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SELECTIVE REMOVAL OF CARIOUS DENTIN: SCIENTIFIC EVIDENCE VERSUS CLINICAL PRACTICE

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ABSTRACT

It is an integrative review, whose objective was to analyze the demand and use of health services by adolescents. The research was made with articles published from 2013 to 2018, in the English, Portuguese and Spanish languages, through the BVS and PubMed, using the descriptors: adolescent; access to health services; adolescent health services; patient acceptance of health care and health services. Twelve articles were included in the final sample. The percentage of demand and use of health services varied from 22% to 94%. Among the factors considered, the following variables were directly associated with the demand and use of services: female sex, high schooling of the parents, presenting psychosomatic complaints and some behaviors of health risk. Variables inversely associated: not being able to pay for consultation, race black and yellow and have already consulted with a specialist, incases of primary care services.Actions are needed to encourage adolescents belonging to all social groups to seek health care before the onset of disease symptoms.

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INTRODUCTION

The current knowledge on the etiology, progression and management of dental caries has significantly changed diagnostic criteria and treatment modalities. There has been a direct influence of current scientific evidence on clinical procedures, with a greater focus on oral health promotion by preserving dental tissues that can undergo remineralization and by maintaining pulp vitality. For years, the diagnosis of dental caries was based on the mere presence of carious lesions. The lack of scientific knowledge of dentists regarding the multifactorial etiology and behavior of dental caries has led to standardized treatment restricted to extractions and restorations (Laske *et al*., 2019). According to this surgical-restorative model, the diagnosis of cavitated lesions indicates an immediate need for surgical intervention, with the complete removal of all softened dentin and cavity preparation to the full extent of susceptible areas to avoid caries relapse (Elderton, 1985; Weerheijm and Groen, 1999). However, as individualized prevention strategies and health promotion are not considered in this model, it has proven to be inefficient in the control of dental caries (Berkowitz, 2003). The diagnosis of dental caries is currently based on the identification of its etiological factors, determinants and modifiers, whereas its treatment should be individualized, focused on patient awareness of plaque control and the adoption of healthy dietary habits. According to the philosophy of minimally invasive therapy, tooth restoration is only one part of the treatment strategy and should be performed using a more conservative approach, with maximum preservation of dental tissues that can undergo remineralization (Franzon *et al*., 2007; Khokhar and Tewari, 2018). In recent years, technological advances have enabled the use of minimally invasive procedures to treat dental caries. The development of adhesive materials and the discovery of novel carious tissue removal methods have allowed a greater preservation of dental tissues capable of remineralization. A novel carious lesion treatment method was created based on the selective removal of carious

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dentin (SRCD) combined with hermetic sealing of the cavity (Mertz-Fairhurst *et al*., 1979). Different original studies and systematic reviews have addressed the effectiveness of SRCD. The authors concluded that SRCD for deep cavities in asymptomatic primary or permanent teeth reduces the risk of pulp exposure and has no harmful effects to the patient. Moreover, there is no scientific evidence to justify the complete removal of carious tissues. Thus, the selective removal technique should be implemented in daily clinical practice (Khokhar and Tewari, 2018; Mertz-Fairhurst *et al*., 1979; Maltz *et al*., 2002; Ricketts, 2008).Scientific evidence confirms that the remineralization of remaining carious tissue following SRCD occurs due to the interruption of lesion activity through the hermetic sealing of the cavity, regardless of the restorative material (Mertz-Fairhurst *et al*., 1998; Ribeiro *et al*., 1999; Lula *et al*., 2011). Mounting evidence on SRCD and hermetic sealing has been widely published in the literature for over twenty years. Due to its strong emphasis in guidelines proposed by public health authorities, this method has reached a large portion of dentists worldwide. However, there is still a high number of dental professionals who continue to follow the basic principle that has driven surgical dentistry for centuries, that is, the removal of the whole carious tissue (Bjorndal and Larsen, 2000; Oen *et al*., 2007; Thompson *et al*., 2008; Katz *et al*, 2013). It is therefore important to understand why this model continues to be widely accepted despite the available scientific knowledge advocating otherwise. The objective of the present quantitative and qualitative study was evaluate the knowledge and attitudes of dentists working in public healthcare services in the city of Recife, Brazil, on the concepts and practice of minimally invasive dentistry.

MATERIAL AND METHODS

The study sample consisted of dentists working in oral health teams in Primary Care Units (PCUs) in the city of Recife, Northeastern Brazil. The data were collected using two previously validated questionnaires developed by a team of specialists in pediatric dentistry (Katz *et al*., 2013). In Recife, a total of 130 dentists work for the Brazilian public healthcare system in PCUs and are distributed among six city administrative districts. For the quantitative analysis, 109 dentists from all the six districts were interviewed and each response was analyzed individually. Those who reported not having used the SRCD technique or that used it provisionally were selected to participate in a qualitative study group (N = 53). The questionnaires were applied by means of interviews to dentists at PCUs of the Brazilian public healthcare system. The first questionnaire addressed a brief description of a clinical case and contained a photograph followed by a question regarding the treatment approach. The case was of a five-year-old child with a deep carious lesion, with no pulp involvement, periapical lesion, bifurcation lesion or spontaneous pain. The photograph showed a primary molar with a class I cavity that had been submitted to SRCD. This information was also provided in the case description. The examiner read the case and provided standardized explanations, such as a soft, wet consistency and orange coloration compatible with an active carious lesion. After the analysis of the photograph and clarifications, the dentists were asked whether they considered the tooth ready to receive restoration and why. The aim of this question was to evaluate the indication for SRCD in the proposed clinical case.

The second questionnaire was used to collect sociodemographic data from the dentists and to inquiry on the use of SRCD in the public healthcare service. All questions were standardized, and the responses were transcribed in full at the time of the interview by a trained examiner. After the analysis of the interviews, the most repeated responses were grouped into thematic categories for subsequent content analysis. The data were computed using the Statistical Package for the Social Sciences (SPSS, version 23.0). Descriptive and inferential statistics were performed using Pearson's Chi-square and Fisher's Exact tests, with a 5% significance level ($P< 0.05$). This study was approved by the Human Research Ethics Committee at the University of Pernambuco (Brazil) under protocol number 02450112.1.0000.5207. The study was executed in full accordance with the World Medical Association Declaration of Helsinki. All participants received clarifications regarding the study methods and authorized their participation by signing an informed consent form. To ensure anonymity, the fragments of the interviews were identified by codes, with the letter "I" for interviewee, and a number referring to the order of the interviews.

RESULTS

In this study, 109 dentists distributed among six city administrative districts were interviewed using a quantitative approach. A total of 80.7% of the interviewees were women; a high number of them had graduated more than 20 years earlier (45%); the vast majority (94.5%) had attended specialization courses (68.8% in public health), but only 8.3% had a master's or doctoral degree. Overall, 75.2% of the interviewees demonstrated a lack of knowledge on current concepts of dental caries. They had no knowledge regarding the difference between the carious lesion and the disease itself. A total of 62 respondents (56.9%) demonstrated a lack of knowledge regarding the treatment of dental caries, 54 (49.5%) answered that treatment only involved the restorative phase, and 8 (7.3%) answered that treatment was only based on patient orientation. The interviewees who demonstrated knowledge about the treatment of dental caries reported that it should include tooth filling and orientation regarding diet and oral hygiene habits as well as patient motivation and awareness. When asked about the requirements for arresting dental caries, 14.7% answered that it depended on the complete removal of the carious tissue. According to most respondents, arresting dental caries also depended on the choice of the restorative material (79.8%) and on an effective filling (94.5%). A total of 88.1% of the interviewees were aware of SRCD and hermetic sealing of the cavity; the majority (76.1%) of them had performed this technique in their workplace; and 48.6% reported its use as a provisional procedure. Among those who performed SRCD in the workplace, 67.5% applied this technique to any patient, and 44.6% of them considered it eligible for both primary and permanent teeth. As for the dentists who did not perform SRCD, half of them reported not knowing how to do it or were unaware of the technique; 23.1% reported not believing that it was effective; and 26.9% reported that there was a considerable patient demand, which prevented follow up, in addition to lack of or poor quality of materials available at the public oral healthcare service. There were statistically significant associations between the indication for SRCD in the proposed clinical case, definitive or provisional use of the technique, and (non-)implementation reasons (Table 1).

Table 1. Association between selective removal of carious dentin in the proposed clinical case, definitive or provisional use of the technique, and (non-) implementation reasons

	Use of selective removal technique			
Variable	No n (%)	Yes n (%)	Total n (%)	*P*-value
Understanding on the nature of the technique				<0.001[2]
Definitive	16 (28.6)	40 (71.4)	56 (100.0)	
Temporary	44 (83.0)	9 (17.0)	53 (100.0)	
Use of the technique in dental office				<0.001[1]
Yes	36 (43.4)	47 (56.6)	83 (100.0)	
No	24 (92.3)	2 (7.7)	26 (100.0)	
Reasons for (non-)implementation				<0.001[1]
Does not consider it to be effective	7 (100.0)	0 (0.0)	7 (100.0)	
Unaware of technique or lack of knowledge on how to do it	11 (84.6)	2 (15.4)	13 (100.0)	
Lack of patient follow up or lack of adequate material	7 (100.0)	0 (0.0)	7 (100.0)	
Considers the technique to be effective	35 (42.7)	47 (57.3)	82 (100.0)	
TOTAL	60 (55.0)	49 (45.0)	109 (100.0)	

[1] Fisher's Exact test
[2] Pearson's Chi-square test

Table 2. Interviewees' responses in the qualitative analysis grouped into four thematic categories

GROUP	Examples of what was reported
Disbelief in the partial removal technique	
	"No, because the carious tissue was not completely removed... I only perform this in cases of temporary restorations in which the patient is uncooperative."
	"I don't practice partial removal because I don't have the courage to do so."
	"No, because the cavity could become aggravated..."
Continued philosophy of restorative surgical model	
	"No, because I learned it this way and I believe that one has to remove all softened tissue."
	"Yes... in some cases ... with trepidation after the course... in practice, I remove all softened tissue."
	"(...) leaving dental caries is unacceptable!"
Confusion of techniques linked to the use of materials	
Use of glass ionomer cement	
	"No... based on clinical experience and due to questions with regard to remineralization."
	"Only if the material were glass ionomer cement... the only material that can be used in cases of partial removal; it releases fluoride... in cases of amalgam or resin... complete removal... if there is enough time and if the patient is cooperative... I perform complete removal."
	"With atraumatic restorative treatment... dentin with the possibility of repair... I would not do it with resin... it does not have the property of regenerating the pulp."
Low quality of the material available in the public healthcare system	
	"No, because the material at the public service does not provide a hermetic sealing."
	"No, due to the inadequate material at the service."
	" (...), but with reservation due to the seal... we don't always have the necessary conditions for this."
Technique associated with pulp protection using calcium hydroxide	
	"No... for definitive restoration, I would remove more carious tissue... my action would be capping with ionomer cement, waiting about 60 days and reopening the cavity for the complete removal of carious tissue."
	"No... temporary cavity preparation and I ask the patient to wait."
	"No. Expectant treatment, followed by restoration or I would perform complete removal for a definitive restoration."
	"Yes... temporarily... to see the reaction... more or less five years...depending on the reaction, I reopen and remove the rest of the dentin."
The use of the method restricted by the work environment	
	"No... I don't believe in the technique... the technique depends on other factors... oral hygiene, diet... in public service, I don't know when a patient is going to return. Therefore, I perform the complete removal of carious tissue... If it were a private practice, I would remove only the softened dentin and I would perform the restoration with glass ionomer cement... I follow up the case for six months."
	"No... due to the conditions at the public service... I am aware of the technique, but I don't perform it in practice due to the work environment... the context of the patient involved... I have no control over the oral hygiene or dietary habits of the patient... and the material at the service is not ideal."

Most of the interviewees who reported that they would not indicate the SRCD in the proposed clinical case also considered the technique to be a provisional procedure and did not use to do it in the PCUs. Considering the explanations for use or non-use of the SRCD procedure in the clinical case, 57.3% of the interviewees in favor of SRCD recommended the technique for the proposed clinical case against 42.7%, whom stated otherwise. Moreover, among those who reported that they would use the SRCD in the clinical case, 15.4% admitted not knowing how to do it.

Among the 109 dentists initially interviewed, 53 (48.6%) reported that they would not indicate the SRCD for the proposed clinical case, did not use this technique in their daily work or would use it only as a provisional measure. These dentists were selected to participate in the qualitative analysis (Table 2). This was a representative group of all dentists working in public healthcare services in the city of Recife (42% of the total of 130 registered dentists). In this group, 88.2% (n = 45) reported having previous knowledge about the SRCD technique; their age ranged from 26 to 65 years, with a

mean age of 45.0 years; most were women (77.4%), with over 20 years of experience since graduation (54.7%), and were specialists (92.5%) – most of them were specialists in public health (62.3%); only 3.8% had a postgraduate degree and 66.0% had not attended any refresher course.

DISCUSSION

The analysis of the interviewees' responses resulted in four thematic categories, which are described and discussed below.

Disbelief in the selective removal technique: The analysis of the interviewees' profiles reveals a group of dentists with vast clinical experience, as most of them had graduated 20 years earlier. These interviewees were part of a group with considerable responsibility for dental caries management in the PCUs. Moreover, these individuals worked in oral health teams in Northeastern Brazil, an area with a greater demand for dental care as compared to others across the country (Ministry of Health of Brazil, 2012). Consistent with previous reports (Bjorndal and Larsen, 2000; Oen *et al*., 2007; Thompson *et al*., 2008; Katz *et al*., 2013), most interviewees in this study did not believe in the SRCD technique and would only do it as a provisional procedure.

Continued philosophy of the restorative surgical model: The disbelief in the SRCD technique has been linked to the restorative surgical model philosophy, which still drives clinical practice. The restorative surgical models is governed by the principles proposed by Black, who categorically stated in 1908 that, in the interest of meticulous, scientific dental practice, no carious or softened material should be left in any case. Thus, dentinal tissue would only be adequately ready to receive restorative material when resistance to probing was enough to promote the "sound of healthy dentin"(Black, 1908). For many years, such concepts were considered basic commandments in dental practice. Black's concepts reigned over restorative dentistry for a long time, engraining the idea in the minds of both dentists and the public that leaving carious tissue on a tooth constituted negligence, which leads many dentists to overlook rules that have ever since been established and recognized. Despite the technical and scientific advances on the understanding of caries progression and development and the changes suggested in terms of treatment to remove the least amount of sound dental tissue, the present findings demonstrate that many dentists have not followed up this evolution and remain reluctant to accept the precepts of minimally invasive dentistry. This attitude may be justified by the fact that complete carious tissue removal remains part of the academic background of dentists, and many of them have not based their clinical practice on scientific evidence through constant updating. Moreover, the science of cariology and the technical details of operative dentistry are taught and researched separately in several dental schools. Black's concepts were very important to the knowledge-building process of dental caries. Although centered on treatment, Black also made various incursions into the field of prevention and suggested ways to avoid caries development. He further predicted that in a not-too-distant time, the development of dental caries would be more fully understood and new concepts would arise (Hamama, You, Burrow, 2015). In Black's time, the concepts were created considering the size of the instruments as well as the available materials. Current knowledge and new adhesive dental materials have provided the possibility of a more conservative treatment for dental caries. Thus, scientific evidence in the new era has changed concepts, which should be assimilated by dentists. There is an evident need to establish strategies to encourage the use of SRCD combined with hermetic sealing of cavities to provide less invasive treatment options for the management of dental caries. Moreover, there is a need for a change with regard to the way practical issues are approached, with the replacement of personal opinion-driven conducts by evidence-based ones.

Confusion of techniques linked to the use of materials: A high number of interviewees were unaware of the indication for SRCD combined with hermetic sealing, questioned their effectiveness and confused them with other techniques, such as atraumatic restorative treatment. Many reported the mandatory use of glass ionomer cement for the success of the technique. This confusion of concepts and techniques and the low quality of the material available in the PCUs in the city of Recife may render SRCD unviable, according to the interviewees. Several studies have been conducted on the selective removal of carious dentinal tissue combined with hermetic sealing of cavities. These studies showed that the sealing itself inactivates the lesion, regardless of the restorative material. The reduction or inactivation of bacteria is explained by the lack of access to substrate for metabolism. Thus, the success of the selective removal technique depends mostly on the hermetic sealing of the cavity rather than on restorative material properties (Mertz-Fairhurst *et al*., 1998; Ribeiro *et al*., 1999; Bjorndal and Larsen, 2000; Maltz *et al*., 2007). The SRCD technique was also confused with expectant treatment. Despite the scientific evidence on the advantages single-step SRCD, many dentists would only perform this technique combined with pulp protection using calcium hydroxide to determine the pulp response over time, followed by a second intervention. The originally proposed SRCD technique was based on expectant treatment with the use of topical medications, which was expected to lead to the remineralization of the remaining dentin within a period of 60 days (Fusayama, 1970). Thus, there would be the need for a second intervention for the removal of the remaining carious tissue and cavity preparation without risking pulp exposure. The idea to transform this temporary procedure into a definitive one, with restoration in the same session and no need for a second intervention, has been extensively studied and is currently the most widely accepted practice(Mertz-Fairhurst *et al*., 1979; Oliveira *et al*., 2006). Thus, SRCD followed by hermetic sealing in a single step is indicated for deep carious lesions in asymptomatic primary or permanent teeth, with a reduced risk of pulp exposure and simplification of treatment(Ranly and García-Godoy, 2000; Rickets, 2001; Uribe, 2006).

The use of the technique is restricted by the work environment: The use of the SRCD technique is restricted by the work environment due to the inconsistency of patient follow up through regular visits and to the context in which patients use public healthcare services. As a norm, the patient's background should be considered when evaluating the possibility of a given treatment. However, the need for SRCD in a specific clinical case should be the determinant factor for the implementation of this technique. Some definitions have been reformulated over the past one hundred years in dentistry, resulting in changes in clinical practice due to the evolution of scientific knowledge, dental instruments and materials. The present findings show that the dentists interviewed do not believe in SRCD and demonstrate a lack of

understanding due to outdated concepts. These attitudes could negatively impact the control of dental caries, with the use of unnecessary procedures, which could lead to a repetitive cycle of restorations and compromise the ability of public services to resolve cases. The dentists interviewed proved to be outdated on the concepts of minimally invasive dentistry. Despite the implementation of the Family Health Strategy in the Brazilian public healthcare system, which was established with a focus on health promotion, conventional treatment with invasive interventions continues to be practiced. Most of the dentists interviewed were aware of SRCD and hermetic sealing of the cavity. However, a significant number of interviewees did not perform these procedures due to a disbelief in the effectiveness of the technique. Thus, despite demonstrating scientific knowledge, such understanding is not being used for the benefit of the patients, as many dentists continue to remove the whole carious tissue. It is therefore suggested that investments be made to update and capacitate dentists about current concepts on cariology, thereby encouraging them to adopt minimally invasive procedures.

Conclusions

Based on the present findings, the following conclusions can be drawn:

- The dentists interviewed did not believe in the selective removal of carious dentinal tissue and demonstrated a lack of understanding due to outdated concepts. They were also outdated about the concepts of minimally invasive dentistry.
- While most of the dentists interviewed were aware of the selective removal of carious dentinal tissue and hermetic sealing of the cavity, many of them did not perform these procedures due to a disbelief in the effectiveness of the technique.

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