrees as well as those from public institutions decided for more conservative approaches. Dentists involved in scientific research tend to follow the scientific literature up more frequently [26]. Brazilian public universities have been responsible for about 95% of Brazil's scientific development and this research activity may influence students to follow the current approaches [27]. Similarly, dentists working in the public sector were more conservative than those in the private sector, probably due to the collaboration between health

agenciesand higher education institutions, in promoting training and refresher courses for dentists working in the Brazilian Public Health System (SUS - acronym in Portuguese) [28]. Another aspect is that in public services dentists feel free to choose treatment, with less market pressure, which can favour choices for conservative treatments. In the same way, access to endodontic treatment in public services in Brazil exists but is restricted, so conservative strategies may be adopted by dentists to avoid the need for treatments of high complexity.

Considering the size of Brazil and its population and diversity, this is important to highlight that this study is the first research with participants from all six Brazilian regions, which makes it extremely relevant to guide educational sectors and actions regarding the current and future Brazilian dentists. At the end of this study, it is clear that the management of deep carious lesions is still controversial among dentists and its theoretical basis is to be widely employed in practice to promote a paradigm change. As the main contribution from this study to future public policies in Dentistry, it is necessary to emphasize the importance of sending the key answer and commentaries based on the updated literature back to the participants, as performed in this study. It is believed that these questions may lead dentists, even the most sceptical, to reflect on the topic and make a change in their daily practice. The questionnaire can be validated in the future and used as a fixed instrument to evaluate the topic in Brazil and in other nations worldwide.

CONCLUSION

In summary, it can be concluded that most of dentists is not aware of the minimally invasive dentistry concepts that represents a drastic change of paradigm and it can take a considerable long time to incorporate those changes into their clinical daily practice. To achieve this goal, the dissemination of more conservative approaches regarding the management of deep carious lesions needs to be strengthened and increased, based on the updated scientific literature.

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Author's Contributions

NOS: Writing – Original Draft Preparation, Methodology. DAC: Methodology. NSR: Conceptualization. MMR: Software. LRMS: Writing – Review & Editing. MBC: Data Curation. FPR: Supervision. VPAS: Project Administration, Funding Acquisition.

Conflict of Interest

No conflicts of interest declared concerning the publication of this article.

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Regulatory Statement

The study was conducted in accordance with all the provisions of the local human subject's oversight committee guidelines and policies of Research Ethics Committee of the Universidade Federal do Ceará, Brazil. The approval code for this study is: 4.277.387.

REFERENCES

1. Kassebaum NJ, Smith AGC, Bernabé E, Fleming TD, Reynolds AE, Vos T, et al. 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;96(4):380-7. http://dx.doi.org/10.1177/0022034517693566. PMid:28792274.
2. Schwendicke F, Frencken JE, Bjørndal L, Maltz M, Manton DJ, Ricketts D, et al. Managing carious lesions: consensus recommendations on carious tissue removal. Adv Dent Res. 2016;28(2):58-67. http://dx.doi.org/10.1177/0022034516639271. PMid:27099358.
3. Maltz M, Moura MS, Jardim JJ, Marques C, De Paula LM, Mestrinho HD. Partial caries removal in deep lesions: 19-30 months follow-up study. Rev Fac Odontol Porto Alegre. 2010;51(1):20-3. http://dx.doi.org/10.22456/2177-0018.16367.
4. Bjørndal L, Larsen T, Thylstrup A. A clinical and microbiological study of deep carious lesions during stepwise excavation using long treatment intervals. Caries Res. 1997;31(6):411-7. http://dx.doi.org/10.1159/000262431. PMid:9353579.
5. Weber CM, Alves LS, Maltz M. Treatment decisions for deep carious lesions in the Public Health Service in Southern Brazil. J Public Health Dent. 2011;71(4):265-70. http://dx.doi.org/10.1111/j.1752-7325.2011.00258.x. PMid:22320284.
6. Schwendicke F, Meyer-Lueckel H, Dörfer C, Paris S. Attitudes and behaviour regarding deep dentin caries removal: a survey among German dentists. Caries Res. 2013;47(6):566-73. http://dx.doi.org/10.1159/000351662. PMid:23899958.

7. Katz CRT, Andrade MRB, Lira SS, Vieira ÉLR, Heimer MV. The concepts of minimally invasive dentistry and its impact on clinical practice: a survey with a group of Brazilian professionals. Int Dent J. 2013;63(2):85-90. http://dx.doi.org/10.1111/idj.12018. PMid:23550521.

8. Sales GC, Marques MG, Rubin DR, Nardoni DN, Leal SC, Hilgert LA, et al. Are Brazilian dentists and dental students using the ICCC recommendations for caries management? Braz Oral Res. 2020;34:e062. http://dx.doi.org/10.1590/1807-3107bor-2020.vol34.0062. PMid:32609231.

9. Alnahwi TH, Alhamad M, Majeed A, Nazir MA. Management preferences of deep caries in permanent teeth among dentists in Saudi Arabia. Eur J Dent. 2018;12(2):300-4. http://dx.doi.org/10.4103/ejd.ejd_397_17. PMid:29988208.

10. Innes NPT, Schwendicke F. Restorative thresholds for carious lesions: systematic review and meta-analysis. J Dent Res. 2017;96(5):501-8. http://dx.doi.org/10.1177/0022034517693605. PMid:28195749.

11. Laske M, Opdam NJM, Bronkhorst EM, Braspenning JCC, van der Sanden WJM, Huysmans MCDNJM, et al. Minimally invasive intervention for primary caries lesions: are dentists implementing this concept? Caries Res. 2019;53(2):204-16. http://dx.doi.org/10.1159/000490626. PMid:30107377.

12. Chisini LA, Conde MCM, Correa MB, Dantas RVF, Silva AF, Pappen FG, et al. Vital pulp therapies in clinical practice: findings from a survey with dentist in Southern Brazil. Braz Dent J. 2015;26(6):566-71. http://dx.doi.org/10.1590/0103-6440201300409. PMid:26963197.

13. Tarek R. Knowledge, attitude, and practice survey of dentists in Palestine toward deep dentin caries removal. Cons Dent Endod J. 2016;1(2):28-32. http://dx.doi.org/10.5005/jp-journals-611-0216.

14. Muller-Bolla M, Garcia A, Aïem E, Doméjean S. Dentists' decisions for deep carious lesions management in primary teeth. Int J Paediatr Dent. 2020;30(5):578-86. http://dx.doi.org/10.1111/ipd.12639. PMid:32189409.

15. Stangvaltaite L, Kundzina R, Eriksen HM, Kerosuo E. Treatment preferences of deep carious lesions in mature teeth: questionnaire study among dentists in Northern Norway. Acta Odontol Scand. 2013;71(6):1532-7. http://dx.doi.org/10.3109/00016357.2013.775338. PMid:23530812.

16. Mackenzie L, Banerjee A. Minimally invasive direct restorations: a practical guide. Br Dent J. 2017;223(3):163-71. http://dx.doi.org/10.1038/sj.bdj.2017.661. PMid:28798466.

17. Ricketts D, Lamont T, Innes NP, Kidd E, Clarkson JE. Operative caries management in adults and children. Cochrane Database Syst Rev. 2013;28(3):CD003808. http://dx.doi.org/10.1002/14651858.CD003808.pub3. PMid:23543523.

18. Baratieri LN, Monteiro JS. Odontologia restauradora: fundamentos e possibilidades. São Paulo: Grupo Editorial Nacional/Editora Santos; 2010.

19. Wells C, Dulong C, McComack S. Vital pulp therapy for endodontic treatment of mature teeth: a review of clinical effectiveness, cost-effectiveness, and guidelines. In: Canadian Agency for Drugs and Technologies in Health, organizer. CADTH rapid response report: summary with critical appraisal. Ottawa: Canadian Agency for Drugs and Technologies in Health; 2019. Online.

20. Bjørndal L, Simon S, Tomson PL, Duncan HF. Management of deep caries and the exposed pulp. Int Endod J. 2019;52(7):949-73. http://dx.doi.org/10.1111/iej.13128. PMid:30985944.

21. Cushley S, Duncan HF, Lappin MJ, Chua P, Elamin AD, Clarke MEL, et al. Efficacy of direct pulp capping for management of cariously exposed pulps in permanent teeth: a systematic review and meta-analysis. Int Endod J. 2021;54(4):556-71. http://dx.doi.org/10.1111/iej.13449. PMid:33222178.

22. Kunert M, Lukomska-Szymanska M. Bio-inductive materials in direct and indirect pulp capping-a review article. Materials. 2020;13(5):1204. http://dx.doi.org/10.3390/ma13051204. PMid:32155997.

23. Tawil PZ, Duggan DJ, Galicia JC. Mineral trioxide aggregate (MTA): its history, composition, and clinical applications. Compend Contin Educ Dent. 2015;36(4):247-64. PMid:25821936.

24. 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;52(7):923-34. http://dx.doi.org/10.1111/iej.13080. PMid:30664240.

25. Paddick JS, Brailsford SR, Kidd EA, Beighton D. Phenotypic and genotypic selection of microbiota surviving under dental restorations. Appl Environ Microbiol. 2005;71(5):2467-72. http://dx.doi.org/10.1128/AEM.71.5.2467-2472.2005. PMid:15870335.

26. Gonçalves APR, Correa MB, Nahsan FPS, Soares CJ, Moraes RR. Use of scientific evidence by dentists in Brazil: room for improving the evidence-based practice. PLoS One. 2018;13(9):e0203284. http://dx.doi.org/10.1371/journal.pone.0203284. PMid:30231035.

27. United Nations Educational, Scientific and Cultural Organization [Internet]. UNESCO science report: the race against time for smarter development; executive summary. Paris: UNESCO; 2021 [cited 2021 March 17]. Available from: https://unesdoc.unesco.org/ark:/48223/pf0000377250

28. Coordination for the Improvement of Higher Education Personnel [Internet]. Research in Brazil: funding excellence. Brasília: Web of Science Group; 2019 [cited 2021 April 22]. Available from: https://jornal.usp.br/wp-content/uploads/2019/09/ClarivateReport_2013-2018.pdf

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