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SUMMARY

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EDITORIAL

The main purpose of the Naval Dental Journal is to promote the dissemination of knowledge by making scientific research accessible to all dentists. It is a channel for the publication of clinical studies and literature reviews, which occupies the honorable second position among the most accessed periodicals of the Brazilian Navy. Based on this satisfaction, we invite our readers to get to know the second issue of the 49th edition of RNO, which features six scientific articles, being two original articles, one clinical case report and three literature reviews.

The first original article evaluates the knowledge of an Intensive Care Unit (ICU) nursing team regarding oral hygiene in critically ill patients under hospitalization and, based on this evaluation, the authors prepared an educational flyer aiming to improve the knowledge of the professionals. The second article brings a study on the cut resistance of new scalpel blades, after use and cleaning with different methods.

The case report addresses an endodontic treatment accomplished after root canal obliteration and pulp necrosis, resulting from dental trauma, in which, after a 3-year follow-up, it was possible to observe periapical tissues healing.

Finally, we present three literature review articles: the first one about the percentage of yttrium in the composition of monolithic zirconias and the influence on their properties; the second one expose different approaches to control orofacial pain in patients with head and neck cancer in palliative care; and finally, one about the lean healthcare methodology and its applicability in dentistry, regarding to the implementation of management processes in clinics, offices, and hospitals.

I would like to take the opportunity to congratulate the authors of the studies published here, thanking them for their preference in choosing Naval Dental Journal, as well as their perseverance and merit in fulfilling such a noble vocation, which is the dissemination of scientific knowledge.

I would also like to express my gratitude to the members of the Editorial Board and Reviewers who, with a selfless spirit and remarkable professionalism, have worked hard to improve the information contained in the manuscripts, striving for excellence in every detail.

I wish you all an excellent and rewarding reading!

TERESA CRISTINA PEREIRA DE OLIVEIRA
Commander
Editor in chief

ORIGINAL ARTICLE

EDUCATIONAL INTERVENTION IN A NURSING TEAM ON ORAL HYGIENE OF CRITICALLY ILL PATIENTS IN AN INTENSIVE CARE UNIT

INTERVENÇÃO EDUCATIVA EM UMA EQUIPE DE ENFERMAGEM SOBRE HIGIENE BUCAL DE PACIENTES CRÍTICOS NA UNIDADE DE TERAPIA INTENSIVA

Milena Rayane de Andrade Teixeira[1], Michelline Cavalcanti Toscano de Brito[2], Sabrina Sales Lins de Albuquerque[2], Ângelo Brito Pereira de Melo[2]

ABSTRACT

Ventilator-associated pneumonia (VAP) is a type of recurrent infection in critical patients admitted to the Intensive Care Unit (ICU) and has high morbidity and mortality rates. Its pathogenesis results from the introduction of oral microbiota bacilli passed from the orotracqueal tube to the lower respiratory tract, functioning as a potential reservoir of infectious material. The aim of this study is to assess the knowledge of an ICU nursing team on oral hygiene (OH) in critically ill patients under hospitalization and, from the data obtained, to elaborate an informative material on the main issues pointed out. It is an exploratory, descriptive and quantitative study carried out in two stages: the application of a questionnaire to analyze the team's knowledge on oral hygiene methods as a measure of disease prevention; and the preparation of an educational booklet with approaches on the subject in order to inform and update the participants. We counted with the collaboration of 65 professionals, mostly female and aged between 31-40 years. As for oral hygiene in patients under mechanical ventilation, most of the participants answered that they had not received information on the subject during professional training, as well as not having knowledge of the protocol for these procedures in the institution they were working. All of them agreed that oral hygiene is important in critically ill patients. However, the majority did not associate it with the prevention of VAP. Thus, the implementation and supervision of interdisciplinary actions to promote oral health in critically ill patients under hospitalization is capable of promoting a standardized conduct, as well as better care for the individual admitted in the ICU.

Keywords: Ventilator-associated pneumonia; Intensive Care Unit; Patient care team; Oral hygiene; Health education.

RESUMO

A pneumonia associada à ventilação mecânica (PAVM) é um tipo de infecção recorrente em pacientes críticos sob internação na Unidade de Terapia Intensiva (UTI) e apresenta altos índices de morbimortalidade. Sua patogênese decorre da introdução de bacilos da microbiota oral passados do tubo orotraqueal para o trato respiratório inferior, funcionando como um potencial reservatório de material infeccioso. O objetivo desse estudo foi avaliar os conhecimentos de uma equipe de enfermagem de UTI sobre a Higiene Bucal em pacientes críticos sob internação e, a partir das informações obtidas, elaborar um material informativo sobre as principais questões apontadas. Foi um estudo exploratório, descritivo e quantitativo realizado em duas etapas: a aplicação de um questionário para analisar os conhecimentos da equipe sobre os métodos de higiene bucal, como medida de prevenção da enfermidade; e a elaboração de um folheto educativo com abordagens sobre o tema, no intuito de informar e atualizar os participantes. Obteve a colaboração de 65 profissionais, em sua maioria do sexo feminino e da faixa etária entre 31-40 anos. Sobre a higiene bucal no paciente em ventilação mecânica, a maior parte respondeu não ter recebido informações sobre o tema durante a formação profissional, bem como não ter conhecimento do protocolo destinado a este procedimento na Instituição de trabalho. Em sua totalidade, consideraram importante a higiene bucal em pacientes críticos. No entanto, a maioria não a associou com a prevenção de PAVM. Assim, a implantação e supervisão de ações interdisciplinares de promoção à saúde bucal em pacientes críticos sob internação é capaz de promover uma conduta padronizada e uma melhor assistência ao indivíduo na UTI.

Palavras-chave: Pneumonia associada à ventilação mecânica; Unidade de Terapia Intensiva; Equipe de assistência ao paciente; Higiene bucal; Educação em saúde.

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INTRODUCTION

Ventilator-associated pneumonia (VAP) is a healthcare-associated infection (HAI) that represents a prolonged hospital stay and high hospital expenses for patients in Intensive Care Units (ICUs) (1-6). It affects the pulmonary parenchyma from 9% to 27% of patients on mechanical ventilation (MV) (7), mainly male patients (8), and is a therapeutic challenge given it presents a mortality risk of 8.1% to 31.9% (9), reaching the mark of 50% in some cases (10). Its pathogenesis results from the introduction of oral microbiota bacilli passed from the orotracqueal tube to the lower respiratory tract, functioning as a potential reservoir of infectious material (6,11,12).

Oral bacteria in a mechanically ventilated patient may become more virulent after 48 hours of orotracheal intubation (3,10,13), and the extravasation and aspiration of secretions reaching the lungs are the main triggers of VAP (1,4,6,11,12). Each day of MV stay corresponds to a 1% to 3% risk of occurrence, with the first five days being those with the highest risk of occurrence. However, agents with a multidrug-resistant profile predominate in late-onset pneumonia (3), and *Acinetobacter baumannii* is the the most commonly found in cases (5,14).

Samples collected from dental and lingual biofilm reveal a 63% presence of microorganisms formed in the connection of the humidifier in intubated patients and the highest frequencies found as a source of colonization are associated with Gram-negative bacilli, responsible for about 60% of pneumonias (15), such as *Pseudomonas aeruginosa (5,13), Acinetobacter spp, Staphylococcus aureus, Enterobacter spp, Proteus mirabiis, Klebsiella pneumoniae, Escherichia colli, (5,15) and Acinetobacter baumannii* (13,15). Moreover, periodontal pathogens such as *Pseudomonas aeruginosa, Staphylococcus aureus, and Porphyromonas gingivalis* were common to both environments (16).

Among the main risk factors that trigger VAP are: longer MV stay; underlying disease; unplanned extubation; nasoenteral tube diet with gastric positioning; previous antibiotic therapy; and tracheostomy (17). Hence, the adhesion to a set of infection prevention actions – bundle - by means of measures such as elevation of the headboard to 30º/40º; daily assessment of sedation and performance of weaning protocols; cuff pressure checks every 8 hours and maintenance between 20-30 cm/HO; hand washing; and oral hygiene (OH) with chlorhexidine are indicated as attention conditions to VAP (7,13,18, 17, 19).

In this context, the nursing team plays an important role in care related to the use of MV in the ICU, as well as in the control and prevention of infections (18,17,20,21). It is fundamental to implement standardized protocols and conducts that contribute to the better adhering of professionals to care practices in ICUs (14,17,18,19) for preventing the effects of a poor OH and, therefore, the incidence of VAP (2,17,21,22). Thus, the aim of this study is to assess the knowledge of an ICU nursing team on OH in critically ill patients under hospitalization and, from the data obtained, to elaborate an informative material on the main issues pointed out.

METHODS

This is an exploratory, descriptive, and quantitative study carried out with nursing professionals of the ICU of the University Hospital Lauro Wanderley (HULW) in João Pessoa, Paraíba, Brazil, between 2016 and 2017. The ICU has an adult general profile and assists clinical and surgical patients. The research was approved by the Research Ethics Committee of HULW under CAAE (Certificate of Application for Ethical Appraisal) 51758815.8.0000.5183. All of the participants signed an Informed Consent Form elaborated in compliance with CNS (National Health Council) Resolution no. 466 dated 2012. We included ICU nurses and nursing technicians who were available to participate and excluded professionals that, due to vacation, service scales, or work demands, were not available to collaborate.

The study was divided into two stages. The first one being the application of a questionnaire that was elaborated by the authors in order to assess the knowledge of the nursing team from the ICU on OH in critically ill patients under hospitalization. The questionnaire consisted of the following variables: gender; age; working time; professional category; specialization course; working time in the ICU; VAP triggering mechanisms; receiving guidance on OH orientations during vocational training; importance of the procedure; OH routine in the institution; presence of protocol; optimal frequency of achievement; materials used; and the relationship between OH and VAP. Secondly, an educational intervention was carried out through the elaboration and distribution of an educational booklet with approaches on the subject to inform and update the participants, illustrating the main answers and divergences obtained in the questionnaire. Microsoft Word® and Canva_1689 ®were used to make the informative booklets. The questionnaires and informative booklets addressed a content based on the standardization of the OH technique for critically ill patients under hospitalization of the SOP (Standard Operational Procedure) ellaborated by the AMIB (Brazilian Society of Intensive Care) (23) (Figure 1).

UNIVERSIDADE FEDERAL DA PARAÍBA – UFPB
HOSPITAL UNIVERSITÁRIO LAURO WANDERLEY – HULW
RESIDÊNCIA INTEGRADA MULTIPROFISSIONAL EM SAÚDE HOSPITALAR – RIMUSH
ÊNFASE EM ATENÇÃO AO PACIENTE CRÍTICO
NÚCLEO DE ODONTOLOGIA

ORAL HYGIENE IN CRITICALLY ILL PATIENTS UNDER HOSPITALIZATION – A PREVENTION MEASURE FOR VENTILATOR-ASSOCIATED PNEUMONIA – VAP

Resident: Milena Rayane de Andrade Teixeira
RIMUSH – 2017
(2021 update version)

WHAT IS VAP?

VENTILATOR-ASSOCIATED PNEUMONIA (VAP) IS AN INFFECTION THAT AFFECTS THE PULMONARY PARENCHYMA OF 9% TO 27% OF PATIENTS ON MECHANICAL VENTILATION (MV) (1). IT OCCURS, MAINLY, DUE TO THE ASPIRATION OF ORAL MICROBIOTA BACILLI PASSED FROM THE OROTRACQUEAL TUBE TO THE LOWER RESPIRATORY TRACT, WHICH FUNCTIONS AS A POTENTIAL RESERVOIR OF INFECTIOUS MATERIAL (2,3).

STANDARD OPERATIONAL PROCEDURE - SOP

OBJETIVOS:

- ✓ ORAL HYGIENE ROUTINE BY A MULTIPROFESSIONAL TEAM – NURSING AND DENTISTRY (4).

RECOMMENDED MATERIALS/DRUGS/ EQUIPMENTS/INSTRUMENTS:

- ✓ PPE: APRON, DISPOSABLE MASK AND CAP, PROCEDURE GLOVES, HARD HAT, GOGGLES, CLOSED-TOE SHOES;
- ✓ TOOTHBRUSH (SMALL HEAD AND SOFT BRISTLES);
- ✓ TONGUE SCRAPER (OPTIONAL);
- ✓ TWEEZERS; GAUZE PAD;
- ✓ SUCTION PROBES;
- ✓ SWAB SPONGE;
- ✓ 10 ML OF 0.12% AQUEOUS CHLORHEXIDINE DICLUGONATE SOLUTION;
- ✓ DISPOSABLE CUP/RECIPIENT;
- ✓ SALINE SOLUTION 0.9%;
- ✓ LIP MOISTURIZER (4)

PROCEDURES PERFORMED BEFORE ORAL HYGIENE

- ✓ PERFORM THE EXTRA- AND INTRAORAL ASSESSMENT (HARD AND SOFT TISSUES);

√ OBSERVATION OF SALIVARY CHANGES (HIPO- AND HIPPERSALIVATION);
√ DENTAL MOBILITY, BLEEDING, TRAUMATIC AND INFECTIVE LESIONS OF MUCOUS MEMBRANES, LIPS OR PERIBUCAL EDEMA;
√ DETECTION OF THE PRESENCE OF TEMPORARY ORTHOSES/DENTAL PROSTHESIS OR OCCLUDERS, PROCEEDING WITH THEIR REMOVAL BEFORE STARTING ORAL HYGIENE;
√ CLEANNING THE PROSTHESES WITH 0.12% CHLORHEXIDINE AND DELIVERING THEM TO THE PATIENT'S FAMILY OR THE NURSING TEAM. REGISTERING THE NAME OF THE PERSON THAT RECEIVED THE PROSTHESES IN THE MEDICAL RECORD;
√ EVALUATION OF POSSIBLE NEED FOR DENTAL INTERVENTION (4).

ORAL HYGIENE PROTOCOL:

1. PERFORM THE ASPIRATION OF BOTH THE ORAL CAVITY AND OROPHARYNX;
2. OBSERVE IF THE OROTRACHEAL TUBE IS CORRECTLY POSITIONED BEFORE PERFORMING THE ORAL HYGIENE;
3. POSITION THE PATIENT BY KEEPING THE HEADBOARD ELEVATED (FROM 30º TO 45º) AND LOWER SIDE GRID ON THE WORKING SIDE UNLESS IT IS NOT INDICATED BY THE MULTIDISCIPLINARY TEAM.
4. SOAK THE GAUZE IN NON-ALCOHOLIC CHLORHEXIDINE FOR DEBRIS REMOVAL;
5. CLEAN THE TEETH WITH GAUZE AND SPATULA, BRUSH, OR SWAB SOAKED IN AQUEOUS SOLUTION OR 0.12% CHLORHEXIDINE DIGLUCONATE GEL;
6. USE 20 ML SYRINGES WITH PLUNGER AS A RUBBER MOUTH OPENER (IT SHOULD BE ATTACHED TO THE DENTAL FLOSS FOR AVOIDING ACCIDENTAL SWALLOWING) OR A SET OF STERILE WOODEN SPATULAS WRAPPED IN GAUZE, MASKING TAPE, AND GLOVES, IF NECESSARY;
7. WRAP THE GAUZE IN THE FINGERS MOISTENED WITH 0.12% CHLORHEXIDINE SOLUTION (OR THE TONGUE SCRAPER) AND SIDE, SCRAPING THE TONGUE, THE VESTIBULES, CHEEKS, PALATE, AND GUMS OF BOTH DENTAL ARCHES;
8. PERFORM SWEEPING MOVEMENTS FROM THE GUMS TOWARDS THE TEETH, SMOOTHLY AND REPEATEDLY, THROUGH THE BUCCAL AND LINGUAL FACES OF ALL TEETH AND CHEWING SURFACES. FOR EDENTULOUS PATIENTS, SANITIZE THE GINGIVAL RIDGE;
9. CLEAN THE OROTRACHEAL TUBE WITH GAUZE SOAKED IN 0.12% CHLORHEXIDINE SOLUTION;
10. ASPIRATE THE ORAL CAVITY AND OROPHARYNX AGAIN;
11. REHYDRATE THE LABIAL MUCOSA;
12. DISPENSE CONTAMINATED MATERIAL IN AN ADEQUATE PLACE;
13. TURN OFF THE ASPIRATING TOOL AND LIFT THE SIDE GRID;
14. WASH YOUR HANDS;
15. UPDATE THE PATIENT'S PROGRESS IN THE CLINICAL RECORD (4).

ORAL HYGIENE IS ABLE TO PREVENT THE ADVANCE OF BACTERIA FROM THE ORAL CAVITY TO THE RESPIRATORY TRACT! IT IS CRUCIAL TO REDUCE VENTILATOR-ASSOCIATED PNEUMONIA (VAP) (2,3).

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Figure 1 - *Diagramming of the booklet on description of SOP for OH.*
Source: Based on the AMIB SOB and adapted by the authors. João Pessoa, Paraíba State, Brazil. AMIB Update, 2021.

The data obtained were tabulated and analyzed by the Statistical Package for Social Sciences (SPSS) software, version 26.0, for Windows, using descriptive statistics. The population included 78 individuals, from which a simple random probabilistic sample of 65 professionals was extracted according to the sample calculation with sampling error of 5% and a confidence level of 95% according to an online calculator (24).

RESULTS

We randomly included 65 professionals: 14 nurse assistants and 51 nursing technicians distributed in the different work shifts (alternate morning, afternoon, and night). The completion of the instrument had an estimated time of 10 minutes for each participant and was performed during the work shift. The participants were mainly female and aged between 31-40 years. As for the professional category, the majority of the participants were nursing technicians (Table 1).

TABLE 1 - PARTICIPANTS' PROFILE.

VARIABLES	SAMPLE (n = 65)	
	n	%
Sex		
Male	20	30.7
Female	45	69.3
Age group (years)		
20-30	10	15.4
31-40	29	44.6
41-50	16	24.6
51-60	8	12.3
61-70	2	3.1
Professional category		
Nurses	14	21.4
Nursing technicians	51	78.6

Regarding working time, most professionals reported having more than five years of professional experience. Nonetheless, as for the period of work in the ICU, most nurses reported having provided care for more than five years in the sector, while technicians reported having from one to five years of experience in the ICU. Regarding professional updating (i.e., engaging in specialization or improvement courses), there was a predominance of having engaged in some course in the group of nurses. Nursing technicians, on the other hand, did not (Table 2).

TABLE 2 - WORKING TIME, TIME SPEND IN ICU, UPDATING, AND COURSES.

VARIABLES	NURSES (n = 14)		NURSING TECHNICIANS (n = 51)	
	n	%	n	%
Working time (years)				
<1	0	0	0	0
1-5	4	28.5	18	35.3
>5	10	71.5	33	64.7
Working time in ICU (years)				
<1	3	21.4	12	23.5
1-5	4	28.6	24	47
>5	7	50	15	29.5
Update on specialization courses Improvement				
Yes	13	92.9	24	47
No	1	7.1	27	53
Specialization/improvement courses				
Audit in Nursing	1	7.1	0	0
Hemodialysis	0	0	1	2
Family Health	1	7.1	1	2
Public Health	0	0	1	2
Wounds and Dressings	1	7.1	2	4
Surgical Instrumentation	0	0	2	4
Workplace Safety Nursing	4	28.6	3	5.9
Cardiology Nursing	2	14.3	1	2
Urgencies and Emergencies	2	14.3	3	5.9
ICU Nursing	6	42.9	8	15.7
Nephrology Nursing	1	7.1	2	4
Hemodynamics Nursing	1	7.1	1	2
Public Health Management	2	14.3	0	0

Regarding OH in critically ill patients under hospitalization, all participants stated that it is important to perform the procedure in the ICU. Although more than one response has been reported, most have associated this care with the prevention of the spread of infections in the oropharynx. However, concerning guidelines on the oral health theme during vocational training, both nurses and nursing technicians reported not having received information on the subject. When asked which patient this procedure is most important to, most of the group answered that it is important for all, regardless of severity or type of invasive support (Table 3).

TABLE 3 - IMPORTANCE OF OH IN CRITICALLY ILL PATIENTS.

VARIABLES	NURSES (n = 14)		NURSING TECHNICIANS (n = 51)	
	n	%	n	%
Consider OH important				
Yes	14	100	51	100
No	0	0	0	0
Importance of OH in critically ill patient				
Well-being state	3	21.4	9	17.6
Better oral health	8	57.1	8	15.7
Prevention of oral cavity infection	7	50	15	29.4
Prevention of infections in oropharynx	13	92.9	24	47
Guidance during vocational training				
Yes	4	28.5	11	21.6
No	10	71.5	40	78.5
Important for invasively supportive patient				
Via oral route	0	0	0	0
Via nasoentereal probe	0	0	0	0
Nasoenteral probe and orotracheral tube	4	29	4	7.9
All patients	8	57.1	47	92.2

Regarding the routine of OH at the institution, nurses and nursing technicians reported having knowledge of the routine. Though, the majority of the sample group stated that they did not have information about the protocol for this procedure. As for the frequency of performance, both categories (i.e., nurses and nursing technicians) stated that the ideal frequency of OH is three times a day. Among the material used, all of the professionals mentioned the use of personal protective equipment (PPE), followed by aqueous solution of chlorhexidine digluconate at 0,12% (Table 4).

TABLE 4- ROUTINE, PROTOCOL, FREQUENCY, AND MATERIALS USED FOR OH IN CRITICALLY ILL PATIENTS.

VARIABLES	NURSES (n = 14)		NURSING TECHNICIANS (n = 51)	
	n	%	n	%
Knows the OH routine for critically ill patients				
Yes	8	57.2	43	84.3
No	6	42.9	8	15.7
OH frequency for the critically ill patient				
1/day	3	21.4	3	5.9
2/day	3	21.4	9	17.8
3/day	5	35.7	28	55
4 or more/day	3	21.4	11	21.2
Knows the institution's OH protocol				
Yes	4	28.5	4	7.8
No	9	64.3	45	88.2
Unanswered	1	7.2	2	4
Materials used to carry out OH				
PPE	14	100	51	100
Toothbrush	8	57.1	35	68.6
Tongue scraper	4	28.6	24	47
Gauze	14	100	37	72.5
Suction system	7	50	25	49
Aqueous chlorhexidine digluconate solution 0,12%	10	71.4	37	72.5
Disposable cup/container	8	57.1	37	72.5
Lip moisturizer	10	71.4	37	72.5
Wooden spatula	10	71.4	27	53
Toothpaste	8	57.1	35	68.6
Saline solution/distilled water	4	28.6	14	39.2

As for the knowledge related to VAP, nurses and nursing technicians cited as the main trigger mechanism the aspiration of contamined secretion from the oral cavity and oropharynx. Most nurses related OH to the prevention of systemic infections, such as bacterial endocarditis and sepsis. The nursing technicians linked OH with maintaining the healthy state of the mouth, teeth, gums, and lips (Table 5).

TABLE 5 - MAIN TRIGGERING MECHANISM OF VAP AND THE RELATIONSHIP OF OH WITH THE CRITICALLY ILL PATIENT.

VARIABLES	NURSES (n = 14)		NURSING TECHNICIANS (n = 51)	
	n	%	n	%
Main VAP triggering mechanism				
Reflux of the gastrointestinal tract	0	0	11	21.6
Aspiration of mouth and oropharynx secretion	10	71.4	24	47
Hematogenous dissemination	0	0	2	3.9
Exogenous inoculation of contaminated material	4	28.6	12	23.6
Person to person transmission	0	0	0	0
Not answered	0	0	2	3.9
Relationship of OH with the critically ill patient				
Comfort and well-being	0	0	0	0
Bacteria disposal	2	14.3	5	9.8
Healthy state of mouth, teeth, gums, and lips	3	21.4	21	41.1
VAP prevention	3	21.4	11	21.6
Prevention of bacterial endocarditis and sepsis	6	42.9	14	27.5

DISCUSSION

VAP is the most common nosocomial pneumonia that occurs among patientd admitted to ICUs (25). The MV bundle implementation during nursing care, through a set of practices based on scientific evidence for the control of hospital infection and better prognosis of the patient, seems to be the strategy adopted for the prevention and control of possible adverse events (17,19).

The study, aimed at focusing on the importance of carrying out OH in ICU, revealed that all participants agree with this practice. Nonetheless, there was no common ground regarding the knowledge about the procedures and the technique applied. The literature points out that the most rigorously studied oral antiseptic regarding the prevention of VAP is chlorhexidine and that OH protocols are composed, mainly, of this solution (10,12), therefore in accordance with this study, in which the 0.12% chlorhexidine digluconate solution was the most cited one.

The answers to the questionnaire revealed differences in relation to the frequency of OH, suggesting that there is no oral care routine in the hospital ICU. These results are in compliance with the fact that the participants reported not having received guidance during professional training and not having knowledge of the OH protocol of the institution. Given this scenario, studies that implemented OH care with 0.12% chlorhexidine achieved positive results in the reduction of VAP (22,26). Güler and Türk demonstrated that the application frequency should be observed, since its concentrations vary from 0.12%, 0.2%, and 2% (27).

Concentrations of 0.12% to 2% have a wide spectrum of action on gram-positive, gram-negative bacteria, fungi, yeasts, and lipophilic viruses, in addition to having 12-hour substantivity (6,10,19). However, the authors disagree as to the frequency of application in which the literature cites a greater efficacy with the use of the substance every 8 hours (28,29). On the other hand, there are also satisfactory results when used twice a day, reducing between 80% to 90% os microorganisms in salive (6,10,19). Thus, this rinse associated with efficient brushing and aspiration of accumulated secretions near the endotracheal tube, showed positive results in reducing the incidence of VAP (11,12).

In a study to assess the effects of OH on the incidence of infections in patients undergoing MV in the ICU, the 0.12% chlorhexidine solution or gel is associated with a 40% reduction in the chances of developing pneumonia in critically ill adults, although there is no evidence in the results of mortality, duration of MV, or staying period in the ICU (11). The use of 0.12% chlorhexidine in patients undergoing MV may present 50% more survival when compared to those who do not use any OH technique in the ICU (30). It is well known that this rinse may have minimal and reversible side effects with the suspension of use, such as unpleasant taste, mild irritation of the mucosa, staining of the teeth, and dysgeusia. Despite of these effects, benefits surpass disadvantages (31).

The MV use causes a reduction in saliva production, favoring the appearance of dental biofilm (9,22). Thus, periodontal disease, mainly caused by this microbial reservoir, is also strongly associated with nosocomial pneumonia since patients hospitalized with this condition are more likely to develop the disease (16). Hence, it is clear that there was no agreement between the participants on the links of the critically ill patient, OH, and the systemic diseases. It is important to note that the oral cavity works as a focus on the set of agents capable of producing pathologies, such as bacterial endocarditis, periodontal diseases, and oral candidiasis; also, maintaining a care routine goes beyond comfort, since it is essential to reduce changes in the microbiota and the development of infections (6,25). Many studies have demonstrated the importance of OH in patients under MV and the reduction of infection rates after the implementation of an oral care protocol (1,6,7,10,17,18,22,25,31).

Among the risk factors identified in the studies as triggers of VAP are: reintubation (5), which increases the risk by 9.36 times (32); smoking and high injury severity score (7,14); advanced age and malnutrition (5); lower level of consciousness; and previous use of antibiotics of the carbapenem class (14). Another relevant factor was the need for tracheostomy, in which authors emphasized that this procedure weakens the upper respiratory tract, causing damage to physiological functions and defense mechanisms (14,33). Likewise, another risk factor is the non-appropriate performance of aspiration of the airways, since the excess secretion in the pulmonary structures of passages can decrease the vagal nervous response and cause cough, therefore intensifying microbial proliferation (10,18).

We observed that the entirety team of the nursing considers OH important for critically ill patients under hospitalization, mainly due to the prevention of spread of oropharyngeal infections, which highlights the care with the risk of aspiration of contaminated oral secretion, although they have not associated this care with VAP prevention. Given this, the data obtained in this study are in accordance with results obtained in the literature (6,10,11,17,18,20). In another study, to identify nursing care in patients undergoing MV in the ICU, among the prescribed interventions, keeping the head elevated to 30º and checking the positioning of the orotracheal tube or tracheostomy were the most found nursing care (34). Thus, the authors point out the importance of improvements on the use of VAP prevention protocols, therefore contributing to the reduction of hospital stay, complications, and infections associated with MV (25,27,31).

It is crucial to ascertain the knowledge and attitude of professionals working in ICUs so that interventions are planned with the team on the application of VAP prevention measures (3,12). For this, the adoption of bundles works as a package of measures based on scientific evidence integrated with the practice of prevention aimed at reducing the lack of information and improving professional conduct (3,12,17). The greater the adherence to good practices in the ICU, the lower the risk of VAP (1,3,7,10,13,22,35). These standardized protocols are considered safe, efficient, low-cost, increase the quality of care provided to the patient and present positive results when applied by the nursing team (3). In a recent study, the application of a bundle of shares achieved an 81% reduction in VAP (7). In another analysis, adherence to the bundle package was satisfactory in 92.0% of cases (36). It is noticeable that educational measures play an important role in the prevention of infections and function as a good strategy in the prevention of HAIs (6,12,25,37). The study noted that the knowledge and preparation of the nursing team to perform OH on intubated patients is inconsistent. Thus, it is essential to implement and supervise an interdisciplinary protocol for oral health promotion of critically ill patients undergoing hospitalization – a SOP – promoting an approximation between the sciences of dentistry and nursing, respecting

the approach of action of each of these areas and enabling comprehensive care to the individual.

Health work is operationalized through well-structured knowledge that integrates technologies that can assist in the care of patients under intensive care (22). In order to solve failures and improve patient care, the research sought to modify learning actions and obtain effective results through educational tactics with nursing teams to prevent VAP (3,10,22,35). As an alternative for collaboration in ICU activities, digital technology is mentioned, a tool that is capable of improving nursing intervention during MV and assisting in planning team actions, promoting safer and more effective patient care (38).

The booklets were used as instruments to enhance the actions of health promotion and education, observing a greater scientific empowerment of the participants since it provided a reduction of the weaknesses of knowledge on the subject. The professionals considered it important to prepare the educational material, clearly and objectively agreeing to a quick consultation to resolve doubts during work routines. Therefore, the study originated an educational material for the extension of learning that can be used continuously, generating preambles for other informative instruments to be developed in order to strengthen the educational process and knowledge construction in health.

As limitations of the study, we highlight the challenge for its explanation; bringing professionals together for moments of discussion on the topics addressed, due to the extensive routine of activities during shifts; difficulty in moving the team to a learning environment; and lack of motivation of professionals to develop other activities outside their work environment, such as participating in a moment of interaction between dental surgeons and nurses. Given this scenario, the booklets were distributed to the participants and other professionals, who mostly contributed to a greater dissemination of knowledge about and effective OH in the ICU environment as a means of preventing VAP.

CONCLUSION

Based on the studies and results found, we observed that institutions with defined protocols and high adherence of ICU professionals to the specific practices of OH care are able to reduce VAP rates. Hence, it is necessary to guide and train professionals so that they know, in addition to the technique, the importance of the procedure for the prevention of oral and systemic infections. The implementation of a OH protocol in the ICU acts as an indicator of quality of care and assesses the levels of VAP development. Moreover, it is suggested that the oral assessment is included in the medical and nursing prescription through a checklist prepared by the hospital infection control service so that it can be checked daily. This objective strategy may facilitate the systematization of procedures, also enabling a significant reduction in hospital expenses.

The authors declare that there is no conflict of interest.

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ORIGINAL ARTICLE

EVALUATION OF THE EFFECTIVENESS OF CUTTING SCALPEL BLADES AFTER USE AND CLEANING BY DIFFERENT METHODS

AVALIAÇÃO DA EFETIVIDADE DO CORTE DE LÂMINAS DE BISTURI APÓS USO E LIMPEZA POR DIFERENTES MÉTODOS

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ABSTRACT

When performing incisions during oral and maxillofacial surgical procedures, the surgeon requires a blade that ensures precise cuts which reduce unnecessary tissue injuries. After searching the literature, we realized that there is a lack of studies that assesses scalpel blades for dental use. Herein, this study aims to assess the cutting power of new scalpel blades after cleaning with different methods. Sixty sterile scalpel blades were divided into seven groups: I) new blade; II) the second insertion; III) blade cleaned with gauze; IV) blade cleaned with gauze and saline; V) blade cleaned with saline; VI) blade cleaned with cotton, and VII) blade cleaned with cotton and saline. A universal testing machine (Osvaldo Filizola, São Paulo, Brazil) was used for the insertion and measurement of the shear strength. The results revealed that cleaning the blade with gauze and saline was the method that had the greatest loss of the cutting capability. The reinsertion of the scalpel blade without any type of cleaning or the cleaning of the blade with cotton and saline were the methods that obtained the best result, which did not compromise the mechanical properties of the tested material. This study concludes that cleaning methods affect the cutting power of scalpel blades.

Keywords: Oral Surgery; Surgical Wound; Dentistry.

RESUMO

Na execução dos procedimentos cirúrgicos bucais e maxilofaciais o operador, ao realizar incisões, necessita de uma lâmina que garanta um corte preciso, diminuindo lesões desnecessárias aos tecidos. Ao fazer uma busca na literatura, constatou-se carência de estudos que avaliassem lâminas de bisturi de uso odontológico. Diante desse cenário, o objetivo do presente estudo foi avaliar o poder de corte de lâminas de bisturi novas e após limpeza com diferentes métodos. Sessenta lâminas de bisturi estéreis foram divididas em sete grupos: I) lâmina nova; II) segunda inserção; III) lâmina limpa com gaze; IV) lâmina limpa com gaze e soro; V) lâmina limpa com soro; VI) lâmina limpa com algodão e VII) lâmina limpa com algodão e soro. Para inserção e aferição da resistência ao corte utilizou-se uma máquina de ensaio universal (Osvaldo Filizola, São Paulo, Brasil). Os resultados revelaram que a limpeza da lâmina com gaze e soro fisiológico foi o método que teve maior perda de corte. Já a reinserção da lâmina de bisturi sem quaisquer tipos de limpeza ou a limpeza da lâmina com algodão e soro foram as que obtiveram melhor resultado, não comprometendo as propriedades mecânicas do material testado. Conclui-se, com a realização desse estudo, que os métodos de limpeza afetam o poder de corte das lâminas de bisturi.

Palavras-chave: Cirurgia bucal; Ferida cirúrgica; Odontologia.

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INTRODUCTION

Since the beginning of humanity, consciously, bloody therapeutical procedures also took their first steps (1). The physician, taking advantage of both traditional and cultural resources, as well as based on empiricism, which is the result of observation, did what was possible to save lives. These results operated through a bilateral sacrifice: to the patient was the suffering and to the physicians was the uncertainty of success (2-5).

When performing surgical procedures, the tissue incision is present (6-8). For this to occur, the surgeon must stick to some basic principles of surgery (9,10). However, the lack of a clear and accurate definition of the use and reuse of scalpel blades throughout the same surgical procedure raises some questions. To what extent would the lack of precision of the cut, as well as the use of materials for cleaning the blades, influence the cutting of the blades?

Based on this premise, it is necessary to clarify the safety and efficacy of the use and reuse of the scalpel blade during the surgical procedure, which is the object of this study, in addition to verifying the hypotheses that cleaning methods and serial insertions of the blades reduce their cutting power.

METHOD

This work is an *in vitro* laboratory study. We used 60 no.5 scalpel blades (Advantive, Xishan City, Jiangsu, China) divided into seven groups (n = 5): I) new blade (control group); II) the second insertion; III) cleaned with gauze; IV) cleaned with gauze and saline; V) cleaned with saline) VI) cleaned with cotton, and VII) cleaned with cotton and saline. After they were selected, we inserted the blades into test specimens made in addition silicone (Figure 1). A universal testing machine (Oswaldo Filizola AME-2kN, São Paulo, Brazil) was used for the insertion and measurement of the shear strength. A scalpel cable was attached to the upper claw of the machine, which remained perpendicular to the specimen during the insertion test. The insertion forces were expressed in kilograms/force (Kgf), and the established deformity pattern was 14 mm of blade insertion.

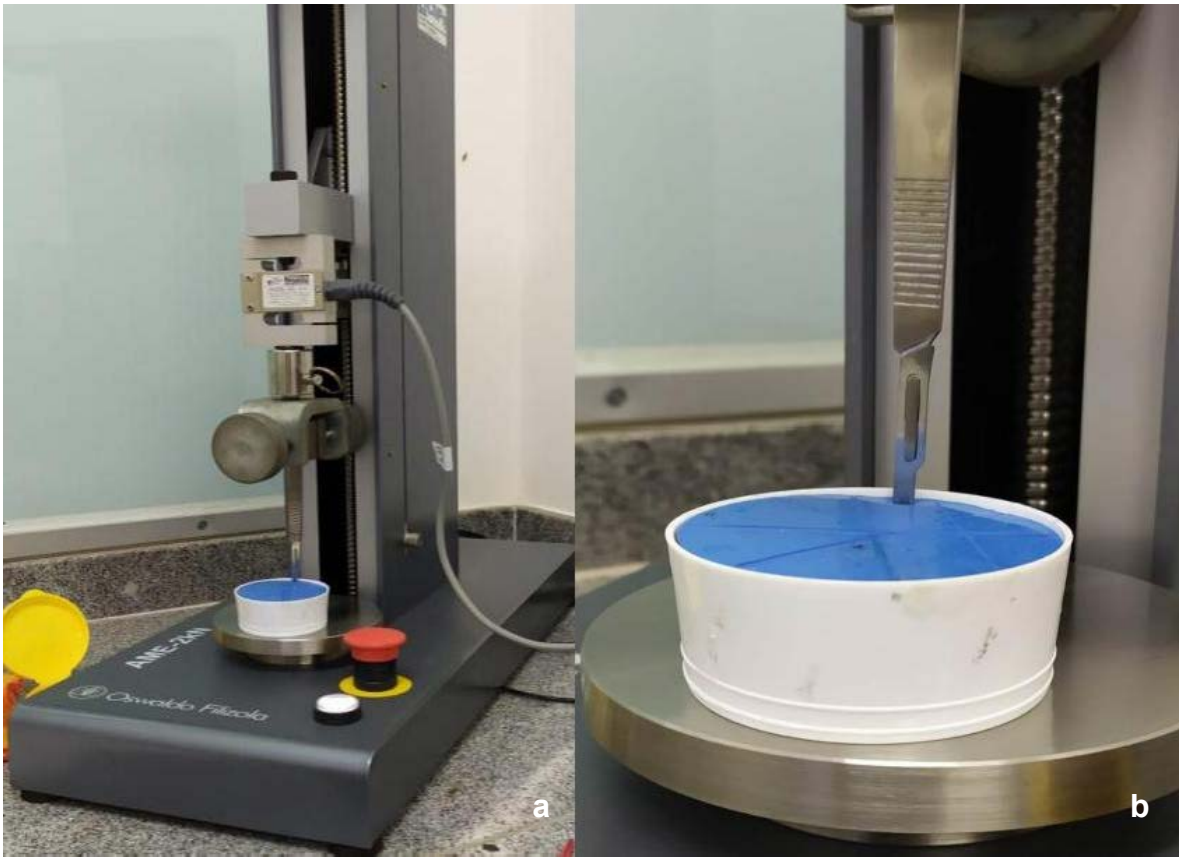

Figure 1. *The mechanical test being performed: a) scalpel blade coupled to the universal mechanical testing machine Oswaldo Filizola AME-2kN; b) approximate view of the blade being inserted in silicone.*

The data obtained were analyzed using the SPSS software version 21.0 (Statistical Package for Social Sciences SPSS. 21.0, 2012, Armonk, NY: IBM Corp.). For assessing normality and homoscedasticity, the Shapiro-Wilk and Levene tests were used, respectively.

Descriptive statistics were calculated and the mean and interquartile range parameters were adopted for all intra- and intergroup insertion force evaluation data (in Kgf). Firstly, each measure insertion force successively assessed on each blade was allocated into two test groups: 1st to 5th and 6th to 10th. The paired t-test or the Wilcoxon test were adopted as inferential statistics in the intragroup comparisons to assess whether there are differences between the means/medians of each scalpel blade between the 1st to 5th and 6th to 10th tests.

To assess the effect size and clinical relevance, Cohen's d effect size was adopted, and interpreted as small (< 0,20), medium (> 0,20 or 0.4.9), and high (> 0.80)(11). The intergroup comparison was performed through the Kruskal-Wallis test and the pairwise analyses through the Mann-Whitney test. For all inferential analyses, a level of significance of 5% was adopted.

RESULTS

The mean and interquartile range values of the groups were described in Tables 1 and 2. In the intragroup comparison, blades cleaned with gauze and saline showed a significant loss of performance ($p < 0.05$), with an increase in the means in Kgf. Such losses may be considered clinically relevant since they have a high effect size (d = 4.50).

TABLE 1. COMPARISON OF THE INSERTION FORCE OF THE SCALPEL BLADES BETWEEN THE GROUPS.

Groups	Insertions		p (Value)*	Effect size (Cohen's d)	Effect size's interpretation
	From 1st to 5th	From 6th to 10th			
I	0.173 + (0.010)	0.171+ (0.015)	0.749	0.28	Low effect
II	0.179 + (0.015)	0.181 + (0.015)	0.374**	0.22	Low effect
III	0.171 + (0.010)	0.173+ (0.015)	0.861**	0.50	Medium effect
IV	0.157+ (0.025)	0.175+ (0.005)	0.037**	4.50	High Effect
V	0.171 + (0.005)	0.165+ (0.005)	0.468**	1.50	High Effect
VI	0.159 + (0.047)	0.181+ (0.015)	0.207	1.10	High Effect
VII	0.179 + (0.020)	0.179 + (0.010)	1.000**	0	Not relevant

*Insertions were represented by interquartile mean/amplitude; *p values were represented by the Wilcoxon test** or paired t-test.*

TABLE 2. POST-HOC PEER REVIEW.

Comparisons	p value**
Group I x Group VII	0.006
Group II x Group III	0.048
Group II x Group IV	0.009
Group II x Group V	0.016
Group III x Group VII	0.012
Group IV x Group VII	0.018
Group V x Group VII	0.007

***p value referring to the Mann-Whitney test, with a significance level of 5%*

As for the intergroup assessment, Figure 2 presents the box-plot graph and measures of dispersion, asymmetry, tail length, and outliers (extreme values). Thus, in Table 1, significant differences were found between medians of all groups through the Kruskal-Wallis test (*P* = 0.039). After peer review (post-hoc), differences were observed between 14 comparisons (Table 2). No significant differences were found between the blades from the control group and the one that was only inserted for the second time I and II (P > 0.05). The most expressive findings are revealed by group II (second insertion), which revealed significant differences (p<0.05) with three cleaning methods: blade cleaned with gauze (group III), blade cleaned with gauze and saline (group IV), and blade cleaned with saline only (group V).

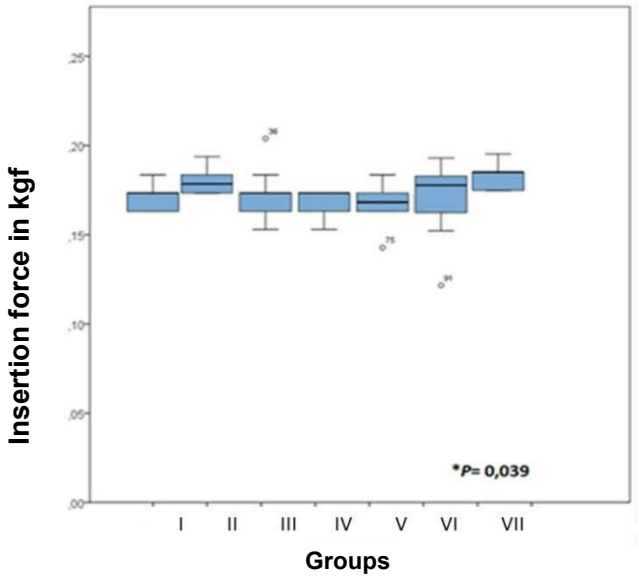

Figure 2. *Box-plot graph for the comparison of the incision force between groups. *p value referring to the Kruskal-Walis test, with a significance level of 5%.*

Another compelling finding lies in the fact that new blades (group I) present statistically significant differences with the medians of the insertion forces of blade in group VII (cleaned with cotton and saline). Blades of group VII also revealed differences regarding blades cleaned with gauze (group III), blades cleaned with gauze and saline (group IV), and blades cleaned with saline (group V).

DISCUSSION

This study aimed at assessing the efficacy of the use and reuse of scalpel blades throughout surgical procedures, as well as verifying, through a laboratory experiment, the influence of some materials commonly used for cleaning scalpel blades for dentistry use.

The desire to have an effective method that does not change the cutting power of the instruments is not exclusive to dentistry (12,13). Refractive surgeons are often confronted with recommendations for cleaning their scalpels. The problem encountered lies in the maximization of cleaning, which would maintain the longevity of these instruments. Beran carried out a study whose aim was to assess ophthalmological scalpel cleaning methods and it revealed that a systematic multilevel process is necessary for the maintenance of the longevity of diamond scalpels, a result that corroborates the findings of our study (14).

After observing the results obtained in our study through intragroup comparison, it is understandable that the blades cleaned with gauze and saline presented a significant loss of performance, which can be considered clinically relevant. The gauze, which has a higher cut resistance than cotton, acted directly on the tested material, diminishing the cutting power of the scalpel blade. This result is of clinical importance since many professionals repeat this act during surgical procedures. The loss of the cutting power not only causes economic losses, but also increases the surgical time, inaccuracy of the cuts, and greater tissue damage.

Interestingly, there were no relevant differences between the insertion of the new blade and its reinsertion. Hence, reusing a blade without cleaning it does not lead to clinically relevant losses to perform the procedure.

Pithon *et al*. when assessing the insertion and reinsertion of anesthetic needles, observed that the Terumo needle was the only one that did not endure a loss of performance throughout its five insertions; needles of all other brands tested, contrastingly, had a loss of performance, and those of Septoject XL, Carpule, and Procare, showed an increase in the force required for penetration from the second insertion, while the Injex needle showed acted likewise from its third insertion (15). Although our study assessed the penetration of a scalpel and not needles, the values achieved with the scalpel from the second insertion were similar.

Moreover, the results revealed that the new blades showed statistical differences with the median insertion forces of the blade of group VII (cleaned with cotton and saline). This group also presented differences regarding blades cleaned with gauze (group III), blades cleaned with gauze and saline (group IV), and blades cleaned with saline (group V). Since there shall not be loss in the cutting performance, the professional may opt for cleaning the blade with cotton and saline before reinserting it. The cotton, as it is a more fragile material, does not compromise the blade's mechanical properties.

It is important to emphasize the need for clinical studies that verify the preliminary results presented here.

CONCLUSION

By performing this study, we conclude that cleaning a scalpel blade with gauze and physiological saline was the method that had the greatest cutting capability loss. The hypothesis that cleaning methods and serial inserts of the blades reduce their cutting power have been confirmed.

The authors declare no conflict of interest.

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CASE REPORT

ENDODONTIC TREATMENT OF TEETH WITH POST-TRAUMA ROOT CALCIFICATION: CASE REPORT

TRATAMENTO ENDODÔNTICO DE DENTE COM CALCIFICAÇÃO RADICULAR PÓS-TRAUMA: RELATO DE CASO CLÍNICO

Thayla Huber Antes[1], Leonardo Thomasi Jahnke[1], Wesley Misael Krabbe[1], Marcus Vinícius Reis Só[1], Ricardo Abreu da Rosa[1].

ABSTRACT

The calcification of the root canal is a process that may occur after a dental trauma or slowly develop due to physiological dental aging. It is characterized by hard tissue deposition on both the pulp chamber and the root canal. Periapical radiography and computed tomography can be used to diagnose this condition. In some cases, it may be associated with pulp necrosis and the presence of periapical injury, and the treatment may be considered to be quite complex. This case report addresses the endodontic treatment of the upper left central incisor, symptomatic, with root canal obliteration and pulp necrosis as a sequela of dental trauma. After all the tests, chronic apical periodontitis was diagnosed, and conventional endodontic treatment was proposed. The most significant difficulty faced was when locating the root canal's entrance. Numerous radiographs were carried out to avoid deviations. The opening of the root canal could only be found at the end of the middle third, so treatment could proceed by using the crown-down technique and intracanal medication based on calcium hydroxide during the sessions. When the patient was asymptomatic, the root canal has been filled. The accomplishment of the technique was successful, and after finishing the case, there was remission of symptoms. After a six-month follow-up period and three years, the healing of the periapical tissues was observed.

Keywords: Dental pulp calcification, dental trauma, pulp necrosis, periapical diseases.

RESUMO

A calcificação do canal radicular é um processo que pode ocorrer posteriormente a um traumatismo dentário ou que pode se desenvolver lentamente em decorrência do envelhecimento dentário fisiológico. É caracterizada pela deposição de tecido duro tanto na câmara pulpar como no canal radicular. Essa condição pode ser diagnosticada através de radiografias periapicais e tomografia computadorizada. Em alguns casos, pode estar associada à necrose pulpar e presença de lesão periapical, e o tratamento pode ser considerado bastante complexo. Este relato de caso clínico aborda o tratamento endodôntico do elemento 21, sintomático, com obliteração do canal radicular e necrose pulpar como sequela de um traumatismo dentário. Após a realização de todos os exames, foi dado o diagnóstico de periodontite apical crônica, sendo proposto o tratamento endodôntico convencional. A maior dificuldade encontrada foi a localização da entrada do canal radicular. Inúmeras radiografias foram realizadas a fim de evitar desvios. Somente ao final do terço médio foi possível localizar a entrada do canal radicular e dar prosseguimento ao tratamento, utilizando a técnica coroa-ápice e medicação intracanal à base de hidróxido de cálcio durante as sessões. Foi possível realizar a obturação do canal radicular quando a paciente se mostrou assintomática. Obteve-se sucesso na realização da técnica, e, após a conclusão do caso, foi possível observar remissão dos sintomas. Após um período de acompanhamento de 6 meses e, posteriormente, de 3 anos, foi possível observar cicatrização dos tecidos periapicais.

Palavras-chave: Calcificação da polpa dentária, traumatismo dentário, necrose pulpar, doenças periapicais.

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INTRODUCTION

The apposition of hard tissue throughout the root canal's walls is a slow process, usually associated with physiological aging. In response to tooth wear and stimulation, localized hard tissue deposition occurs in both the pulp chamber and the root canal. Nevertheless, partial or total calcification of the pulp may also be associated with caries, traumatic injuries, and systemic conditions(1).

The development of root canal calcification depends on two main factors: the patient's age and the type of injury the tooth has suffered(1). Non-physiological calcification of the root canal happens through the deposition of tertiary dentin in response to a stimulus or trauma. This dentine has an irregular shape, and the amount to be formed will depend on the calcification rate (1).

The precise mechanism of root canal obliteration is unknown, but it is believed to be related to damage to the neurovascular supply of the pulp at the time of trauma(2). Calcification of the pulp chamber leads to the dental crown's darkening, loss of translucency, and yellowish appearance(3). This condition may be clinically visible three months after the trauma, but in most cases, it is not diagnosed within one year(4).

After root canal obliteration and depending on the degree of alteration, pulp necrosis can be a late complication(1, 5). The incidence of pulp necrosis in calcified teeth has been increasing over time and its development is related to teeth that suffered severe trauma and teeth that had complete root formation at the time of trauma(3).

In these cases, the location and negotiation of the root canal become a significant challenge in the endodontic practice(6). These procedures may lead to iatrogenic failures and poor prognoses(7). Thus, it is necessary to create good case planning and elaborate a proper treatment plan to obtain a better prognosis. This work aims to describe a clinical case concerning the endodontic treatment of a tooth with root canal calcification, which presented pulp necrosis and periapical injury after a dental trauma.

CASE REPORT

A 27-year-old female patient, Caucasian, without any systemic health changes, attended the dentist appointment at the Dental School of the Federal University of Rio Grande do Sul, reporting slight discomfort in the upper left central incisor with complaining about the color change of this tooth.

During anamnesis, the patient reported having suffered trauma to the anterior region of the face during a basketball game 14 years prior to the appointment. At that time, she sought dental care in which no dental intervention was deemed necessary. Two years after the event, during a routine dental appointment, an x-ray of the upper left central incisor was performed, and the need for endodontic intervention was verified. The attempt to locate the root canal was unsuccessful, and the tooth received a restoration with glass ionomer cement and composite resin.

During the clinical examination, it was found that the dental crown of the upper left central incisor presented a direct restoration in composite resin on the palatine face. The tooth did not have any wear and root exposure. Periodontal tissue was healthy, with no outbreaks of inflammation or infection. There was no intra or extraoral edema, nor fistula. Also, both upper left and right central incisor presented a slight color change. The crown of the upper left lateral incisor was healthy, with no signs of alterations.

A periapical x-ray of diagnosis was carried out, in which severe calcification of the root canal of both teeth was observed. Nonetheless, periapical alterations were observed only in the upper left central incisor. The upper left lateral incisor revealed hard blade integrity, as shown in Figure 1. Moreover, the patient had already undergone a computed tomography of this area, confirming the radiographic findings in Figure 2.

During the clinical examination, all tests were done on both teeth. Both elements responded positively to horizontal and vertical percussion and apical palpation tests. Under relative isolation, the sensitivity test was performed with Endo Ice (Maquira, Maringá, Paraná, Brazil) and obtained a negative response from the two teeth.

After all the tests, chronic apical periodontitis was diagnosed regarding the upper left central incisor, and the treatment plan was established. We chose to perform the endodontic treatment conventionally, even considering the limitations and risks of the technique. The patient was informed of the proposed treatment and the prognosis of the case; subsequently, the free informed consent was signed.

In the second appointment, endodontic treatment was initiated. Initially, the restoration of composite resin was removed using 1014 diamond burr (KG Sorensen, Cotia, São Paulo, Brazil). Afterward, absolute isolation of the operative field was performed with a folding arch, rubber sheet, and rubber dam clamp #211 (Golgran, São Caetano do Sul, São Paulo, Brazil). We tried locating the root canal's entrance with Endodontic Heine Probe (Golgran, São Caetano do Sul, São Paulo, Brazil) and files type K 08 and 10 (Maillefer, Dentsply, Petrópolis, Rio de Janeiro, Brazil), unfortunately without success.

Subsequently, we used a spherical carbide bur, LN drill (Maillefer, Dentsply, Petrópolis, Rio de Janeiro, Brazil), with a long neck in low rotation to wear the cervical and middle thirds. Throughout this process, various periapical radiographs were carried out to guarantee that the drill was inside the canal and was not generating deviations (Figure 5).

Figure 1 - *Diagnostic radiography*

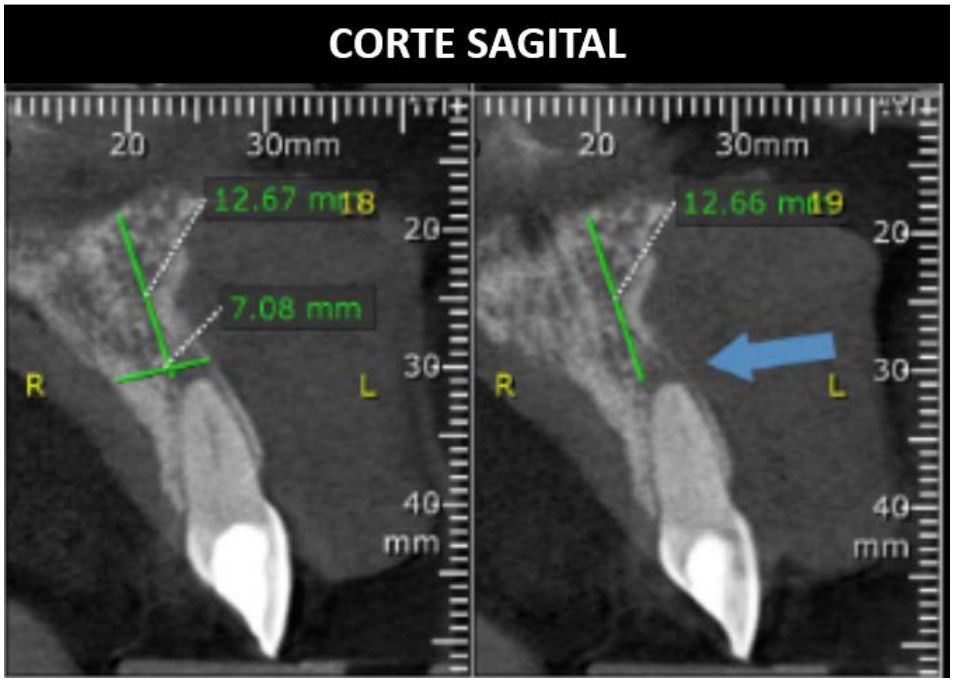

Figure 2 - *Computed tomography, sagittal view*

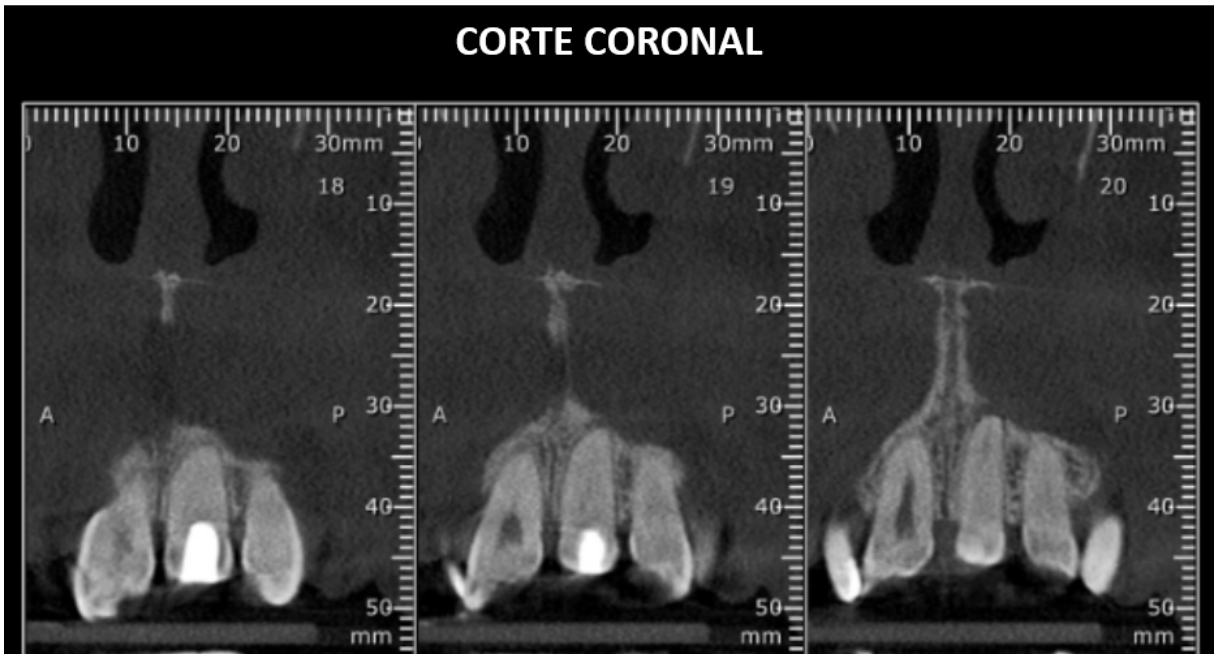

Figure 3 - *Computed tomography, coronal view*

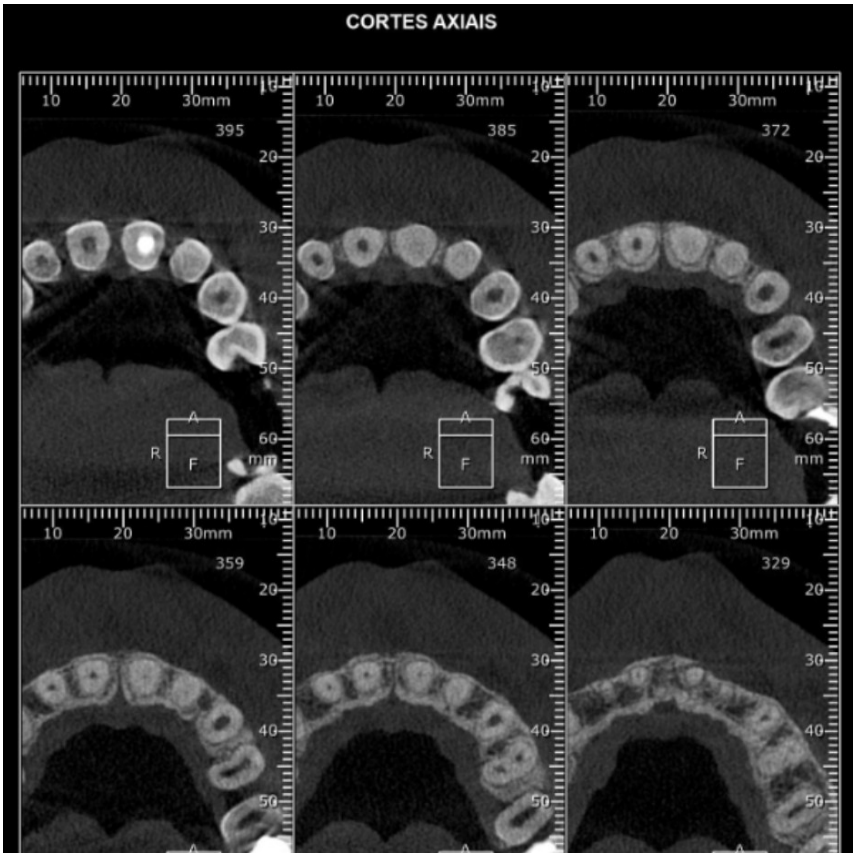

Figure 4 - *Computed tomography, axial view*

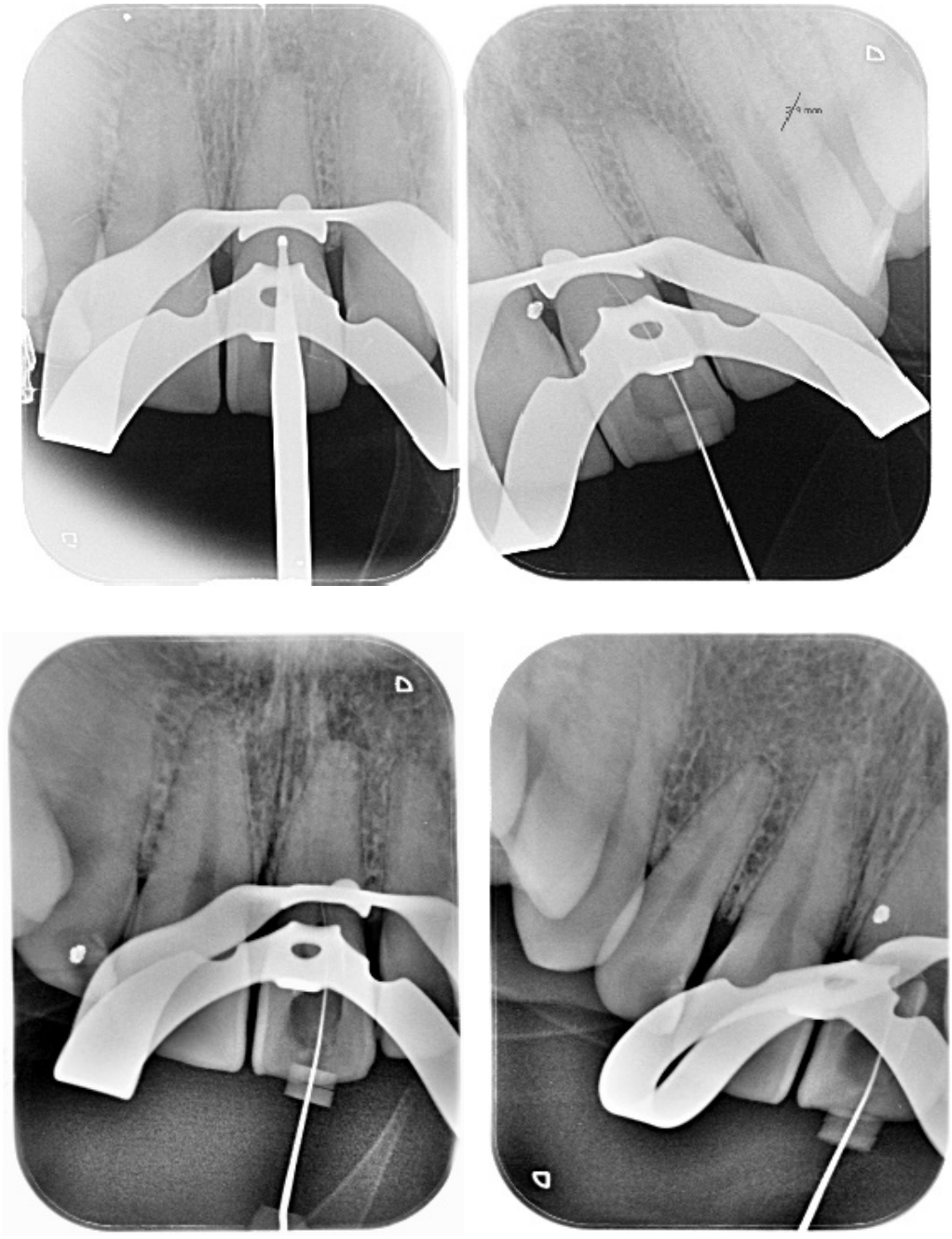

Figure 5 - *Periapical radiographs evidencing the location of the root canal entrance with no deviations.*

At the end of the middle third, the root canal entrance was detected, and a file type K08 was used to make the exploration. Orthoradial, mesiorradial, and distoradial periapical radiographs were performed with file K08 in position and could confirm the location of the root canal (Figure 6).

The irrigation process was performed with a disposable 27G needle (Injex, Ourinhos, São Paulo, Brazil), attached to the disposable plastic syringe with sodium hypochlorite 2.5% (Farmácia Marcela, Porto Alegre, Rio Grande do Sul State, Brazil). By the end of the appointment, a cotton ball with tricresolformalin (Biodinâmica, Ibiporã, Paraná, Brazil) was placed at the entrance of the root canal, and the tooth was sealed with temporary sealer material (Cavitec; Caitech, São José dos Pinhais, Paraná, Brazil), followed by glass ionomer cement (MaxxionR; FGM, Joinville, Santa Catarina, Brazil). The occlusal adjustment was performed, and the patient was instructed on possible postoperative discomfort.

In the third appointment, absolute isolation of the operative field was performed, followed by the removal of the crown's sealing and cotton ball with intracanal medication. The same irrigation and

aspiration processes. The measure of root canal length was performed with apical locator Propex Pixi (Dentsply, Petrópolis, Rio de Janeiro, Brasil), confirmed with periapical radiography, and the working length (WL) was defined at 21 mm, with an incisal lip as a reference. The root canal was enlarged with K-type filed (Maillefer, Dentsply, Petrópolis, Rio de Janeiro, Brazil) #8, #10, and #15 throughout the tooth's length (WL + 1 mm). The canal was irrigated with 2 mL of sodium hypochlorite solution 2.5% at each instrument change.

Afterward, the mechanical chemical preparation of the root canal was carried out with Wave One Gold (Maillefer, Dentsply, Petrópolis, Rio de Janeiro, Brazil), Small (20.07), Primary (25.07), Medium (35.06), and Large (45.05) reciprocating files. After completion of the preparation, the *smear layer with 17% EDTA* (Farmácia Marcela, Porto Alegre, Rio Grande do Sul, Brazil) was removed during three minutes, followed by irrigation with saline solution (Farmácia Marcela, Porto Alegre, Rio Grande do Sul, Brazil) and drying the canal with absorbent paper cones #45.

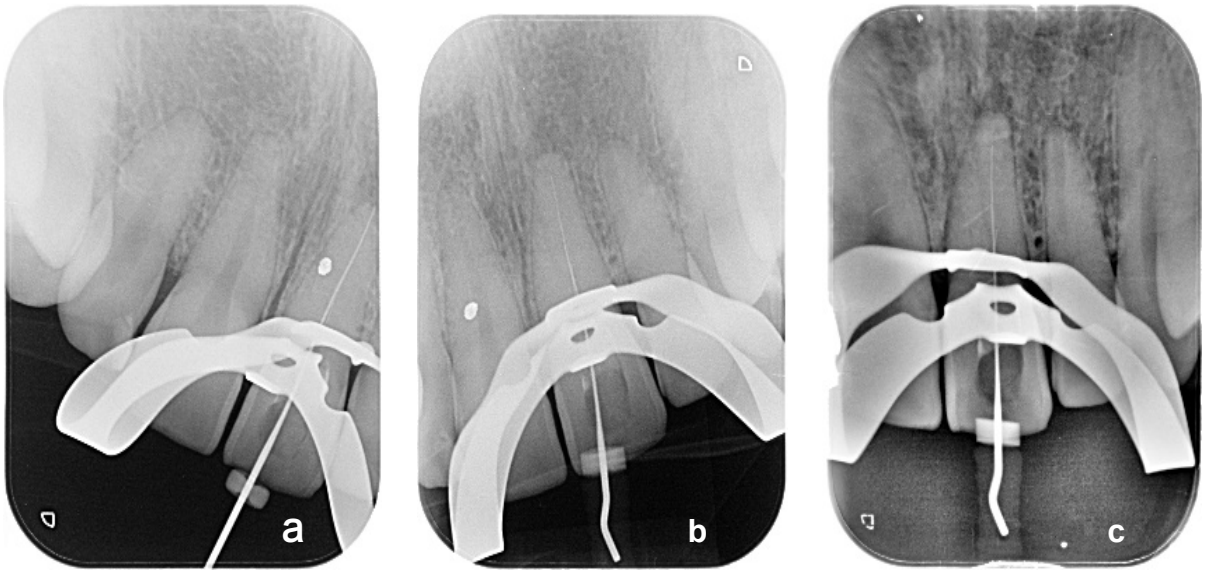

Figure 6 - *Radiographs at different horizontal angles to confirm the absence of root canal deviation. Mesiorradial (a), orthoradial (b), and distoradial (c) radiography.*

Due to the presence of periapical injury, we chose to use intracanal medication based on calcium hydroxide (UltraCal®XS; Ultradent Products, Inc, Indaiatuba, São Paulo, Brazil) (Figure 7a). The tooth was sealed with a cotton ball, temporary sealer, and glass ionomer cement (MaxxionR; FGM, Joinville, Santa Catarina State, Brazil).

After 34 days, the appointment happened to fill the canal. Sealing and intracanal medication were removed through successive irrigations with sodium hypochlorite 2.5% under absolute isolation. The central cone #45 (Figure 7b) was tested, and root canal filling was carried out with gutta-percha points and epoxy resin cement (AH Plus; Dentsply, Petrópolis, Rio de Janeiro, Brazil) with the Tagger Hybrid Technique (Figure 7c). The root canal entrance was sealed with temporary shutter cement, followed by direct restoration in composite resin.

After the conclusion of the endodontic treatment, the patient was referred to another department of the Dental School of UFRGS to perform the definitive restoration and whitening of the tooth. After 15 days of the filling appointment, all tests were redone in the upper left central and lateral incisors. Both responded negatively to horizontal and vertical percussion tests and apical typing test. Besides that, the patient reported no longer feeling any discomfort. Thus, it was decided not to carry out any endodontic intervention in the upper left lateral incisor and to monitor the case clinically and radiographically.

After six months, the patient returned to the clinical and radiographic control of the upper left central incisor and to evaluate the situation of the upper left lateral incisor. After clinical tests of horizontal and vertical percussion and apical palpation, the patient did not feel discomfort in the tooth submitted to endodontic treatment nor in the upper left lateral incisor. On radiographic examination, regression of the periapical lesion was observed, with the re-establishment of the periodontal space and the hard blade in the apical region of upper left central incisor (Figure 8a).

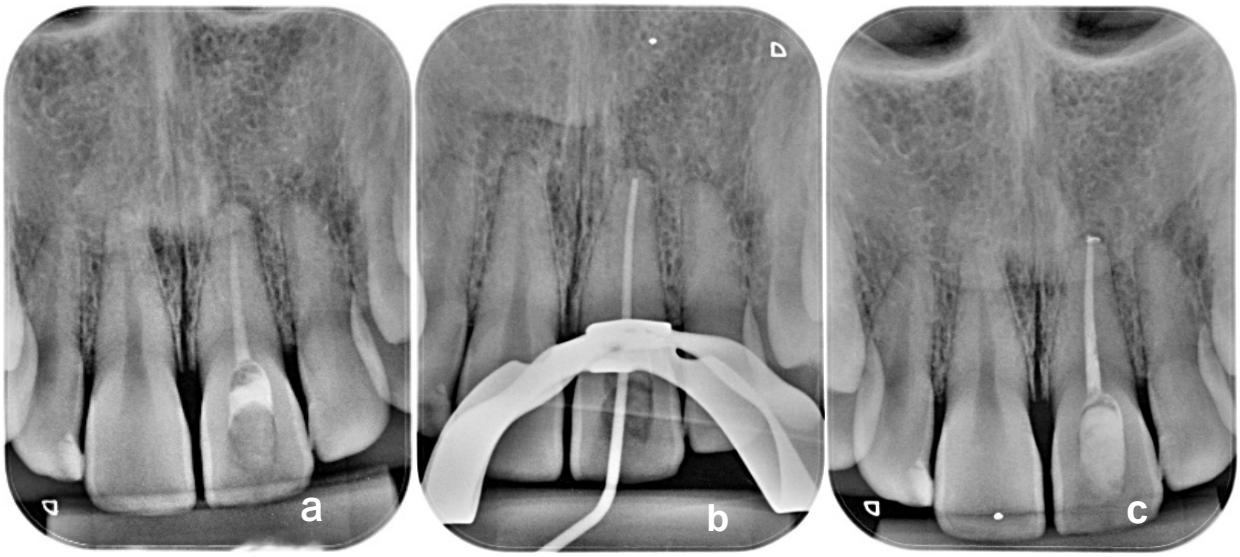

Figure 7 - *Periapical radiography evidencing the presence of intracanal medication (a), cone test radiograph (b), and final radiography (c).*

Figure 8 - *Proservation radiography: six months after endodontic treatment (a) and three years after endodontic treatment (b).*

In a new follow-up appointment, three years after the completion of endodontic treatment, it was possible to observe treatment success since there was no painful symptomatology in percussion and palpitation tests. Radiographically, repair of the periapical region was identified (Figure 8b).

DISCUSSION

The diagnosis of teeth with pulp calcification is essential for the development of a proper treatment plan, so, radiographic and clinical examinations, followed by percussion and sensitivity tests, are required. After trauma, affected teeth do not always react to sensitivity tests (4). This lack of response can be reversible; after a few weeks, the test may begin to display its results (8). Additionally, in many cases, the degree of atresia of the pulp chamber due to a previous trauma may be of such magnitude that there is virtually no more pulp tissue in this region. In cases like this, the thermal stimulus cannot reach these nerve fibers, and the obtaining of false-negative results is quite frequent. In this sense, in the presence of root canal obliteration, it is accepted that pulp sensitivity tests are unreliable (3,9). In the case report described above, this approach was adopted for the upper left lateral incisor, since after the endodontic intervention in the upper left central incisor the painful clinical signs and symptoms ceased, not demonstrating the need for endodontic intervention.

Moreover, the complete obliteration of the pulp in the radiographic image does not necessarily mean the absence of space in the pulp canal. In the majority of the cases, there is a pulp space and root pulp, but the sensitivity of radiographs is too low to allow its image to be captured (10). A study by Kuyk and Walton measured the diameter of the canal of 36 teeth on radiographs and then compared it with the actual measurements of the canals obtained through histological sections. They found out that, histologically, all root thirds had canal light, although many regions did not present a canal on a radiograph (11). Complete radiographic obliteration does not necessarily mean the absence of root canal space, given that, in most cases, a pulp canal space is indeed present. This study confirmed previous findings by Patersson and Mitchel, who observed that some form of the patent canal usually persists (10).

The advance in digital radiographs, including cone beam computed tomography, has the potential to help diagnose and plan this kind of treatment. Three-dimensional images allow a better view of traumatized teeth and eliminate overlaps. Many studies reveal the improvement of the diagnosis capacity with computed tomography compared to conventional intraoral radiography (12). In this case, computed tomography was used as an additional resource for elaborating the treatment plan. This way, we measured the calcification level of the root canal, in which there was a more significant presence of root lumen.

Root canal treatment in these cases should only be initiated if the tooth that presents symptoms or radiographic signs of periapical disease (13). According to the endodontic guide of cases of challenging access by the American Association of Endodontists (AAE), this kind of treatment is considered highly difficult. In such cases, reaching a predictable prognosis is challenging, even for a more experienced professional. Additionally, a study by Kiefner et al. revealed that the time it takes an endodontics specialist to locate obliterated root canals can range from 15 minutes to an hour using a clinical microscope. If this feature is not used, time increases further (13). As for this case, it was necessary to have an appointment of almost two hours for the location of the root canal to be successfully achieved. Beside to a careful wear of the root dentin, transoperative radiographs with different horizontal incidences were performed to better visualize any deviation of the original root canal trajectory.

The negotiation of calcified canals is a significant challenge (14). Cvek *et al.* found that the most crucial number of irreversible instrument fractures occurred in obliterated root canals (15). Typically, small-caliber files are required to achieve patency; however, these files do not have the necessary stiffness to cross restricted spaces and end up fracturing when used with force. An alternative is to obtain patency by alternating Kerr #08 and #10 with smooth vertical pressure movements, replacing them with new instruments before fatigue occurs. Moreover, it is recommended to use the crown-down technique (16). As a general rule, the pulp calcification process occurs in a corono-apical direction, thus, once the cervical third canal is located, the instruments tend to progress more efficiently and advance toward the end of the canal (17).

Another very recurrent risk in the endodontic treatment of calcified canals is perforation. To avoid perforation, various radiographic shots should be made at different horizontal angles to maintain alignment and ideal direction of the root canal (18).

A study performed by Schindler and Gullickson suggested that at the moment a canal is not located, apical surgery is recommended (19). Parendodontic surgery of apical surgery is seen as a good option for the treatment of calcified canals, as it offers a direct approach to the root apex (20). However, root canal localization may continue to be challenging even after root cutting (17). As for the case described

above, the patient was informed of all of the possible risks, that the prognostic was doubtful and that, in case the treatment failed, surgical approach would be necessary.

Pulp canal obliteration produces a clinical scenario in which canals should be located in more apic parts of progressively narrow roots due to dentin, caries, orthodontics, systemic disease, or trauma (17). Besides, it accounts for up to 75% of perforations during the attempt to locate and negotiate calcified canals (21). Aiming to reduce these risks, a study by van der Meer *et al.* revealed that it is possible to perform the digital planning of the endodontic treatment of calcified teeth based on cone beam computed tomography and intraoral scans(22). Through these scans, endodontic guides are created through prototyped manufacturing to direct the drill to the root canal. Similarly, case reports describing the use of 3D printed guides to access a calcified upper incisor and a lower molar support the clinical usefulness of the technique (23).

In recent years, guided endodontics has been employed to conduct endodontic treatment of calcified teeth, remove fiberglass pins, teeth with anomalies, and periapical surgeries (25). This technique has the advantage of direct access to root canal light in calcified teeth, surpassing the mineralized area with minimal deviation. Some authors reported that guided endodontics maintains a more significant dental structure, regardless of operator experience, compared to conventional access (26).

Nevertheless, guided endodontics presents some limitations. For example, access is performed with a giant diameter drill (1.3 mm) which can cause in certain situations, as in the case of teeth with mesiodistal flattening, an excessive wear, weakening the root remnant and compromising the survival of the treated tooth. In addition, its use is indicated in straight canals or the straight sections of curved canals and the difficulty accessing posterior teeth is due to the dimensions of the endodontic guide and the drill used for access(26).

Lastly, the cost of cone-beam computed tomography and guide making can be considered a limiting technique factor. In this case, it was chosen not to perform the guided endodontics due to the high cost since the patient could not afford the guide's expenses.

CONCLUSION

Endodontic treatments of traumatized teeth may be quite complex, especially when there is partial or total root canal obliteration due to trauma. Based on periapical radiographs in different angles, computed tomography, and patient treatment adherence, as well as the knowledge of the inherent risks to this type of approach, conventional endodontic treatment should be recommended. After a follow-up period of six months and, later, three years, there was remission of symptoms and healing of periapical tissues after treatment of upper left central incisor with a partially calcified canal and presence of periapical lesions.

The authors declare no conflict of interest.

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INFLUENCE OF YTRIO PERCENTAGE ON MONOLITHIC ZIRCONIA PROPERTIES: LITERATURE REVIEW

INFLUÊNCIA DO PERCENTUAL DE ÍTRIO NAS PROPRIEDADES DA ZIRCÔNIA MONOLÍTICA: REVISÃO DE LITERATURA

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ABSTRACT

The fundamental disadvantage of conventional zirconia is its high opacity. Depending on different conditions, especially on the content of the yttrium stabilizer, it is possible to circumvent this issue. Thus, numerous generations of yttrium-stabilized zirconia have been developed seeking to combine the robustness of zirconia with the esthetics of porcelain veneers. This study aimed to analyze how the increase or reduction of the percentage of yttrium in the composition of monolithic zirconia can influence their properties, especially regarding translucency. This study was carried out through a review in the SciELO, PubMed, and Google Scholar databases, with papers published between 2013 and 2021. Hence, we concluded that the higher Y2O3 content tended to increase the amount of isotropic cubic phase present and reduce the amount of birefringent tetragonal phase in ZrO2, along with minimization of light scattering by secondary phases, leading to increased translucency and aging resistance. As yttrium oxide increases, the sizes of the zirconia grains tend to increase as well. Toughness and fracture resistance may be considerably sacrificed.

Keywords: Yttrium; Zirconium; Ceramics; Dental Prosthesis; Dental Porcelain; Dental Materials.

RESUMO

A principal desvantagem da zircônia convencional é sua alta opacidade. Dependendo de diversas condições, especialmente o conteúdo do estabilizador ítrio, é possível contornar essa questão. Em vista disso, várias gerações de zircônia estabilizada com ítrio foram desenvolvidas buscando aliar a robustez da zircônia com a estética das facetas em porcelana. O presente trabalho teve como objetivo realizar uma análise a respeito de como o aumento ou a redução do percentual de ítrio na composição das zircônias monolíticas podem influenciar em suas propriedades, sobretudo no que tange à translucidez. Este estudo foi executado através de uma revisão nas bases de dados SciELO, PubMed e Google Scholar, com artigos publicados entre 2013 e 2021. Desse modo, concluiu-se que o maior teor de Y2O3 tendeu a aumentar a quantidade de fase cúbica isotrópica presente e reduzir a quantidade de fase tetragonal birrefringente no ZrO2, juntamente com uma minimização da dispersão de luz por fases secundárias, levando ao aumento da translucidez e resistência ao envelhecimento. À medida que o óxido de ítrio aumenta, os tamanhos dos grãos de zircônia tendem a aumentar também. A tenacidade e a resistência à fratura podem ser consideravelmente sacrificadas.

Palavras-chave: Ítrio; Zircônio; Cerâmica; Prótese dentária; Porcelana dentária; Materiais dentários.

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INTRODUCTION

In dentistry, restorative and prosthetic techniques aim to reestablish the masticatory function and natural esthetics. These techniques have been developed further, constantly aiming at the improvement of the means and materials employed, especially due to the increasing esthetic demand in contemporary society (1). A beautiful and harmonic clinical result depends on the marginal integrity, surface characterization, and anatomy, in addition to the final compatibility of the colors when compared to the original teeth, which is closely related to optical characteristics such as translucency. The latter is considered one of the most important determining factors of esthetics in dentistry (2).

In this scenario, ceramics are displayed as an exceptional alternative in the reproduction and mimicking of enamel and dentin (2). They present good biocompatibility, thermal expansion coefficient close to that of the tooth, they are non-reactive and have good satisfying resistance to abrasion and compression, in addition to a high degree of intraoral stability, characteristics that grant longevity and safety in restorative works (3,4,5,2). As for their composition, the ceramics may be glassy, infiltrated, and polycrystalline (crystalline) (2).

Zirconia, a polycrystalline ceramic, has been highlighted in its current market for its significant advantages, such as mechanical properties that are superior to other ceramic systems, radiopacity, low corrosion potential, chemical inertia, volumetric stability, and elasticity modulus values comparable to those of steel (6,2,7). Additionally, its characteristic milky white color, high opacity, biocompatibility, and mechanical attributes superior to those of metal alloys, lead them to be used as a substitute material for metals in the infrastructures of ceramic prostheses, implant structures, crowns, and fixed dental prostheses (8,9,10,11).

As for its use in infrastructures (i.e., in two-layer restoration, consisting of the zirconia core or structure covered by a vitro-ceramic veneer that provides the necessary color and optical characteristics), the laminate-core bond strength is considered low and can be led to delamination and fracture of the material, which is clearly a disadvantage (5). Regarding monolithic restoration (full contour), it is composed of only one ceramic piece that can be stained when necessary and is commonly used in posterior and in high occlusal loads regions. The esthetic result may be inferior when compared to the bilayer one, but its mechanical properties are superior (5). Zirconia (ZrO_2) has been pointed as the first choice for monolithic restorations of complete contour, as it provides a less invasive preparation of dental tissues since its mechanical superiority allows the production of pieces with less thickness and only one layer (12,7).

The core structures and monolithic zirconia pieces are manufactured through computer-assisted design and manufacturing technology system CAD/CAM (computer-assisted design/computer-assisted machining), milling commercially available blocks, which are usually pre-sintered (7). Zirconia is the advanced ceramic that displays the best mechanical performance for dental use and machining with the CAD/CAM system (13). Hence, the advent of this technology resulted in greater ease of customized and automated processing, making production faster, and simpler, and boosting its popularity (8,14,10).

The number of crystals in the glass matrix is said to directly influence the translucence of the ceramic: the greater the number of crystals in the glass matrix, the lower the ceramic's translucence, and the fewer infiltrated particles, the greater the translucence (2). Conventional monolithic zirconia (3Y-TZP) has atoms arranged in an essentially crystalline, regular arrangement, with grain contours and crystallographic conformations that are centers of light scattering and alter the optical properties, making them highly opaque (i.e., with a very low translucence) (15,14).

Consequently, the main disadvantage of conventional zirconia is its high opacity. Depending on the sintering conditions, some factors such as grain size, density, additives, and especially the content of the yttrium stabilizer may circumvent this issue. Thus, various generations of zirconia stabilized with yttrium were developed, aiming to combine the robustness of zirconia with the esthetics of porcelain veneers, in addition to contributing to better efficiency in the polymerization of resin cement with greater translucency, increasing clinical applicability, and preserving dental structure with less thickness requirement (16,17).

The first yttrium stabilized zirconia (Y-TZP) that was marketed had a 3 mol% yttrium oxide composition (3Y-TZP). Nowadays, there are commercial zirconia for dentistry with percentages of yttrium ranging from 3 to 5% (e.g., 4Y-TZP and 5Y-TZP, which are more translucent), revealing that the addition or reduction of the percentage of yttrium plays a significant influence on the final properties of the piece (8,9,10,18,19).

Thus, this study aims to review the literature to analyze how the alteration of the percentage of yttrium in monolithic zirconia may influence their properties, especially concerning translucency.

LITERATURE REVIEW

This study was performed, initially, through an integrative review in the SciELO and PubMed

databases. The following keywords were used in conjunction: (Yttrium or *Ítrio*), (Zirconium or *Zircônio*), (Ceramics or *Cerâmica*), (Dental Prosthesis or *Prótese Dentária*), (Dental Porcelain or *Porcelana Dentária*), and (Dental Materials or *Materiais Dentários*), both in English and Brazilian Portuguese, for all the articles related to the subject to be found. Subsequently, a complementary search was performed using the keyword "Yttrium" on Google Scholar. A total number of 42 papers were found, of which 30 were included and 12 were excluded. Inclusion criteria included articles published between 2013 and 2021, *in vitro* studies, clinical trials, and literature reviews. Papers that preceded 2013, in addition to those that did not address the objective of the study, were factors used as exclusion criteria.

Zirconia

Zirconia is the 18th most abundant element in the Earth's crust, existing in a pure state in the amorphous (a bluish black powder) and crystalline (a white and ductile metal) forms (2). Zirconia-based polycrystalline ceramics may be classified according to their microstructure into three types: FSZ (fully stabilized zirconia), PSZ (partially stabilized zirconia), and TZP (tetragonal zirconia polycrystals). The most used in dentistry is TZP, and it is predominantly composed of the tetragonal phase (t), metastable and stabilized with yttrium oxide (3-6% in weight), giving rise to Y-TZP (tetragonal zirconia stabilized with yttria) (20). It can assume three crystallographic phases according to temperature: monoclinic (room temperature up to 1170ºC), tetragonal (t) (between 1170ºC and 2370ºC), and cubic (c) (when the temperature is above 2370ºC to the melting point) (20,21). Pure zirconia is monoclinic at room temperature and this phase is table up to 1170ºC. Above that, in the tetragonal phase, it depends on stabilizers; in the cubic phase, it is only stable at very high temperatures (22).

When this stabilized material is subjected to stresses (e.g., chewing, wearing, and polishing), a transformation from the tetragonal to monoclinic phase may occur, accompanied by an increase in volume. The monoclinic form (m) occupies a volume of 3 to 5% greater than the tetragonal grains, resulting in a generation of compression and nucleation stresses of microcracks (microcrack toughening) around the defect, preventing the crack from propagating and leading to the material's fracture. This mechanism, known as "transformation toughening," is mainly responsible for the fact that Y-TZP is the dental ceramic that presents the best mechanical properties (20,1).

Another toughening mechanism occurs due to the formation of microcracks that arise after local volumetric expansion in the transformation of the tetragonal to monoclinic phase. In this case, the voltage generated by the volumetric expansion exceeds the value supported by the elastic regime of the material, and microcracks arise around the transformed region. These microcracks serve as deflectors and crack branches that are propagate in the material (8,23).

3Y-TZP ceramics have also been shown to be susceptible to progressive chemical aging, termed low-temperature degradation (low-temperature degradation - LTD), which can occur in the presence of water at room temperature. The process involves the penetration of water into surface microcracks, inducing a reversal of the metastable zirconia t-phase back to its most stable m-phase. These reversions cause local peeling stresses, further driving the microcracks and transferring deeper internal stresses underground, grain by grain. Microcracks coalesce and lead to the detachment of the grains, with consequent degradation of resistance (24,25). Zirconia with higher c content is less susceptible to aging, as this phase does not undergo transformation (26,27).

The doping agent is an oxide and acts as a grain contour engineering tool that has control over the composition of ZrO2 grain contours (14). Stabilizers or doping agents are added to aid sintering and control transformability, and directly influence material properties (27). Thus, many components are added for stabilization of the metastable tetragonal phase at room temperature, such as calcium oxide (CaO), magnesium oxide (MgO), lanthanum oxide (La2O3), cerium oxide (CeO2), and, especially, yttrium oxide (Y2O3) (22,1).

Yttrium

Yttrium (Y) and its compounds originate from the chemical processing of ores, in which the presence of lanthanide elements is large, known as rare earths. It is a metallic chemical element, its atomic number is 39, and it has an atomic mass of 88.90584u; it is soft, silvery, solid at room temperature, and of triatomic character, which contributes to the presence of several charge-neutralizing oxygen vacancies (10,7).

RESULTS AND DISCUSSION

Influence of Yttrium

As the content of yttrium oxide increases, the amount of isotropic cubic phase—optically homogeneous, in which the refractive index is constant despite direction, i.e., the light ray propagates with the same speed in all directions—increases in grain contours, which can lead to a decrease in birefringence (optical property of a material that has different refractive indexes for different directions of light propagation) (18).

According to Zhang *et al*., the most studied method for bettering zirconia translucency is to increase the yttria content, introducing a more isotropic cubic phase and less birefringent tetragonal phase, along with minimization of light scattering by secondary phases, such as alumina particles and porosities (12).

Accordingly, Zhang *et al*., when evaluating optical, mechanical, and stability properties of yttrium-stabilized zirconia with different compositions, concluded that the introduction of optically isotropic cubic phase zirconia (cubic phase is stable and does not undergo stress toughening), along with the increase of the yttria content (5 mol% in this study), showed the best effect to increase translucency as well as aging resistance on 3Y-TZP ceramics (25). Toughness and fracture resistance, however, were considerably sacrificed.

Zhang and Lawn, when discussing the tendency of using a higher yttria content to produce partially stabilized zirconia, 4 mol% (4Y PSZ) or 5 mol% (5Y-PSZ), with increased amounts of non-birefringent cubic phase, deduce that even though translucency has improved, resistance and toughness were decreased because cubic zirconia does not undergo voltage-induced transformation (26).

In their review, Pekkan *et al*., when evaluating the factors that affect the translucence of monolithic Y-TZP ceramics, found that the higher Y2O3 content tended to increase the amount of cubic phase present in ZrO2 and concluded that a combination of the fine grain size and cubic ZrO2, with an isotropic refractive index (which helps to avoid the dispersion of grain contours), produces improved translucence (14).

In his thesis, Fonseca (2019) stated that the higher amount of yttrium in zirconia causes the stabilization of the cubic phase at room temperature, which results in a decrease in mechanical resistance and increased translucency of the material due to the optical isotropy of this phase (8).

Shin and Lee, in their work, when comparing the surface roughness between dental zirconia with different yttrium oxide compositions under the same polishing conditions, observed that, as the composition of yttrium oxide increased, the sizes of the zirconia grains tended to increase. Thus, they stated that translucency can be improved by increasing the grain size; nonetheless, it was found that the increase in the composition of yttrium oxide can lead to a decline in the composition of the tetragonal phase of the surface, which has the potential to harden by transformation, and as a result, the mechanical properties of zirconia would be impaired (18).

Kontonasaki *et al*., in turn, point out in their study that the general trend is that, as the sintering temperature increases, the translucency and grain size also increase. Therefore, in zirconia core ceramics, in which an increase in sintering temperature can cause a decrease in flexural strength, this decrease is attributed to a probable migration of yttrium to the grain contours (7).

Pereira *et al*. attribute the higher stabilizer content yttrium the responsibility for the high resistance to aging and for eliminating the zirconia transformation hardening mechanism, in addition to being responsible for the appearance of a large number of cubic crystals in its microstructure. They also estimate that the higher the temperature for sintering and the higher the yttrium content, the larger the size of crystalline grains (28).

For Harada *et al*., the increase in yttrium concentrations tends to increase the amount of optically isotropic cubic phases. Cubical grains are normally bigger than tetragonal grains, resulting in fewer grain limits. Light transmission through polycrystalline ceramics is strongly affected by birefringence at the grain border; therefore, the lower amount of verges between the grains leads to increased translucency (29).

In the study conducted by Pandoleon *et al*., on yttrium depletion in zirconia aging, there was a significant decrease in yttrium content after aging for 5 and 10 h, suggesting that yttrium is removed and that its depletion occurs during the transformation t-m with aging in water vapor. Moreover, a high luminescence was observed by the high amount of oxygen vacancies. Thus, the transformation of the t-m phase after aging with significant loss of yttrium resulted in a decrease in oxygen vacancies and reduced luminescence. Surface oxygen vacancies migrated in and involved ZrO2 oxygen, constituting a metal phase of Y2O3 on the surface after aging. Accordingly, the number of oxygen vacancies generated can act as point defects that absorb light, impairing the optical behavior and translucency of the material (30).

Studies directly addressing the correlation between the percentage of yttrium in the composition of zirconia and its final properties are scarce in the literature. Laboratory research, as well as clinical trials seeking to describe what to expect from prosthetic pieces with a higher or lower percentage of this component, advantages and disadvantages of increased translucency, and how this change can interfere with the characteristics of abrasion, mechanical resistance, and fracture toughness, would be of fundamental importance for this line of research.

CONCLUSION

The papers analyzed in this study point in the same direction by agreeing that the percentage of yttrium has a significant influence on the properties

of monolithic zirconia. Thereby, the higher Y2O3 content tended to increase the amount of isotropic cubic phase and reduce the amount of birefringent tetragonal phase in ZrO2, along with minimization of light scattering by secondary phases, leading to increased translucency and aging resistance. It was also found that, as yttrium oxide increases, the sizes of zirconia grains tend to increase as well, and there may be an improvement in translucency; though, toughness and fracture resistance may be considerably sacrificed.

The authors declare no conflicts of interest.

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LITERATURE REVIEW

PAIN MANAGEMENT OF PATIENTS WITH HEAD AND NECK CANCER IN PALLIATIVE CARE: A LITERATURE REVIEW

CONTROLE DE DOR DE PACIENTES COM CÂNCER DE CABEÇA E PESCOÇO EM CUIDADOS PALIATIVOS: UMA REVISÃO DE LITERATURA

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ABSTRACT

Patients with head and neck cancer (HNC) display limitations and functional impairments. Orofacial pain affects the majority of these patients and may be caused by various factors, both in soft and hard tissues. Patients with advanced stage HNC need to be assisted in a way that promotes quality of life for them and their relatives, as a form of palliative care, especially when the disease is no longer likely to be controlled. Pharmacological analgesia is the backbone of the treatment of cancer pain, but it can also be carried out through non-pharmacological therapies. This study aimed at reviewing the literature and seeking the different pathways to control orofacial pain in patients with HNC in palliative care. Searches in the PubMed and SciELO databases were performed with the words "(pain control) AND (palliative care) AND (head and neck cancer)," aiming to find papers published through the last ten years (2011-2021) and restricting them to clinical trials and randomized clinical trials. We found ten articles in the PubMed database and none in SciELO. After reading their titles and abstracts, we excluded five of them since they did not evaluate patients with HNC nor did they have the analgesic approach as a study objective; therefore, five papers were included in our review. Most studies have shown that analgesia in patients in palliative care affected by malignant head and neck injuries happens with opioids. In this review, we observed a few clinical trials, and further studies must be carried out to seek new ways to reduce symptoms and improve the quality of life of these patients.

KEYWORDS: Mouth Neoplasms; Cancer Pain; Pain Management; Pain Measurement; Palliative care; Analgesia

RESUMO

Pacientes com câncer de cabeça e pescoço (CCP) apresentam limitações e comprometimentos funcionais. A dor orofacial acomete grande parte desses pacientes e pode ser causada por inúmeros fatores, tanto nos tecidos moles quanto nos duros. Pacientes com CCP em estágio avançado, necessitam receber assistência que possibilite melhor qualidade de vida para ele e seus familiares, como forma de cuidado paliativo, principalmente quando a doença não tem mais chance de ser controlada. A analgesia farmacológica é o principal pilar no tratamento da dor oncológica, mas também pode ser realizada por meio de terapias não farmacológicas. Este estudo teve como objetivo revisar a literatura buscando as diferentes formas de controle da dor orofacial de pacientes com CCP em cuidados paliativos. Foram realizadas buscas nas bases de dados PubMed e SciELO com as palavras "(pain control) AND (palliative care) AND (head and neck cancer)", buscando artigos dos dez últimos anos (2011-2021) e restringindo para ensaios clínicos e ensaios clínicos randomizados. Encontramos dez artigos na base PubMed e nenhum na SciELO. Após a leitura do título e resumo, excluímos cinco por não avaliarem pacientes com CCP ou não terem a abordagem analgésica como objetivo do estudo, sendo incluídos finalmente 5 artigos em nossa revisão. A maioria dos estudos mostrou que a analgesia realizada nos pacientes em cuidados paliativos acometidos por lesões malignas de cabeça e pescoço acontece com opioides. Nesta revisão observamos poucos estudos clínicos, sendo importante a realização de trabalhos que busquem novas formas de diminuir os sintomas e melhorar a qualidade de vida desses pacientes.

PALAVRAS-CHAVE: Neoplasias bucais; Dor do câncer; Manejo da dor; Medição da dor; Cuidados paliativos; Analgesia.

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INTRODUCTION

Patients with head and neck cancer (HNC), especially after it reaches their oral cavity, display severe limitations and functional impairments. When the injury does not present forms of treatment, palliative care (PC) may be applied. In these cases, the symptoms may worsen, requiring case-by-case special attention(1). PCs seek to better the quality of life of patients and their relatives because of threatening diseases, through the prevention and relief of suffering(2). The principles of palliative care are: to promote relief of pain and other distressing symptoms; to affirm life and recognize death as a natural process; not to seek to anticipate or postpone death; to integrate psychological and spiritual aspects as part of patient care; to offer a support system to aid the patient in living as actively as possible until death; to offer a support system to the family that allows it to take care of the patient until the end(3).

Orofacial pain may be caused by various diseases or abnormalities in the soft and mineralized tissues of the oral cavity and face. These include temporomandibular dysfunction, trigeminal neuralgia, burning mouth syndrome, oral-dental infections, and cancer(4). Pain is a symptom that 80% of patients with cancer experience in the last year of their lives, and a quarter of them experience severe pain(5,6). Patients with HNC in PC display severe functional restrictions. In such a condition, symptoms may worsen and are not always curable, requiring special attention and care(7). The more frequent oral symptoms are pain, dysphagia, bleeding, trismus, tumor wounds, opportunistic infections, drooling, xerostomia, malnutrition, dehydration, anorexia, and disfigurement(1). In cases of advanced oral cancer, pain, ulceration, bleeding, and trismus are the most relevant symptoms(8).

When pain is caused by a malignant injury, it occurs as the disordered growth of tumor cells may lead to harmful, neurological, inflammatory, and ischemic components that cause cancer pain. Peripheral phenomena are the result of the sensitization of inflammatory mediators of primary afferent neurons. Additionally, there are a few central mechanisms (spine and supraspinatus) that can affect pain. Pain can be caused by the direct action of the tumor (related to tumor invasion) or by treatment (mucositis caused by chemotherapy and radiotherapy) and is an unpleasant, emotional, and sensitive experience, unique, associated with actual or subjective tissue damage(9). It means, thus, that pain is an individual and unique experience, altered by previous knowledge about the damage that the patient may have experienced or imagined - any situation that the patient refers to and describes. Therefore, for correct treatment, a complete evaluation is crucial(10).

In such a way, to promote relief of pain and other symptoms, it is necessary to have specific knowledge of the patient's condition for prescribing drugs, adopting non-pharmacological measures, and addressing the spiritual and psychological aspects that characterize the "total symptom." Thus, the concept of "total pain" created by Dame Cicely Saunders is taken into account, in which all of these factors may contribute to the exacerbation or attenuation of symptoms, and care must be focused on its multifactorial form and taken into consideration in the approach towards the patient in PC with HNC (11,12).

The World Health Organization (WHO) created, in 1986, the first protocol for the management of cancer pain considering the "analgesic ladder." The tactic was to assess and adapt the drug management according to the need of the patient, moment by moment, sequentially, and progressively. The aid in the reduction of symptoms can be around 70 to 90% of cases with the proposed method(13,14). Pharmacological analgesia is the backbone of the treatment of cancer pain. The basic principles of the analgesic ladder are points by mouth and by clock (concerning administration intervals), a treatment that must be personalized for each patient, with continuous evaluation throughout it and frequent reassessments that may allow dose readjustments more efficiently, as well as more accurate diagnoses concerning pain(15).

In addition to the possibility of controlling pain with pharmacological analgesics, there is the use of non-pharmacological therapies, including relaxation, distraction, directed imagination techniques, acupuncture, massage therapy, etc (10,16). This study aimed at reviewing the literature and seeking the different pathways to control orofacial pain in patients with HNC in PC.

LITERATURE REVIEW

A search was carried out in the PubMed and SciELO databases with the words "(pain control) AND (palliative care) AND (oral cancer)" and "(pain control) AND (palliative care) AND (head and neck cancer)." The search was limited to the period of the last ten years (2011-2021) and restricted to clinical trials and randomized clinical trials.

The variables of the articles were analyzed, such as study type, the number of patients evaluated, forms of analgesia, forms of pain measurement, possible side effects, and results found. In the search for "(pain control) AND (palliative care) AND (oral cancer)," we found 39 papers in PubMed and five in SciELO, but none of them met the inclusion criteria of our review. As for the words "(pain

control) AND (palliative care) AND (head and neck cancer)," we found ten articles in PubMed and none in SciELO (Figure 1). After reading their titles and abstracts, we excluded five of them since they did not evaluate patients with HNC nor did they have the analgesic approach as a study objective.

Among the papers that were selected, we extracted information on the study site, study design, the number of patients studied, the form of analgesia tested, how symptoms were measured, possible side effects, and results obtained by the study (Table 1). The year of the studies ranged from 2015 to 2020, two of them from 2018. The studies' sites included India, Italy, and London, and two of them were from the Netherlands.

Four out of the five papers analyzed were controlled, randomized clinical trials and only one was a clinical trial. How patients' pain was measured varied in all studies of the different research groups, namely: Numerical Rating Scale (NRS-11)(17), Brief Pain Inventory (BPI), which is a numerical rating scale filled by the patient (18,19). Leeds assessment of neuropathic symptoms and signs (S-LANSS fillable by the patient) (20), and the Visual Analogue Scale (VAS) for self-assessment(21). The only study that reported side effects was the one that tested Fentanyl *versus* Methadone in 82 patients(19), finding out that 72% of those evaluated reported dry mouth. All of the other studies did not report the presence of adverse effects.

In the study of Kashyap *et al*., 2020, 80 patients were included, sectored into two different groups of 40 each. The control group received the usual treatment with oral opioids (morphine and tramadol), while the experimental group, in addition to opioids, received Scrambler therapy (ST)(17). As a result, a decrease in pain was found in both groups, but the control group experienced a higher intensity of pain. In the studies by Haumann *et al*., 2016 (12) and Haumann *et al*., 2018 (13), the results of Fentanyl and Methadone treatments were assessed. In the 2016 paper, 52 patients were included, 26 in each group, and the results were significantly better for the Methadone group compared with the use of Fentanyl in cases of neuropathic pain treatment. As for the 2018 paper, 82 subjects were included—40 in the Fentanyl group and 42 in the Methadone one. It was found that Methadone is not inferior to Fentanyl in the treatment of nociceptive pain.

Regarding the study conducted by Williams *et al*., (2015) (14), 156 patients were included—75 in the experimental group and 74 in the control group. The study's objective was to provide the experimental group with a pain treatment protocol, with a weekly adaptation of medications, regular visits, association with an educational program, and guidance on pain, whereas individuals in the control group were kept with the usual care. When comparing the results between the groups, no difference was found in the pain severity index. However, the experimental group presented better comfort, greater adherence, and fewer complaints.

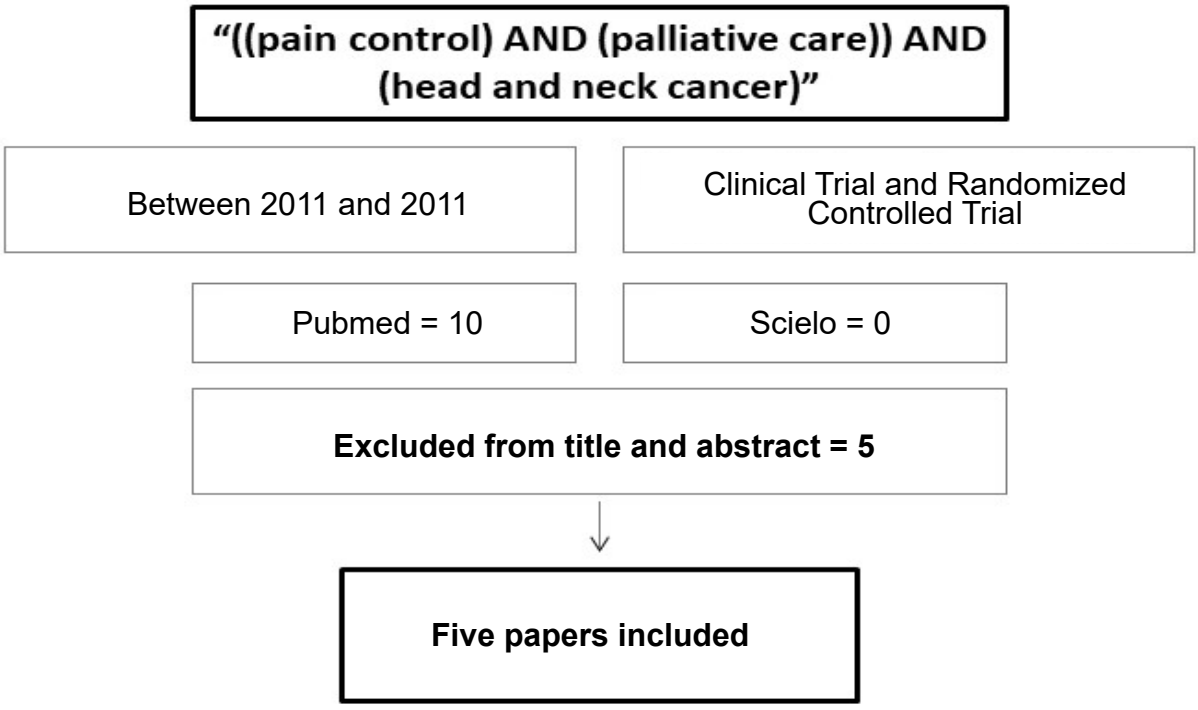

Figure1. *Flowchart of articles included in the review.*

TABLE 1. SELECTED ARTICLES

Author, year	Study site	Study design	Number of patients	CG	Type of analgesia	Pain measurement	Side effects	Results:
Kashyap *et al.*, 2020 (17)	New Delhi (India)	RCT	80 patients - 40 in the EG and 40 in the CG	Yes	EG = oral opioids (morphine and tramadol) + Scrambler therapy CG = oral opioids (morphine and tramadol)	Numerical Rating Scale (NRS-11)	Not reported	Overall, pain decreased in both groups. However, from the second day of treatment, there was a difference in mean pain scores, with patients in the control arm experiencing slightly more pain than patients in the intervention arm. The difference in mean pain increased over the treatment and follow-up period.
Haumann *et al.*, 2016 (18)	Maastricht (the Netherlands)	RCT	52 patients - 26 in the Fentanyl group and 26 in the Methadone group	No	Fentanyl and Methadone	Brief Pain Inventory (BPI)	No serious adverse effects were observed in the study	Methadone is significantly better than Fentanyl in neuropathic pain treatment in patients with head and neck cancer, in terms of pain relief and time to obtain pain relief in cancer patients.
Haumann *et al.*, 2018 (19)	Maastricht (the Netherlands)	RCT	82 patients - 40 in the Fentanyl group and 42 in the Methadone group	No	Fentanyl and methadone	Brief Pain Inventory (BPI)	The most common side effect was dry mouth, reported by 72% of patients during the study	Methadone is not inferior to Fentanyl in the treatment of radiation-induced nociceptive pain in patients with head and neck cancer, between one and three weeks of pharmaceutical pain treatment.
Williams *et al.*, 2015 (20)	Royal Marsden Hospital (London)	RCT	156 patients - 75 in the EG and 74 in the CG	Yes	EG = pain treatment protocol and an educational program. CG = usual care.	Leeds assessment of neuropathic symptoms and signs (S-LANSS self-assessment)	Not reported	There was no difference in the Pain Severity Index between the two groups.
Farina *et al.*, 2018 (21)	Campobasso (Italy)	Clinical trial	48 patients	No	To assess the reduction of symptoms produced by accelerated radiotherapy, administered in four total fractions, twice a day.	Visual Analogue Scale (VAS)	Not reported	Short-term accelerated radiotherapy in locally advanced or metastatic cancers is effective in terms of symptom relief and well tolerated even in older patients.

RCT = Randomized Controlled Trial; EG = Experimental Group; CG = Control Group.

With the clinical trial model of Farina et. al., 2018 (15), 48 subjects were assessed for symptom reduction after the application of short-term accelerated radiotherapy. They were treated with a radiotherapy regimen based on four fractions, twice a day, for two consecutive days. The total dose ranged from 14 and 20 Gray (Gy) (median: 20 Gy), and the dose per fraction ranged from 3.5 to 5 Gy (median: 5 Gy). In cases of locally advanced or metastatic cancer, it was effective in relieving symptoms.

DISCUSSION

The forms of analgesia used in cases of patients in palliative care are still basically based on medications. In this review, four out of the five papers included assessed the results of medication treatment and only one assessed another form of analgesia. In order to understand treatment forms, the causes of pain and from where they originated need to be clarified. In the majority of cases, the causes of pain are varied and increasing, and they may or may not be directly related to the disease. Aspects that can affect the cause of pain are tumor type and origin, location, stage, and treatment(4,22).

The neurophysiological classification of pain is based on the trigger mechanism and is sectored into nociceptive, neuropathic, and complex or mixed. Nociceptive pain is caused by the activation of nociceptors (δ and C fibers) and may be somatic or visceral. Somatic pain is triggered or aggravated by exercise and is relieved by rest. Visceral pain is caused by swelling of the hollow organs and characterized by compression, contraction, or colic. It is difficult to position and may be accompanied by nausea, vomiting, and sweating. On the other hand, neuropathic pain is related to persistent or occasional, acute or chronic dysfunction of the central or peripheral nervous system, and may not be related to any detectable damage. It is described as a sensation of burning, tingling, and shock, and may or may not be accompanied by paresthesia and allodynia (a stimulus that does not produce pain but is considered to be painful). Complex or mixed pain is much more common in patients with cancer and its increase leads to inflammation and compression of adjacent structures. It includes the association between nociceptive pain and neuropathic pain, making diagnosis and treatment more complicated(4,23).

Considering the ways of treating patients, the WHO, in 1986, launched the “analgesic ladder” as their first protocol for the management of cancer pain. The strategy was to assess and adapt the drug management according to the need of the patient, moment by moment, sequentially, and progressively. The symptoms’ relief along with this protocol may be around 70 to 90%(13,24,25). Nonetheless, even with the efforts of the WHO, this protocol is inadequate in 40 to 50% of the cases (26,27). Thus, we were able to find many reports on inadequate pain management in cancer patients (6,28).

Taking into consideration the opioid analgesics, which are derived from Opium, whether natural or synthetic, weak or strong, this class of drugs should be administered with caution, starting with low doses and increasing them if necessary. They cannot be discontinued abruptly, as they would generate abstinence in the patient(23). In the studies included in this review, Tramadol was used in association with Morphine(17), and Fentanyl was compared to Methadone(18,19). Tramadol is considered a weak opioid, is synthetic, and is metabolized by the liver, and its oral administration is twice as bioavailable as parenteral administration. Morphine is considered a strong opioid, and it is administered for the treatment of moderate to severe pain. In the study by Kashyap *et al*., 2020(17), the results presented that, with the decrease in patients’ pain, Morphine is reduced first, and only then Tramadol is reduced. Hence, it is expected Tramadol to be reduced less significantly than Morphine.

Fentanyl and Methadone, investigated in the above mentioned works by Haumann *et al*.,(18,19), are considered strong opioids. Fentanyl for transdermal use is a synthetic opioid similar to morphine and is administered over 72 hours. As for Methadone, which is also synthetic, its administration is aimed at reducing cases of neuropathic pain and intense pain, and, in addition to an effect mediated by the opioid receptor, it has an additional effect on the N-methyl-D-aspartate receptor (NMDA). This receptor is known for being important in central sensitization(29). With this double mechanism of action of Methadone, authors found positive results: it is superior to Fentanyl in the relief of pain in patients with cancer pain with a component of neuropathic pain(18).

According to the results found in the existing literature, we observed that cancer pain treatment is still conducted, basically, with opioids. Notwithstanding, it must be taken into account their wide use *versus* their toxicity and side effects. Opioids may be natural, semi-synthetic, and synthetic, and operate on receptors present in the central nervous system and peripheral nervous system(10). Some points worth highlighting are as follows: the probability of tolerance, caused by desensitization of receptors and consequent gradual loss of their function, leads initially to side effects (except constipation) and then to analgesic effects which can be reversed with the increasing of the dose or drugs rotation. As for side effects, the most common ones are nausea, vomiting, sleepiness, and itching, and they occur more frequently at the beginning of drug administration and when the dose is increased. In HNC, the aim of providing comfort prevails in the choice of the best drugs for each patient and is also in the route of administration of each one(16).

Amongst the studies for non-medicated pain control, the use of Scrambler therapy was assessed, which is similar to transcutaneous electrical nerve stimulation (TENS). They are the most used neuromodulatory techniques(30). Scrambler therapy is a new method, introduced in the early 2000s, which uses a device that produces 16 different electrical current signals. These signs simulate the normal action potential of the nerve, and the electrodes around the area of pain usually lead to immediate relief. Each session of ST lasts 30 to 45 minutes. The majority of patients report pain relief as early as the first sessions, which continues after that(31,32). It has been used to treat pain, including cancer pain. Pain relief associated with this therapy was considered significant and lasting among numerous patient groups(33). In the study, results improved over time. Thus, it may be a good choice for patients for whom pharmacological pain management has not brought sufficient relief(17).

Another therapy assessed is palliative radiotherapy, which may have relevant importance in this population(34). Since it is a sort of therapy that does not interfere with others, it could simply be integrated into the treatment plan without causing the interruption of other treatments. The study conducted by Farina *et al*., 2018, treated patients with a radiotherapy regimen based on four fractions, twice a day, for two consecutive days. The total dose ranged from 14 and 20 Gray (Gy) and the dose per fraction ranged from 3.5 to 5 Gy (median: 5 Gy). The pain relief response rate was 89.7% after radiotherapy. Therefore, we found in the literature other reports that assess this therapy and address its benefits. Taking into account older patients, radiation treatment plays a vital role in curative and palliative cancer therapy(35). Hence, palliative treatment with radiotherapy could be part of the therapeutic arsenal in this scenario(21).

The problem of pain in patients with cancer has already been considered, and copious recommendations have been made by national and international bodies(36,37). These include pain screening and the use of analgesic treatment pathways integrated into routine cancer treatment(38). A study with patients with HNC presented a prevalence of “moderate to severe” pain in 34% of patients treated with usual care guidelines(39). Accordingly, the objective of the study by Williams *et al*., 2015, was to determine whether it would be possible to improve pain reduction scores through the introduction of a combined screening, treatment, and educational approach (intervention group) in these patients. The results did now show any additional benefit since both groups experienced substantial improvements in pain scores. Patients in the intervention group had some improvements, but with a substantially increased cost, not adequate in cost-benefit(20). In such a way, the pain screening model is easy to implement and can be combined with existing therapies. It is an effective and economical treatment strategy for patients with cancer pain.

CONCLUSION

Most of the analgesia performed in patients affected by malignant head and neck injuries happens with opioids. Our review of the literature found a small number of clinical trials with this population. Thus, we believe it is of paramount importance that more studies that seek new ways to reduce symptoms and bring relief from suffering should be carried out.

The authors declare that there is no conflict of interest.

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LITERATURE REVIEW

LEAN HEALTHCARE METHOD AND DENTISTRY: A LITERATURE REVIEW

METODOLOGIA LEAN HEALTHCARE E A ODONTOLOGIA: UMA REVISÃO DA LITERATURA

Rafael Matheus Lima[1], Selma Maria de Azevedo Sias[2], Maurício de Souza Leão[3]

ABSTRACT

This study aimed to carry out a literature review on the lean method, assessing its applicability in dentistry. The research has a bibliographic, descriptive, and retrospective scope. Thus, we selected scientific articles that addressed concepts on the lean method and dentistry. We researched the following databases: Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Biblioteca Regional de Medicina (BIREME), Scientific Electronic Library Online (SciELO), and Public MEDLINE (PubMed). We included, essentially, articles from the last 35 years (1987-2022) with abstracts (in English or Portuguese) that presented the following terms: "Lean Methodology" and "Health Management and Dentistry." Worldwide healthcare has experienced an explosion in knowledge, innovation, and the ability to manage formerly fatal conditions. However, it is still far from the expected standard of quality, results, cost, and equity. Lean Methodology has been implemented in clinics, offices, and hospitals to attain improvements in dental and oral health service processes, resulting in significant advances in these, as well as in the quality of care and cost reduction for organizations. The Lean Method can be applied in dentistry since it can act in reducing waste, eliminating redundancies in activities, and increasing the safety of care.

Keywords: Method, Health Management, Dentistry.

RESUMO

O objetivo do presente estudo foi realizar uma revisão de literatura sobre a metodologia *lean*, avaliando sua aplicabilidade na odontologia. A pesquisa delineada é de natureza bibliográfica, descritiva e retrospectiva. Assim, foram selecionados artigos científicos que abordavam conceitos sobre metodologia *lean* e odontologia. As buscas foram realizadas nos bancos de dados virtuais: Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), Biblioteca Regional de Medicina (BIREME), Scientific Electronic Library Online (SciELO) e Public MEDLINE (PubMed). Foram incluídos sobretudo artigos dos últimos 35 anos (1987-2022) e que apresentaram pelo menos o resumo, em inglês ou português, com os seguintes termos: "metodologia *lean*"; "gestão em saúde e odontologia". A saúde mundial sofreu uma explosão no conhecimento, na inovação e na capacidade de gerenciar as condições anteriormente fatais. Contudo, ainda está longe do padrão esperado de qualidade, resultados, custo e equidade. O *lean thinking*, ou pensamento enxuto, tem sido implementado em clínicas, consultórios e hospitais com o objetivo de conseguir melhorias nos processos de serviços odontológicos e de saúde bucal, resultando em melhorias significativas nos processos, qualidade do atendimento e redução de custos para as organizações. A metodologia *lean* pode ser aplicada na odontologia visto que pode atuar na redução de desperdícios, eliminação de redundâncias de atividades e aumento da segurança da assistência.

Palavras-chave: Metodologia, Gestão em Saúde, Odontologia.

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INTRODUCTION

Oral health plays an important role in the quality of life of people given that negligence in this healthcare process culminates in tooth loss caused by caries or periodontal disease, resulting, in some cases, in diseases in other parts of the body (e.g., heart and lungs). This occurs because bacteria present in the gums and dental pulps can move from the infected site and access the patient's bloodstream, affecting other organs and causing certain diseases, as well as generating drastic consequences to people's health (1-3).

To achieve effective management of public health services, it is necessary to regulate some challenges regarding human, financial, logistical, and sanitary resources, as well as coordinate processes and verify the needs of the sector to provide a safe and qualified service. Among the numerous management principles, the principle of lean management – known as Lean Thinking or Method – has been used efficiently for decades in manufacturing companies (4).

In the healthcare area, Lean Thinking began acquiring credibility when people started thinking that the knowledge previously applied in the industries could add value to the patient, and the processes could be reformulated in order to improve process flows and reduce waste (5).

The Lean Method means doing more with less, i.e., a set of tools, a management system, and a philosophy that can change how healthcare organizations are administered. Hence, the aim is to help these organizations to gain a broader view of their activities, providing conditions to improve the quality of care to users by reducing errors and the waiting time for care (6). In this sense, the objective of this study was to elucidate a review of the literature, narrative-like, on the Lean Method, clarifying its applicability in dentistry and highlighting some of its benefits.

Moreover, this article's purpose is to assess how the Lean Method can be used in dentistry. For this purpose, a method of review of the literature was used to demonstrate how the implementation of the Lean Method can contribute to improving dental and oral health service processes, quality of care, and cost reduction for organizations.

METHODS

The research has a bibliographic, descriptive, and retrospective scope (7-9). Thus, we selected scientific articles that addressed concepts on the Lean Method and dentistry. Hence, a narrative review of the literature was carried out. We researched the following databases: *Literatura Latino-Americana e do Caribe em Ciências da Saúde* (LILACS), *Biblioteca Regional de Medicina* (BIREME), Scientific Electronic Library Online (SciELO), and Public MEDLINE (PubMed). The following terms were used: "Lean Method" and "Health Management and Dentistry."

As inclusion criteria, we highlight the following: scientific articles; books; master's degree thesis; doctoral thesis–all published in full in national and international journals, both in Portuguese or in English. The established period was 35 years (1987-2022). Texts that did not include the objective of the research in their title or abstract were excluded, as well as ones dated prior to January 1987, and the ones that addressed the method in other areas. Forty-three out of the 68 articles that were found ended up being accepted to integrate this review of the literature (Figure 1). The screening was made in a peer-review manner, in which two researchers evaluated whether the text would be included in this study or not. In case of a disagreement, a third researcher would deliberate.

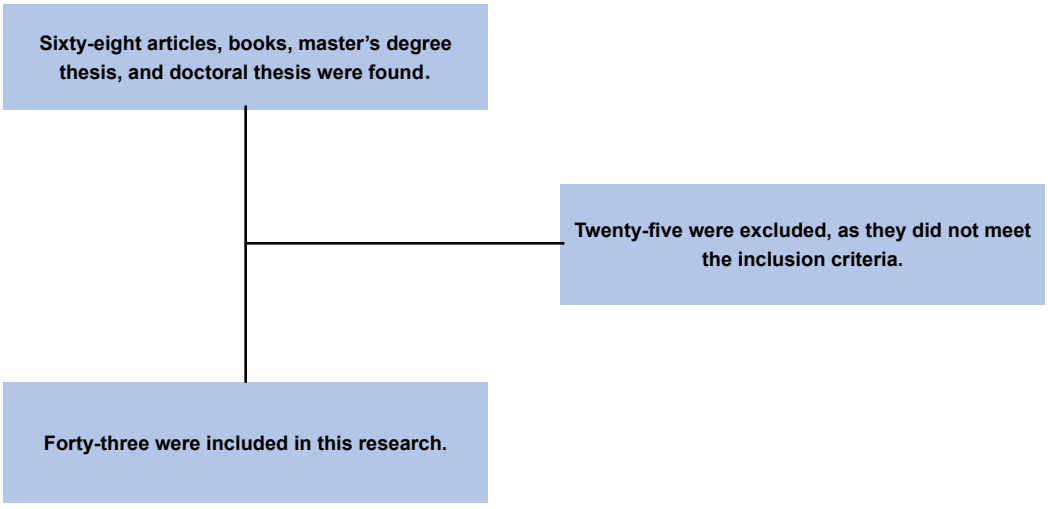

Figure 1 – *Flowchart representing the articles' screening.*

LITERATURE REVIEW AND DISCUSSION

Historically, the means of production and large companies have sought ways to improve the quality of products and services, in addition to reducing production costs. Hence, committed to eliminating errors and increasing production, management methods emerged. The Lean Thinking model is one of them, doctrinally known as a kind of management philosophy. It focuses on suppressing seven sources of waste: overproduction; waiting; transportation; overprocessing; inventory; motion; and defects (10).

The term "Lean" first appeared in 1988 in John Krafcik's master's thesis at the Massachusetts Institute of Technology (MIT), which studied and analyzed the techniques of the Toyota Production System (TPS) (11-14). Yet, it was only in the 1990s, with the publication of "Beyond Toyota," by Womack and Jones (15), that "Lean" came to be used to address this management modality. "The machine that changed the world," based on research developed over five years, concluded that the TPS system was more effective and efficient than any traditional mass production system. This production method was named "Lean."

In "Lean Hospitals," Graban stated that Lean Thinking is a systematic approach through which losses are identified and eliminated throughout the production process (16). Its main goal is to add quality and deliver to the customer only what he considers to be valuable. Thus, this approach has as its main characteristics the valuation of the product for the customer and minimization of the company's waste, therefore promoting the improvement of technologies, resources, and departments. In this scenario, the productive stages develop more easily.

Additionally, Shiver and Eitel define the Lean Method as a highly effective improvement, which originated in manufacturing processes (17). This model is considered the result of thirty years of evolution of production methods of Toyota Motors Company (18). Although it was conceived in the context of the automotive and manufacturing industry, this method can be adapted and applied to other means of production. Over the years, this management model was adapted and widely applied in other business systems-including service companies (15).

It is by using this system that the company is able to identify, prioritize, and extinguish waste, culminating in the reduction of costs and labor. Through this culture, it is possible to create a continuous flow of value to the customer, eliminating losses throughout the operational process and in the shortest possible time (Charts 1 and 2).

CHART 1 - LEAN THINKING PRINCIPLES.

Principle	Objective
Value	Understand what value means to the customer.
Value Stream	Identify which process steps add value by eliminating non-added steps from the time the customer orders to delivery.
Flowing	Keep the process smoothly flowing by eliminating causes of delays such as batches and quality issues.
Pull	Avoid pushing work or materials to the next department, allowing work and suppliers to be pulled when needed.
Perfection	Seek perfection through continuous improvement.

Source: *Graban (16).*

CHART 2 - WASTE FROM THE LEAN PRODUCTION.

Waste category	Traditional definition
Overproduction	Produce too much or too early, resulting in excess inventory.
Defects	Frequent errors in information processing, problems in product quality, or poor delivery performance.
Unnecessary inventories	Excessive storage and waiting for necessary information or products, resulting in excessive cost and low-level customer service.
Improper processing	Execute the process with inappropriate tools, procedures, or systems, to the detriment of simpler and more efficient approaches.
Excessive transport	Excessive transportation of goods or information, resulting in increased time, effort, and cost.
Excessive movement	Excessive movement of people, moving and storing parts, including unnecessary physical movements of operators.
Waiting	Long periods of inactivity of people, information, or goods, result in poor and long lead times.

Source: *Shiver and Eitel (17).*

All the areas of the company can benefit from the application of lean principles, ensuring lowers costs, high-quality services, and delivery of better services in the time and standards desired by the customer. The adaptation of lean production concepts to the service sector is called Lean Service (19).

Although lean production is usually seen as a manufacturing concept, many of its tools were developed in the service industries (20). According to Bowen and Youngdahl, a basal difference between lean production and the lean approach for services is that it occurs in the presence of the consumer, which does not happen in typical manufacturing (21). The authors presented the successful example of the Shouldice Hospital, which reveals that the lean approach, applied to the standardization and efficiency of the support sectors and in the extensive participation of patients also achieves these objectives in the preparation and performance of surgeries and the recovery phases (22).

In this context, we have the application of the Lean philosophy in the healthcare scenario, or the set of concepts, techniques, and tools that improves the organization and management of hospitals and correlated (16). The functionality of the Lean Manufacturing method was also passed on to the health services area. The health sectors are composed of various processes and variables that need ordering and excellence in management. The implantation of this management in the healthcare area is justified by the growing demand for health services in the search to provide high-efficiency and quality care to patients (23).

To achieve improvements, as well as in the automotive sector, speculations were initiated describing lean production in the healthcare area that sought to understand the possible application of tools and techniques known through common sense and experience in general. The Lean Thinking application in the hospital environment was defended by Womack as a process improvement factor that acts to create value for clients and patients (24). The first report of Lean Thinking assigned to improving patient flow includes Bushell and Shelest, who describes a pilot implementation of it in a medium-sized hospital in the United States (25). In turn, Feinstein *et al*. report 24 good results arising from the implementation of the Lean Healthcare in American hospitals (26).

Laursen presented the evolution of the Lean system over time (27). Even though there is imprecision of the dates of the events due to the vagueness around the first application in the field, the authors considere a delay of ten years in the appearance of Lean Healthcare when compared to other industries that provide services, since it was only around 2002 that hospital managements started applying the Lean Healthcare philosophy in its processes.

The first implantations of Lean Healthcare took place in hospitals in England, the United States, Canada, and Australia (28). The improvements that this brings to the healthcare area are possible to be noticed through the analysis of some studies, such as the ones related to its implementation in an operating room and an emergency room of a North American hospital (29).

In order to ensure the implantation of the lean mentality, the following tools are used: rapid improvement events (Kaizen event); the flow of value mapping; 5S (management program); work standardization, process redesign, pulled system/ kanban, and physical arrangement review. Along with the application of these tools and techniques, results were obtained in the reduction of costs of purchase of supply/instrument, expenses of repairs and inventory, improvements in planning, reduction of overtime, increase in capacity, increase in net revenue, and reduction in length of stay (30).

According to Womack and Jones, the concepts within Lean Manufacturing must be applied following five principles: determining what is valuable to the customer; identifying the flow of value; implanting continuous flow; pulled production; and perfection (15). They also consider that the value can only be defined by the final customer (31). In a hospital setting, plenty of customers exist for the very diverse activities and services offered there. The most obvious of the "end" customers is the patient. Most activities and priorities should be focused on this customer (6). According to Graban, there are five principles of Lean Thinking for dental clinics (Chart 3) (6).

CHART 3 - LEAN THINKING PRINCIPLES FOR CLINICS.

Principle	Lean clinics should...
Value	Specify value from the perspective of the final customer (the patient).
Value stream	Identify all value-added steps across departments (the value stream) by eliminating those steps that do not create value.
Flow	Keep the process smoothly flowing by eliminating the causes of delays, such as problems with batches and quality.
Pull	Avoid transferring work to the following process or department, letting work and supplies be pulled as needed.
Perfection	Seek perfection through continuous improvement.

Source: *Adapted from Graban (13).*

Lovelock and Wright stated that services have the following characteristics throughout their provision: intangibility, simultaneity, and customer participation (32). The degree of participation may vary depending on the type of service. However, there is always some participation of the customer, being directly or indirectly.

Another characteristic that is worth mentioning is linked to the necessary degree of knowledge for its execution. Miles *et al*. define the Knowledge Intensive Business Service (KIBS) as the kind of service that heavily relies on professional knowledge (33). For the authors, some of these services are part of technological changes, especially those related to information and communication technology. The KIBS is responsible for generating products whose primary source of information is knowledge (consultancies, reports, training, among others).

Given this scenario, the statistical office of the European Union (Eurostat) grouped KIBS into some service sectors: high-tech; financial; other knowledge-intensive services, which include publishing activities, veterinary activities, public administration and defense, social services, healthcare services, recreational, cultural, and entertainment services (34). It is in the KBIS cluster that dentistry is inserted since it is a branch of healthcare services.

Freire highlights that global health has experienced an explosion in knowledge, innovation, and the ability to manage formerly fatal conditions (35). However, it is still far from the expected standard of quality, results, cost, and equity. The health service, regardless of the country, endures inefficiency and quality problems, which challenge the managers of the area. In Brazil, the history of health services revealed an exponential drop in quality and restriction of access to the population (36).

The health services, dentistry included, constitute a complex environment, and managers of hospitals, clinics, and offices need to understand the peculiarities of their organization. Buzzi and Plytiuk highlighted that there are similarities between healthcare services and other types of services and their respective productive systems: processes; materials

management; human resources management; and customer/patients (37).

Womack and Jones defined the basal principles of the Lean Thinking method as follows: specify the value to the customer; identify the value chain; implement the continuous flow; establish a system of pulled production; perfection (15). Ergo, Lean Thinking is a set of operating philosophies and methods that use the principles of lean production for identifying values to the customers, reducing waste in the production chain, directing steps toward improving the continuous improvement of efficiency and effectiveness of the production system.

The implementation process of lean production is based on the identification and elimination of waste, which add cost and time to the products and processes. Given this scenario, activities that do not add value to the production chain of the product are classified as waste. Aiming at avoiding it, one must understand the definition of waste and its causes (38).

According to Graban, waste is considered the problem and annoyance that constantly arise in the production process, interfering with the work of the team (6). In a broader context regarding Lean Thinking, everything that does not add value to the product is considered to be waste. Womack and Jones stated that Lean Thinking is a way of producing more with less: less human effort; less equipment; and much less space (15). Besides, there are a few other definitions (Chart 4).

CHART 4 - LEAN PRODUCTION DEFINITIONS.

Authors	Lean Production Definitions
Womack, Jones, and Roos (13)	Production system aiming at increasing efficiency through the elimination and reduction of activities that do not add value to the product, therefore retaining the value perceived by customers.
Shingo (39)	Production system that aims at eliminating total amount of losses.
Godinho Filho (40)	Strategic, integrated manufacturing management model that includes a series of principles and enablers (tools, technologies, and methodologies for achieving these principles) that help companies achieve certain performance objectives, thereby increasing their competitive power.
Liker and Morgan (41)	A production system that integrates people, processes, tools, and technologies to deliver customer-defined value by developing a waste-free workflow.

Source: *Regis, Gohr, and Santos (42).*

By applying these concepts in the healthcare area, the results found can bring more quality to the service provided, as well as greater patient satisfaction in the use of the service and employee satisfaction, in addition to making the organizational environment more pleasant. In dentistry, the processes are characterized by repetitive procedures and tasks with intensive knowledge implementation. While the management of materials is basal, given that the excess inventory can compromise the capital invested in some cases (e.g., due to generating waste regarding obsolescence or expiration), it is necessary to ensure the synchronization between the availability of materials and their demand, as well as avoiding that the lack of material makes a procedure unfeasible, which may delay treatment and cause major inconvenience to the patient.

Ergo, applying the abovementioned definitions drawn in Chart 4, with the lean method applied in dentistry, it is possible to cause a reduction in material waste, which therefore contributes to cost reduction and profit increase. Moreover, applying the principles of this method would positively impact the identification and correction of the activities that impair the progress of the service. Also, it is worth highlighting the integration of people, processes, and technologies that promote the best flow, and, consequently, greater quality and efficiency of the service provided (39-42).

We point out, as limitations of our research, the inclusion of a few articles clarifying the application of the Lean method in the dentistry area. Thus, further studies are necessary for observing this application. Research carried out to elucidate this method would be of outstanding importance, for it could demonstrate the evolution of the dental service after the application, in addition to reducing the cost and increasing the efficiency and quality of the service provided.

CONCLUSION

Lean Thinking is implemented in clinics, offices, and hospitals to achieve improvements in dental and oral health service processes. It is directed toward reducing waste, eliminating redundancies in activities, and increasing the safety of healthcare. Thus, the lean method can be applied in dentistry to ensure a better service quality.

The authors declare no conflicts of interest.

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