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EDITORIAL

La odontología aplicada al deporte, una necesidad para el atleta

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El 24 de julio de 2020 el estadio nacional de Tokio, en Japón, se convertiría en el epicentro de los Juegos Olímpicos donde un tumulto de atletas de diversas disciplinas deportivas y de muchos lugares del mundo se darían cita para disputar los logros que desde 776 a. C. se realizaban en la Villa Griega de Olimpia, dentro del Santuario del dios Zeus (aunque en 1896 se iniciaron las de la era moderna); sin embargo, estos eventos deportivos de Tokio fueron pospuestos para el siguiente año (23 de julio de 2021). En 124 años nunca antes habían sido postergados, sólo en 1916, 1940 y 1944 fueron cancelados debido a los conflictos bélicos de las dos guerras mundiales, pero ahora la aparición de un nuevo virus (SARS-CoV-2) de la familia de los coronavirus y causante de la enfermedad COVID-19 que surgió en Wuhan, China, en el año 2019, se extendió por todo el mundo y ocasionó una pandemia que condicionó este aplazamiento, haciendo que esta justa deportiva pasara a la historia no sólo por la espera de romper marcas atléticas.

Es bien sabido, y la evidencia científica lo manifiesta, que mediante la práctica deportiva, el ejercicio o la actividad física se logra obtener un óptimo estado de salud físico, psíquico y social (siempre y cuando no se sufra de una lesión), a esto se le conoce como salud deportiva, cuyo objetivo es promover el ejercicio recreativo y competitivo sin que la competencia y el rendimiento sea lo más importante, sino la contribución de estas actividades a la salud del ser humano. La medicina del deporte es la especialidad cuyo objetivo es el diagnóstico y manejo de las lesiones y la promoción de la salud en la población general a través de la actividad física, el ejercicio o el deporte, además de que es interdisciplinaria, ya que diversas especialidades y otras ciencias la integran. Dentro de las actividades deportivas es evidente la importancia de especialidades como la Nutrición, la Cardiología o la Ortopedia, por mencionar algunas; sin embargo, la Odontología Aplicada al Deporte es la especialidad encargada del estudio, revisión, control, prevención y tratamiento no sólo de las lesiones dentales, bucales y faciales (inclusive de éstas que originan conmociones cerebrales), sino que además se involucra en análisis relacionados con mediciones antropo-cefalográficas que permiten identificar talentosos deportistas. Esta disciplina también tiene la obligación de divulgar y dar nueva información de conocimientos relacionados con la salud estomatológica y el deporte, aplicados en el mundo de la competición deportiva tanto en el terreno aficionado como profesional. Además, se ocupa de mantener el control e información sobre farmacología que pudiera afectar el rendimiento o sustancias prohibidas en competiciones.

Dentro del campo de la literatura científica se encuentra una gran cantidad de publicaciones que hacen referencia a la Odontología con la actividad deportiva, pero la mayoría de éstas están primordialmente enfocadas en determinar o describir la epidemiología de las lesiones, traumatismos o fracturas, ya sean dentales o del área maxilofacial asociadas con ciertas disciplinas deportivas, en especial aquellas que involucran actividades deportivas de contacto. Otros autores se han dedicado a publicar lo referente a la prevención para este tipo de lesiones.

Existe largo terreno recorrido en la literatura científica sobre estos temas y una de las primeras referen-

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cias que hicieron mención de la todavía no mencionada Odontología Aplicada al Deporte se concentró en la fabricación de protectores bucales (siglo XIX); sin embargo, y por el interés en las necesidades bucales de los atletas, es hasta en 1983 que en San Antonio, Texas, se fundó la Academia de Odontología Deportiva que se integra al día de hoy por estomatólogos, médicos, entrenadores y preparadores físicos, docentes y atletas activos o retirados. También esta academia tiene estrecha relación con la Asociación Dental Americana. Algunos países cuentan con sus propias asociaciones dedicadas a este rubro.

A pesar de que existe abundante bibliografía con respecto a esta especialidad, aún no es muy conocida dentro del ramo integral médico de los atletas, lo cual limita la integración de un profesional en este ramo en el equipo de evaluación médica integral. La Odontología Aplicada al Deporte parece no estar debidamente valorada como ciencia que en definitiva contribuye de manera significativa en el rendimiento del atleta, además de que todavía es alejada por otras disciplinas de la salud sin contar también que pocos profesionales en esta área se interesen en estudiarla para hacer crecer estos conocimientos y poder difundirlos a través de la literatura científica; asimismo, se ha demostrado que los atletas desconocen mucho sobre esta disciplina: la Odontología Aplicada al Deporte.

Editorial

Dentistry applied to sport, a necessity for the athlete

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July 24th, 2020, the National Stadium of Tokyo, Japan, should have been the day when it would become the epicenter of the Olympic Games, where a tumult of athletes from various sports disciplines and many parts of the world would gather to dispute and obtain the glory, that since 776 BC were held in the Villa of Olympia, Greece, within the sanctuary of the god Zeus (although in 1896 began those of the modern era). However, these sporting events in Tokyo were postponed for the following year (July 23, 2021). In 124 years, they had never been postponed, only in 1916, 1940 and, 1944 they were canceled due to the war conflicts of World War I, and World War II. But the emergence in 2019, in Wuhan, China, of a new virus belongs to the coronavirus family (SARS-CoV-2), and the disease (COVID-19) caused by this virus, which spread throughout the world causing a pandemic, conditioned this postponement, making this sporting event be remembered in history not only because of the expectation of breaking athletic records.

It is well known, and scientific evidence supports it, that through sports practice, exercise, or physical activity it is possible to achieve an optimal state of physical, psychological, and social health (if you do not suffer an injury), this is known as Sports Health. Sports Health aims to promote recreational and competitive exercise without competition and performance is the most important issue, but the contribution of these activities to the health of the human being. Sports medicine is the specialty whose objective is the diagnosis and management of injuries and the promotion of health in the general population through physical activity, exercise, or sport, besides the fact that it is interdisciplinary since several specialties and other sciences integrate it. Within the sports activities, it is evident the importance of specialties such as Nutrition, Cardiology, or Orthopaedics to mention a few. Dentistry Applied to Sports is the medical specialty that addresses the study, review, control, prevention, and treatment not only of dental or oral and facial injuries (including those that cause concussions), but it is also involved in the analysis related to anthropo-cephalographic measurements that allow the identification of possible talented athletes. This discipline also should disseminate and provide new information and knowledge related to stomatological health and sports, applied in the world of sports competition in both amateur and professional fields. It is also responsible for maintaining control and information on pharmacology that could affect performance or prohibited substances in competitions. There are a huge number of scientific publications that refer to dentistry and sports activities, but most of these are primarily focused on determining or describing the epidemiology of injuries, trauma, or fractures afflicting dental organs or maxillofacial area, related to certain sports disciplines, especially those involving contact sports activities. Other authors have devoted themselves to publishing on the prevention of these types of injuries.

There is a long history in the scientific literature on these topics and one of the first references that made mention of the not yet mentioned Dentistry Applied to Sports focused on the manufacture of mouthguards (XIX century); however, and due to the interest in

the oral needs of athletes, in 1983 in San Antonio Texas that the Academy of Sports Dentistry was founded. Academy of Sports Dentistry is integrated by stomatologists, physicians, coaches and physical trainers, teachers, and active or retired athletes. This academy also has a close relationship with the American Dental Association. Some countries have their associations dedicated to this field.

Although there is already an abundant bibliography on this specialty, it is still not well known within the integral medical field of athletes, limiting the integration of a professional in this field in the integral medical evaluation team. Dentistry Applied to Sport still seems not to be properly valued as a science that ultimately contributes significantly to the athlete's performance and is still distanced by other health disciplines, there are few professionals interested in this area of health, into study to increase this knowledge and disseminate it through scientific literature. It has also been shown that athletes do not know much about this discipline: Dentistry Applied to Sport.

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Facultad de Odontología
SPECIAL ARTICLE

Teaching dentistry in COVID-19 times: concerns about the gradual return to theoretical and clinical activities

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ABSTRACT

In December 2019, rumors coming from China about a new disease changed the entirely world as we know it. In Central America, El Salvador declared national emergency on March 14th, 2020 establishing a mandatory quarantine which affected face-to-face activities, including suspension of the entire educational system and dental attendance. Both measures have negative influences on dental schools, who had to move the entire curricula to virtual learning. Based on a review of the available literature, this short communication addresses faculty members and students concerns through core questions and presents a proposal for reopening academic and clinical activities, approaches to prevent contagion and ways to move forward with the consequences of COVID-19.

Keywords: Teaching, education institutions, COVID-19, dental education, practice guidelines.

La enseñanza de la odontología en tiempos del COVID-19: preocupaciones por el regreso paulatino a las actividades teóricas y clínicas

RESUMEN

En diciembre de 2019, rumores provenientes de China sobre una nueva enfermedad cambiaron el mundo entero tal como lo conocemos. En Centroamérica, El Salvador declaró emergencia nacional el 14 de marzo de 2020, estableciendo una cuarentena obligatoria que afectó las actividades presenciales, incluida la suspensión de todo el sistema educativo y la atención odontológica. Ambas medidas tienen influencias negativas en las Facultades de Odontología, que tuvieron que trasladar todo el currículo al aprendizaje virtual. Con base en una revisión de la literatura disponible, esta breve comunicación aborda las inquietudes de los miembros de la Facultad y los estudiantes, a través de preguntas esenciales, y presenta una propuesta para reabrir las actividades académicas y clínicas, enfoques para prevenir el contagio y formas de superar las consecuencias del COVID-19.

Palabras clave: Enseñanza, educación superior, COVID-19, educación en odontología, guía de práctica clínica.

INTRODUCTION

In December 2019, rumors of a new disease coming from Wuhan, China, completely changed the world as we knew it until then. Everybody thought it was a rare type of flu until cases and deaths began to increase and spread to other countries. No one could imagine the global crisis, fear, and uncertainty that it would unleash.

On March 11, 2020, the WHO declared coronavirus disease 2019 (COVID-19) a pandemic. To date, on July 30th, 2020, there are 17.238.832 confirmed cases in 188 countries; El Salvador has already confirmed 16,230 cases (https://coronavirus.jhu.edu/map.html) and the contagion figures are increasing after the first case reported by the government. Although the fatality rate in the country is low, the risk of infection by the virus is high. Additionally, the reproductive number (Ro) for SARS-CoV-2 ranges from 2.24 to 3.58 and is significantly higher than 1. These findings indicate the potential for SARS-CoV-2 to cause outbreaks of disease.[1]

In Central America, El Salvador declared a state of national emergency on March 14th, establishing

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a mandatory quarantine that affects all face-to-face activities, including the suspension of the entire education system and dental care.

MAIN SECTION

The impact of SARS-CoV-2 is significant in all aspects of world population lives. Higher Education (HE) is no exception. According to UNESCO, 9.8 million African students are experiencing interruptions in their studies due to the closure of higher education institutions. The danger of contamination has led institutions to teach their courses online (https://www.universityworldnews.com/post.php?story=20200409103755715). There is evidence to support that school closures were an effective intervention to mitigate the spread of respiratory infectious diseases and decrease the number of infected students at the peak during the H1N1 influenza pandemic disease.[2]

Schools of Dentristry apply different teaching-learning methods and techniques that also have been directly impacted by the measures taken to counter the pandemic, especially the clinical approach. As part of the Faculty of Dentistry at the University of El Salvador (UES), we also face many challenges to ensure the teaching-learning process and try to follow up the academic courses offered to students in the best possible way. Nevertheless, reasonable concerns do arise: when will be the right time to restart academic and clinical activities in dental schools? What will be our approach to prevent contagion and continue the teaching-learning process? What do we have to do to move on?

Regarding the appropriate time to reopen the theoretical and clinical activities of dental schools, it is clear that it will depend on many factors such as the lifting of restrictions decreed by the government, the level of control of the disease transmission, the health services capability to respond effectively in terms of prevention, treatment, and follow-up. Other factors to consider are the use of good practices suggested by scientific evidence for the daily management of the disease, all the preventive measures taken in the educational, commercial, and financial fields to reduce the probability of progressive transmission chains, and control compliance by the population.

In the HE context, the UES authorities must lead a high level of participation, analysis, discussion, and communication process to design a plan for phased incorporation into the academic activities, considering the characteristics of each school, to minimize the risk of COVID-19 infection.

The droplets of saliva are a dangerous vehicle of contagion, so dental health professionals can become potential carriers of the disease and preventive measures should be taken for a dental facility during this epidemic disease.[3] If the aforementioned conditions are not met, the measures will not be sufficient to open dental school clinics.

Concerning the second question, dental schools around the world adopted online methodologies and the indefinite suspension of clinical activities, except for urgent treatments.[4] Up to now, there has been no consensus on the provision of dental services during the COVID-19 pandemic. Even though the rush and inexperience, the virtual curriculum (online lectures, case studies, and problem-based learning tutorials[3]) with the help of a digital platform, other available applications on the internet, and evaluation logistics efforts, we consider everything works well enough, but there is room for improvement in our school that must be addressed shortly.

Due to the deleterious effects that droplets of saliva and aerosols might have both in the clinics and in the classrooms, standard protective measures in daily work might not be effective enough to prevent the spread of COVID-19, especially when the virus is in the incubation period and people (students, patients, colleagues) are unaware they are infected or hide their infection.

First, during the outbreak period, online lectures, case studies, and problem-based learning tutorials should be adopted to avoid unnecessary aggregation of people and associated risk of infection. Second, it is worth advocating to encourage students to engage in self-learning, make full use of online resources, and learn about the latest academic developments. Third, during this period, it is easy for students to be affected by disease-associated fear and pressure, and dental schools should be prepared to provide psychological support.[3,4]

The traditional way of teaching and learning has suddenly been shaken from its foundations, so institutions must develop a comprehensive plan and a rigorous monitoring scheme to ensure that teachers and students make proper use of the digital platform (https://www.universityworldnews.com/post.php?story=20200409103755715).

However, the biggest challenge for our school administration lies in rescheduling clinical activities. The health of students, teachers, workers, and patients must be guaranteed without violating local and/or national guidelines; international sources on this subject are still scarce.[4]

Although the route of infection and pathogenesis of SARS-CoV-2 have not been fully clarified, concerns

related to dental schools are based on confirmed facts: first, SARS-CoV-2 uses the cellular entry receptor, the angiotensin-converting enzyme II (ACE2) and ACE2 expression in minor salivary glands were higher than in lungs. Second, these findings may suggest that the cause of the asymptomatic SARS-CoV-2 infection may come from the salivary glands.[5] Currently, there is evidence that SARS-CoV-2 can be transmitted by asymptomatic people,[6] who could be treated in our clinical facilities, increasing the cases of contagion and complicating the crisis in a country with a precarious health system, like ours.

The literature is increasingly reporting on key clinical guidelines related to patient assessment, treatment procedures, personal hygiene measures, infection control, and disinfection, preoperative mouth rinses, isolation techniques, and barrier control, imaging, and waste management,[7] all essential to consult and practice rigorously. One should not lose the perspective that a dental school clinic has a more complex interactive environment, so the operational logistics must be comprehensive, precise, and understood by all designated staff inside. The course of action of private dental practices is not linked to decisions and actions taken in dental schools.

It is essential that in the current scenario, priority be given to dental procedures labeled by the WHO as emergencies, proceeding in the most conservative way possible and postponing all elective treatments until the moment the outbreak enters recession. This would be an appropriate step in attempts to shorten the spread of COVID-19.[8]

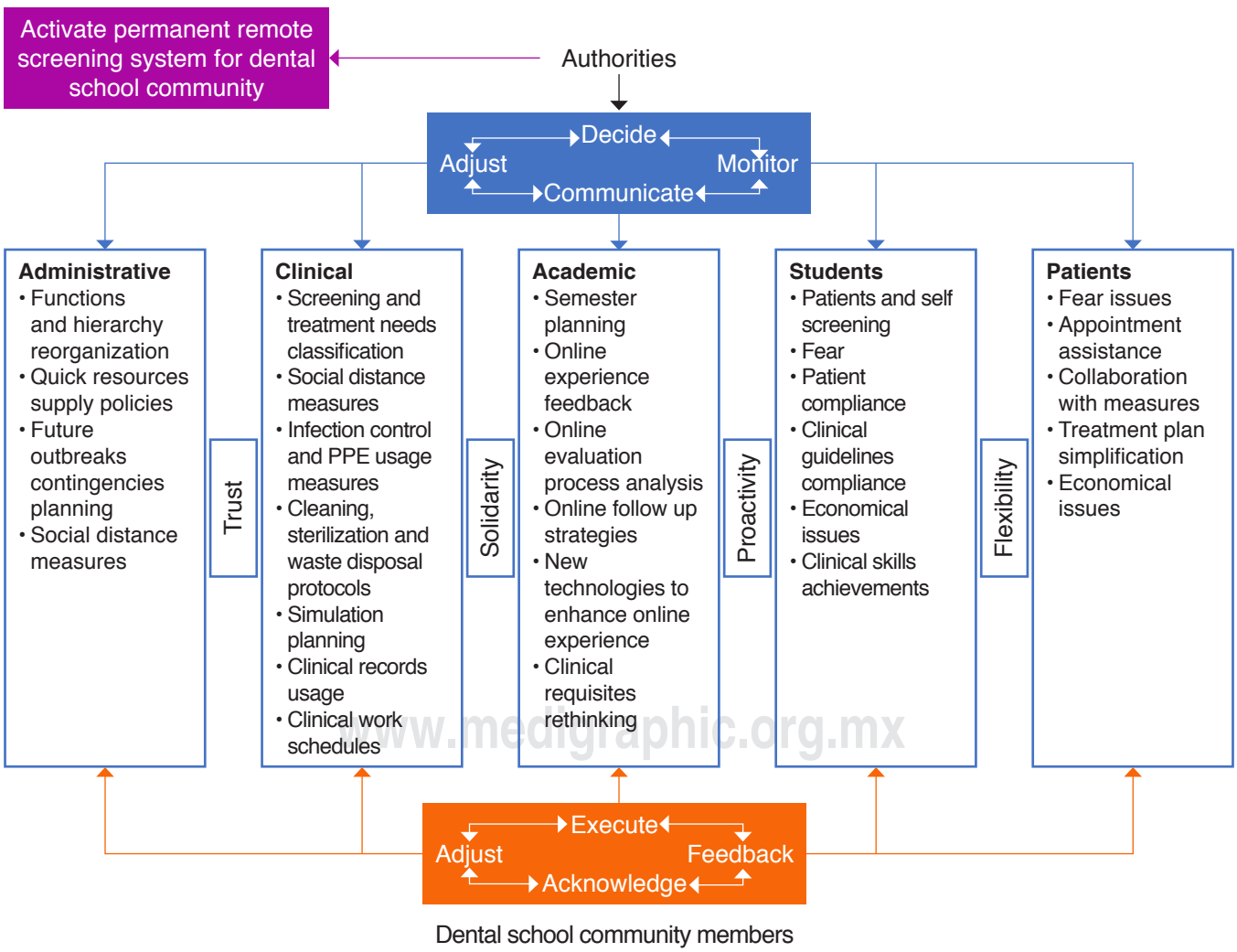

Figure 1: Schematic representation of relevant measures and issues to consider for reducing the risk of COVID-19 infection at dental school.

Regarding the third question, it is advisable to start with a cautious and stepped approach, expanding the virtual curriculum and preclinical practice with social distancing to the maximum. Teachers must embrace technology and pay special attention to student experiences for learning to be rich and effective.[9]

This important period would allow everyone to take a breath and reflect on the mistakes and adjustments to overcome this unwanted learning curve, the need for psychological support for students affected by disease-associated fear and pressure, the expense and availability of personal protective equipment (PPE) for students and clinical instructors[8] and financial problems of the patient, which may interfere with the clinical requirements of the student.[10] Some people think that fatality is the main factor in making decisions but cannot explain why some people can get sick or be cured and others cannot. There is no chance of errors in judgment, every action is taken involves lives. It is true that dentistry is familiar with the risk of cross-infection, but no one should be in unnecessary danger. Until the evidence is complete or a vaccine is available, decisions carry strong moral weight.[8]

The management of this crisis needs a plan that encompasses all the activities to be carried out, before, during, and after the outbreak.[7] It should include a deep analysis and consensus among all the participants in the related processes *(Figure 1)*, analyzing whether treatment philosophies and educational paradigms still are current or is it a call to reengineering and innovation.

In the meantime, it is important to establish a remote communication system to identify trends and outbreaks, as well as to monitor disease in the student community. In this regard, a Brazilian university created a communication channel through which students and staff can report by phone or texting if they are exposed to a person with suspicion or confirmation of COVID-19 or the appearance of symptoms related to the disease. This exemplifies a fast and inexpensive alternative to epidemiological surveillance not only before, during, and after the onset of the outbreak but also upon students and faculty arrival at dental school. It is important to note all patients scheduled for clinical practices at dental school can also be easily monitored through this communication system.

Patients should be assessed remotely (phone call, text, or email) for symptoms of fever, dry cough, and myalgia two weeks before and after clinical attendance at the dental school. Any time, even in the absence of illness confirmation due to limited resources for laboratory testing, students, staff, and patients with suspected symptoms should be advised to self-quarantine. The periodic analysis of the information collected through this remote communication system will not only measure the compliance of the clinical guidelines by the students but will also minimize the possibilities of cross-infection in the activities of clinical practices, facilitate effective communication between teachers and students, will decrease stress and support surveillance efforts.

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Facultad de Odontología
ORIGINAL RESEARCH

Oral health and geriatric syndromes in older adults in a highly specialized geriatric unit

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ABSTRACT

Aim: To determine the frequency of alterations in oral health conditions (hygiene, prosthesis, and xerostomia) and its association with geriatric syndromes (depression, malnutrition, and frailty) in elderly people attending the highly specialized geriatric care unit. **Material and methods:** A cross-sectional study was carried out that recruiZted 124 participants (March 2018 to September 2018). A comprehensive geriatric assessment and standardized dental checkups were performed to obtain diagnoses in oral health and geriatric syndromes. To establish the association between oral health conditions and geriatric syndromes a logistical regression analysis was conducted. **Results:** The mean age was of 78.76 ± 7.08 years, with females being 74.2%. The total amount of edentulous patients was 25.8% and up to 60.5% required some type of prosthesis. 59.4% of the edentulous participants met the diagnosis of frailty. 53.5% of participants with xerostomia were classified as frail. The logistical regression analysis did not show statistical significance. **Conclusion:** The presence of frailty, malnutrition, and depression was greater in patients with prostheses, xerostomia, and poor oral hygiene. The statistical analysis showed a non-significant risk association between oral health conditions and depression, malnutrition, or frailty. These results highlight the importance of the intentional search for oral pathology during the comprehensive geriatric assessment.

Keywords: Frailty, malnutrition, depression, xerostomia, dental prosthesis, oral hygiene.

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Salud bucal y síndromes geriátricos en adultos mayores de una unidad geriátrica de alta especialización

RESUMEN

Objetivo: determinar la frecuencia de alteraciones en la salud bucal condiciones (higiene, prótesis y xerostomía) y su asociación con síndromes geriátricos (depresión, desnutrición y fragilidad) en personas mayores que asisten a la unidad de cuidados especializados en geriatría. **Material y métodos:** Se llevó a cabo un estudio transversal con 124 participantes (marzo 2018 a septiembre de 2018). Se realizó una evaluación geriátrica integral y revisiones dentales estandarizadas para obtener diagnóstico en salud bucal y síndromes geriátricos. Para establecer la asociación entre las condiciones de salud bucal y síndromes geriátricos, se realizó un análisis de regresión logística. **Resultados:** La media de edad fue de 78.76 ± 7.08 años, siendo el sexo femenino 74.2%. La cantidad total de pacientes desdentados fue del 25.8% y hasta un 60.5% requirió algún tipo de prótesis. 59.4% de los participantes desdentados cumplieron el diagnóstico de síndrome de fragilidad. 53.5% de los participantes con xerostomía se clasificaron dentro del síndrome de fragilidad. El análisis de regresión logística no mostró diferencia estadísticamente significativa. **Conclusión:** la presencia del síndrome de fragilidad, la desnutrición y la depresión fue mayor en pacientes con prótesis, xerostomía y mala higiene bucal. El análisis estadístico no mostró significancia en la asociación de riesgo entre condiciones de salud bucal y depresión, desnutrición o fragilidad. Estos resultados destacan la importancia de la búsqueda de patologías bucales durante la valoración geriátrica integral.

Palabras clave: Fragilidad, desnutrición, depresión, xerostomía, prótesis dental, higiene oral

INTRODUCTION

A greater number of elderly people and a decrease in the youngest characterize the world demographic

transition, so the public health approach should aim for the majority to be able to age with a better quality of life and to reduce comorbidities. The inversion of the population pyramid brought with it an increase in the so-called geriatric syndromes (GS) that have been defined as «the cumulative effect of deficiencies in multiple physiological domains that increases the risk of negative outcomes in old age».[1,2] In 2016 in Mexico there were 10 million elderly people, which represented 8.9% of the population and it is expected that by the year 2050 that amount will quadruple.[1,3]

The GS is a pathological entity of multifactorial etiology that occurs in old age, which reflects the poor ability of an aging body to deal with external stressors.[1,3]

A direct association between oral health conditions (OHC) and some GS has been described, in addition to the fact that poor oral health is associated with a lower quality of life.[4-6] The negative impacts of poor oral health on daily life include reduced masticatory ability, limited food options, weight loss, poor communication, and a decrease in both self-esteem and well-being.[7]

Multiple risk factors for poor oral health in the elderly have been described; however, some of the factors that stand out most frequently in the Latin American population are poor water quality, a history of caries, high sugar consumption, poor oral hygiene, and smoking.[8] The aging process produces diverse negative changes in the oral cavity, such as tooth loss, xerostomia, and the need for dental prostheses, which causes greater vulnerability to traumatic and infectious agents. Thus, comprehensive care for the elderly should not focus exclusively on the treatment of pathological diseases and their manifestations but should also pay attention to oral health because it affects the psychosocial and nutritional aspects that accompany the aging process.[2] The present study aimed to determine the frequency of OHC and its association with some GS (depression, malnutrition, and frailty) in elderly people attending a high specialty geriatric care unit in Mexico.

MATERIAL AND METHODS

Participants

This cross-sectional study included 124 participants aged 60 or older attending a geriatric unit in a tertiary care hospital affiliated with a university in Mexico.

Participants were identified through the appointment calendar at the geriatric outpatient clinic. Recruitment occurred between March 2018 and September 2018. Eligible patients were invited to participate in the study and provided their written informed consent. The study protocol was reviewed and approved by the local Ethics Committee.

Measures

Dependent variables

Three conditions considered geriatric syndromes were researched: frailty, malnutrition, and depression. All participants underwent a comprehensive geriatric assessment carried out by standard personnel.

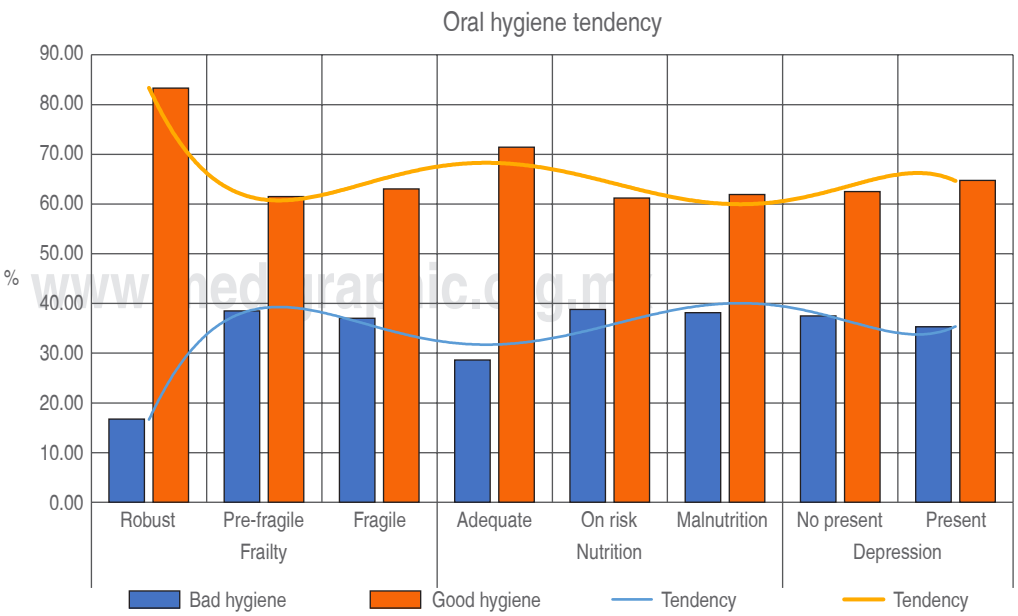

Figure 1:

Amounts and tendencies of geriatric syndromes according to oral hygiene.

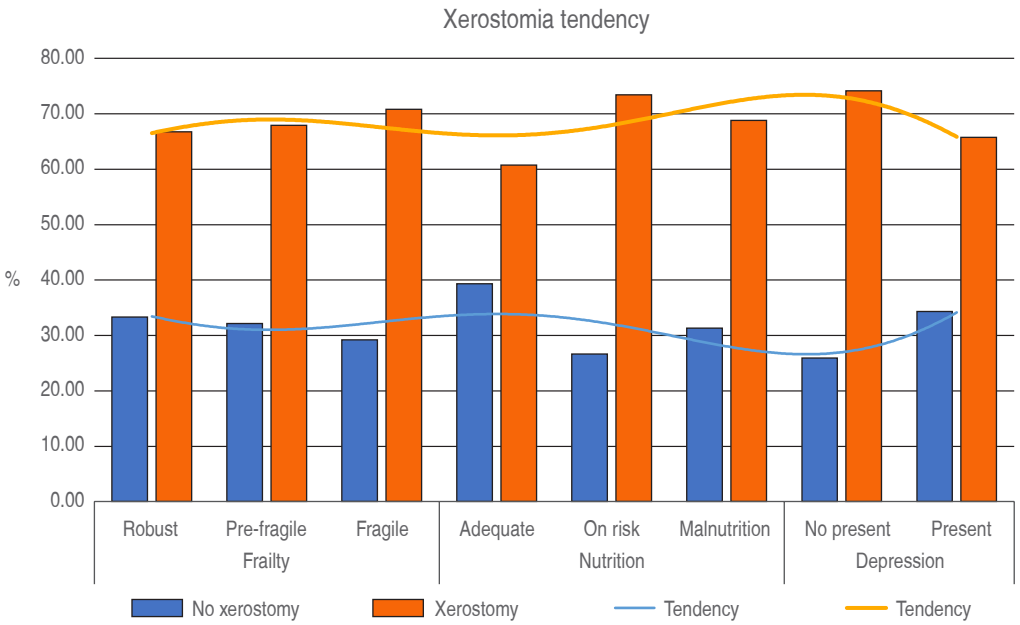

Figure 2:

Amounts and tendencies of geriatric syndromes according to xerostomia.

Frailty

Frailty status was defined according to the five components proposed by Fried et al.[9] Weight loss was defined as a self-report of unintentional weight loss (≥ 10 lbs. or more) in recent years. Exhaustion was determined by two expressions from the Center of Epidemiologic Studies-Depression scale (CES-D scale by their initials in Spanish): «*I felt that everything I did was an effort*» and «*I could not get going*». Slowness was defined by the lowest quintile in the 4-meter timed walk test, at the usual pace, adjusted for gender and height. Weakness was identified by the lowest quintile in the test of adequate grip-strength according to sex and body mass index. Low physical activity was established according to the Physical Activity Scale for the Elderly as recommended. As proposed, participants meeting three or more criteria were classified as frail, one or two were considered as pre-frail and non-frail if none were met.

Malnutrition

The nutritional risk was evaluated through the Mini Nutritional Assessment™ (MNA)[10]. ≤ 23.5 indicated nutritional risk and ≤ 17 was considered for malnutrition.

Depression

Depressive symptoms were assessed using the validated version of the 15 items of the geriatric depression scale (GDS). > 5 indicated the presence of depression.[11,12]

Oral health conditions

Three elements of oral health conditions (OHC) in elderly adults were researched as independent variables: oral hygiene, need for prosthesis/prosthesis hygiene, and xerostomia. Dentists carried out an oral clinical evaluation and the standardization of the examiners showed a kappa index of 0.88.

Oral hygiene

To measure oral hygiene, the simplified oral hygiene index (OHI-S) was used. OHI-S is made up of two elements: debris index (DI-S) and calculus index (CI-S). To obtain the index, the denture was divided into 6 sections and one tooth was selected from each section to be evaluated. The OHI-S result is the sum of the CI-S and DI-S scores, both indexes are rated from 0 to 3 and the qualification is obtained by adding the scores for each surface reviewed and dividing by the number of surfaces examined. A higher score of 1.2 indicated poor hygiene *(Figure 1)*.[13]

Need for prosthesis and prosthesis hygiene

To evaluate prosthesis hygiene Vigild criteria were used.[14] A clinical evaluation was performed and the number of debris in the prosthesis was reviewed. To define the need for prostheses the criteria developed

by Budz were used.[15] At least 3 molars in occlusion were required and according to the clinical evaluation, the patient was classified into one of the following categories: no prosthesis required, prosthesis needed, prosthesis requiring repair, partial prosthesis required, complete prosthesis required, with the prosthesis in good condition.

Xerostomia

An adaptation was made to the visual analogue scale of xerostomia questionnaire proposed by Pai et al., adding a graph to help patients with low educational level to respond more objectively *(Figure 2)*.[16]

Statistical analysis

Baseline descriptive data for the final sample are shown as means and standard deviations for continuous variables and frequencies for categorical variables. The χ^2 test or Fisher's exact test was used as appropriate. A logistical regression analysis was used to determine the relationship between frailty, malnutrition, and depression and a selected set of oral conditions variables. To develop an explanatory model, an unadjusted linear regression analysis was created to identify the variables of geriatric syndromes with different OHC. The selection of the independent variables used in the univariate analyzes was based on a review of the literature and clinical judgment. Regression diagnostics were performed to research any violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. All analyses were evaluated using 95% confidence intervals and a $p < 0.05$ was considered statistically significant. Statistical analysis was conducted using the statistical package Stata for Windows® (Stata Corp., Texas, IL., v. 14).

RESULTS

The mean age was 78.76 ± 7.08 and 74.2% were females. 30.6% were illiterate and up to 67.7% took care of the home. *Tables 1 and 2* show the sociodemographic and health characteristics of the participants classified according to the need for prostheses and prosthesis hygiene, respectively. *Tables 3 and 4* show the characteristics according to oral hygiene index and xerostomia, respectively.

Table 1: Sociodemographic, dental, and geriatric characteristics according to the need for prostheses.

	Prosthesis, n (%)					
	No required	Repair required	Partial	Complete	Good condition	Not valuable
Gender						
Male	3 (9.4)	2 (6.3)	17 (53.1)	3 (9.4)	7 (21.9)	23
Female	3 (3.3)	9 (9.8)	34 (37.0)	15 (16.3)	31 (33.7)	52
Marital status						
Married	3 (7.9)	2 (5.3)	15 (39.5)	7 (18.4)	11 (28.9)	23
Widow (er)	1 (1.6)	9 (14.1)	29 (45.3)	7 (10.9)	18 (28.1)	39
Schooling						
Illiterate	0	5 (13.2)	13 (34.2)	8 (21.1)	12 (31.6)	20
Elementary	4 (5.3)	6 (8.0)	34 (45.3)	9 (12.0)	22 (29.3)*	48
Dentate						
Yes	6 (65)	5 (5.4)	51 (55.4)	10 (10.9)	20 (21.7)	65
No	0	6 (18.8)	0	8 (25.0)	18 (56.3)*	10
Frailty						
Non-frailty	0	2 (33.3)	1 (16.7)	1 (16.7)	2 (33.3)	3
Pre-frailty	4 (7.5)	7 (13.2)	22 (41.5)	4 (7.5)	16 (30.2)	30
Frailty	2 (3.1)	2 (3.1)	28 (43.1)	13 (20.0)	20 (30.8)	42
Nutrition (MNA)						
Adequate	2 (7.1)	3 (10.7)	10 (35.7)	5 (17.9)	8 (28.6)	16
At risk	3 (4.7)	7 (10.9)	27 (42.2)	9 (14.1)	18 (28.1)	39
Malnutrition	1 (3.1)	1 (3.1)	14 (43.8)	4 (12.5)	12 (37.5)	20
Depression						
No	3 (5.6)	3 (5.6)	23 (42.6)	4 (7.4)	21 (38.9)	30 (55.6)
Yes	3 (4.3)	8 (11.4)	28 (40.0)	14 (20.0)	17 (4.3)	45 (63.3)

* $p \leq 0.05$.

Table 2: Sociodemographic, dental, and geriatric characteristics according to prosthesis hygiene.

	Prosthesis hygiene, n (%)		
	Good	Regular	Bad
Gender			
Male	0	–	–
Female	4 (4.3)	4 (12.3)	5 (15.6)
Marital status			
Married	2 (5.3)	7 (18.4)	6 (15.8)
Widow (er)	2 (3.1)	9 (14.1)	14 (21.9)
Schooling			
Illiterate	2 (5.3)	6 (15.8)	10 (26.3)
Elementary	0	14 (18.7)	13 (17.3)*
Dentate			
Yes	2 (2.2)	11 (12.0)	14 (15.2)
No	2 (6.3)	10 (31.3)	10 (31.3)*
Frailty			
Non-frailty	0	0	3 (50)
Pre-frailty	1 (1.9)	11 (20.8)	11 (20.8)
Frailty	3 (4.6)	10 (15.4)	10 (15.4)
Nutrition (MNA)			
Adequate	1 (3.6)	5 (17.9)	6 (21.4)
At risk	2 (3.1)	10 (15.6)	13 (20.3)
Malnutrition	1 (3.1)	6 (18.8)	5 (15.6)
Depression			
No	3 (5.6)	11 (20.4)	10 (18.5)
Yes	1 (1.4)	10 (14.3)	14 (20)

* $p \leq 0.05$.

Regarding oral conditions, the frequency of edentulous was 25.8%, with a mean of missing teeth of 17 ± 9.0. Hygiene in jagged classified by OHI-S ≥ 1.2 was 63.7%, with a mean index of 3.57 ± 2.78) and only 16.3% had good oral hygiene.

Related to using dental prostheses up to 30.6% were classified in good condition; 41.1% required partial prosthesis and only 8.9% required prosthesis repair. In terms of prosthesis hygiene, only 3.2% were classified as having good hygiene; 16.9 with regular hygiene and the most frequent index (19.4%) was poor prosthesis hygiene.

In connection with xerostomia, the level of discomfort due to dryness classified as severe was only 0.8% and up to 83.1% denied having any discomfort. Similarly, dryness when eating was denied up to 75.8%; a frequency of 12% was found in the medium dryness and only 3.2% in a severe degree. On the other hand, when speaking, the perception of dryness increased remarkably, reaching 17.7% in the moderate degree group and 8.9% in a severe degree group.

Concerning the prosthesis need index, 60.5% required some type of prosthesis, either total or partial. About the prosthesis users, only 4.3% had good prosthesis hygiene.

In relation to geriatric syndromes, 52.4% of the participants were classified as frail, and 56.5% were diagnosed with depression. According to the MNA, 51% were classified at risk of malnutrition, 25.8 malnourished, and only 22% had an adequate nutritional status.

Fifty percent of dentate patients were classified as non-frailty, and 53.5% of the patients with xerostomia had frailty. About the participants who needed prostheses, 56.8% presented depression and xerostomia and 53.5% were also diagnosed with depression. The rate of poor prosthesis hygiene was similar in the depression group (56.9 vs 54.5%, respectively). 78% of the elderly who required some type of prosthesis presented malnutrition, and 80.2% with xerostomia were also classified within this category.

The difference between the OHC and GS variables did not reach statistical significance at this level of analysis. The logistical regression analysis did not show statistical significance either.

DISCUSSION

In this research there was not found any significant risk association between oral health

Table 3: Sociodemographic, dental, and geriatric characteristics according to hygiene index.

	Hygiene, n (%)	
	Good	Poor
Gender		
Male	6 (24.0)	19 (76.0)
Female	27 (40.9)	39 (59.1)
Marital status		
Married	10 (37.0)	17 (63.0)
Widow (er)	18 (36.0)	32 (64.0)
Schooling		
Illiterate	8 (30.8)	18 (69.2)
Elementary	22 (37.9)	36 (62.1)
Frailty		
Non-frailty	1 (16.7)	5 (83.3)
Pre-frailty	15 (38.5)	24 (61.5)
Frailty	17 (37.0)	29 (63.0)
Nutrition (MNA)		
Adequate	6 (28.6)	15 (7.4)
At risk	19 (38.8)	30 (61.2)
Malnutrition	8 (38.1)	13 (61.9)
Depression		
No	15 (37.5)	25 (62.5)
Yes	18 (35.3)	33 (64.7)

Table 4: Sociodemographic, dental, and geriatric characteristics according to xerostomia.

	Xerostomia, n (%)	
	No	Yes
Gender		
Male	11 (34.4)	21 (65.6)
Female	27 (29.3)	65 (70.7)
Marital status		
Married	12 (31.6)	26 (68.4)
Widow (er)	21 (32.8)	43 (67.2)
Schooling		
Illiterate	19 (50.0)	19 (50.0)
Elementary	16 (21.3)	59 (78.7)*
Dentate		
Yes	26 (28.3)	66 (71.7)
No	12 (37.5)	20 (62.5)
Frailty		
Non-frailty	2 (33.3)	4 (66.7)
Pre-frailty	17 (32.1)	36 (67.9)
Frailty	19 (29.2)	46 (70.8)
Nutrition (MNA)		
Adequate	11 (39.3)	17 (60.7)
At risk	17 (26.6)	47 (73.4)
Malnutrition	10 (31.3)	22 (68.8)
Depression		
No	14 (25.9)	40 (74.1)
Yes	24 (34.3)	46 (65.7)

* $p \leq 0.12$.

conditions and some geriatric syndromes. These results contrast with the evidence obtained by other researchers. Several studies have shown a significant association between OHC and GS.[3,17] Unexpectedly, in the present study, participants with xerostomia had a lower prevalence of depression than those who did not, probably due to methodological differences in the diagnostic test and the sample size of our study. Interestingly, the prevalence of edentulous subjects in the present study was twice that reported by another's.[18] A probable explanation is that our sample was taken from patients attending a highly specialized geriatric care unit, and therefore with greater health problems, while the samples in other studies were taken from the general population.

Wostmann et al. found that the use of dental prostheses in the elderly had a short-term positive impact on nutritional status. In the present study, participants with a need for prostheses presented higher rates of malnutrition compared to those who did not have such a need, which suggests this same risk association. It is likely that this group of patients benefit from being referred to dental services for the use of prostheses.[4]

Evidence also shows that in patients with masticating and swallowing problems there are variations in micronutrient levels that are not reflected in the MNA.[19] In our study, MNA was used for the diagnosis of malnutrition. Although this instrument does not measure micronutrient variations, the usefulness of the intentional search for deficiencies and its interventions is not very important to generate clinically significant changes.[19-21]

There is significant evidence on the benefits of different oral health interventions (prosthetics, masticatory rehabilitation, orthodontics, xerostomia treatment, etc.) in improving the quality of life and some GS, especially malnutrition.[5,6,22] As we did not find a significant association between OHC and GS in our sample, the question arises as to whether oral health problems are the consequence of some geriatric syndromes and whether oral health behaves more as a protective factor than as a predisposing factor.[7,23,24] In this sense, it is important to carry out longitudinal studies to establish a precise association. Researching carried out in other populations concluded that oral pathology measured with self-perception indices was related to the development of GS. These results do not agree with our findings, since in this study the assessment of oral pathology was performed by a professional in the area, which increased the sensitivity to make the diagnosis, finding, despite this, fewer self-reports of xerostomia. Regardless of the oral conditions described, the high frequency of frailty and malnutrition syndromes stands out, which reflects the health deficiencies of our population that can be explained by several factors.

Our study presents several limitations. First, it is a cross sectional design, and it is not possible to know the direction of the tendencies found. Second, the participants were recruited to attend their medical consultation in a geriatric clinic and this paper was not based on the general population. The sample probably consisted of individuals with heterogeneous characteristics, such as many patients at risk; therefore, the participants in this study had the presence of multiple diseases and related GS.

On the other hand, the most valuable part of this research was to perform the dental evaluation through standardized indices and the diagnosis of geriatric syndromes through a comprehensive geriatric assessment. In our best knowledge, this work is the first in Latin America to describe oral health conditions

in the elderly through standardized dental indices. The results of the regression analysis showed a tendency despite of the already known multifactorial origin of geriatric syndromes. However, it was not statistically significant.

CONCLUSION

The presence of frailty, malnutrition, and depression was greater in patients with prostheses, xerostomia, and poor oral hygiene. The statistical analysis showed a non-significant risk association between oral health conditions and depression, malnutrition, or frailty. These results highlight the importance of the intentional search for oral pathology during the comprehensive geriatric assessment.

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ARTÍCULO ORIGINAL

Estudio comparativo de dientes naturales e impresos en 3D a partir de tomografía volumétrica de haz cónico

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RESUMEN

Objetivo: Determinar la precisión en las medidas de los dientes *en vivo* en comparación con los dientes impresos de los datos obtenidos de una tomografía volumétrica de haz cónico (CBCT, por sus siglas en inglés). **Material y métodos:** Se realizó la medición lineal de 15 órganos dentarios mesiodistal, apicoincisal y linguo-vestibular, donde fueron diagnosticados por medio de un CBCT y cuya extracción estuviera indicada en el tratamiento. Los datos de la CBCT se subieron al programa InVesalius 3, para la segmentación de los órganos y archivados para su impresión, en una impresora Envision Tech con un fotopolímero. Las medidas se ingresaron a una base de datos en el programa SPSS versión 22. En el análisis estadístico se aplicó la prueba t de Student para determinar diferencias estadísticamente significativas entre las variables. **Resultados:** La mediana de la medida vestíbulo-lingual con el OD natural fue de 8.07 mm, y para el OD impreso fue de 7.90 mm. La medida mesiodistal la mediana para el OD real fue de 8.03 mm y para el OD impreso fue de 7.78 mm. La mediana para la medida apicoincisal con el OD real fue de 18.95 mm, y con el OD impreso fue de 18.47 mm. **Conclusiones:** No hubo diferencia estadísticamente significativa que pueda repercutir en el plan de tratamiento en las mediciones del grupo de dientes reales e impresos, sin descartar la posibilidad de que una mínima variación pueda tener repercusiones clínicas.

Palabras clave: Segmentación de dientes, impresión 3D, tomografía volumétrica de haz cónico.

INTRODUCCIÓN

Los tratamientos exitosos de ortodoncia están basados en un diagnóstico y plan de tratamiento detallados. Un factor esencial del diagnóstico y plan de tratamiento ortodóncico es la capacidad de predecir el tamaño real de los dientes que en ocasiones por situaciones naturales o patológicas se encuentran dentro de los maxilares. Una predicción precisa de las dimensiones de estos dientes ayuda a determinar si hay suficiente espacio para su erupción o tracción para una correcta alineación dentro de sus arcos.

Por muchos años, únicamente se contaba con radiografías (ortopantomografía y radiografías periapicales) en dos dimensiones para evaluar el tamaño y forma de los órganos dentarios, tanto aquéllos que ya habían erupcionado como aquéllos que estaban por hacerlo. Con la aparición de la tomografía axial computarizada (TAC) en la década de los 70 el diagnóstico y predicción del tamaño y forma de los órganos dentarios evolucionó y así fue posible obtener una información más precisa de la forma y ubicación de éstos.

En el Área Odontológica, el uso de la TAC estuvo limitada por su alto costo, pero con el desarrollo de la tomografía computarizada de haz cónico (CBCT) se disminuyeron considerablemente los costos en su producción, lo cual lo hizo más accesible. Una tomografía CBCT consta de varios archivos exportables DICOM, término que fue adoptado a principios de los años 80 (por sus siglas en inglés *Digital Imaging and Communications in Medicine*), esto hizo posible el poder observar a partir de un CBCT en forma tridimensional todas las estructuras de la cavidad bucal; sin embargo para poder aislar cada uno de los elementos deseados, se desarrolló el proceso de segmentación de imágenes. Este es un proceso que genera múltiples regiones de una imagen digitalizada cuyo objetivo es simplificar la imagen y convertirla en un objeto de relevancia, fácil de analizar.[1,2]

La segmentación de dientes desde una CBCT permite un modelado virtual de toda la dentición, revelando la anatomía radicular y el hueso de soporte, en un modelo más completo comparado con modelos de yeso tradicionales, ya que por medio de esto es

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posible observar de manera aislada o en conjunto todas las estructuras anatómicas que rodean un órgano dentario, y en el caso de ortodoncia valorar el anclaje de los dientes de acuerdo con el volumen que presenten las raíces dentales.[3,4]

Para convertir una imagen digital en un modelo físico se debe de llevar a cabo un proceso de manufacturación aditiva, conocida como impresión en 3D (tercera dimensión). Se han descrito varias técnicas de impresión en tercera dimensión en la literatura en el contexto de la ortodoncia.[5,6] Estudios han demostrado que determinadas impresoras en tercera dimensión pueden ser precisas para la reproducción de modelos con la capacidad de reemplazar los modelos dentales tradicionales para el diagnóstico y planeación del tratamiento, ya que no solamente será posible determinar forma, tamaño y ubicación exacta de cada estructura que conforma la cavidad bucal, sino también abren la posibilidad de aislar y modelar cada una de estas estructuras para abrir una amplia gama de tratamientos que van desde la predicción del tamaño de los dientes en dentición mixta, el obtener una réplica exacta de un órgano para ser reimplantado,[6-9] hasta la elaboración de un *setup* para crear aparatos personalizados,[10] en donde podamos determinar con exactitud la posición de las raíces dentales.

Liu y colaboradores[11] mencionan que los volúmenes obtenidos de dientes naturales en comparación con los de dientes impresos a partir de un CBCT, al medirlos mediante el sistema de desplazamiento de agua, los dientes impresos presentaron pequeñas diferencias.

El objetivo de este estudio será el determinar si la impresión en 3D de los archivos obtenidos a partir de la segmentación de los órganos dentarios en una tomografía computarizada de haz cónico (CBCT) son en forma y tamaño similares a los de los dientes naturales, utilizando medidas lineales con un calibrador digital.

MATERIAL Y MÉTODOS

Se seleccionaron 15 órganos dentarios de cualquiera de los maxilares, no erupcionados, cuya extracción estuviera indicada en el tratamiento, diagnosticados por medio de una CBCT, provenientes de pacientes que acudieron a tratamiento en el Postgrado de Ortodoncia de la Universidad Tecnológica de México.

Después se realizó la extracción quirúrgica de los órganos dentarios retenidos. Paralelamente, dichos órganos dentarios retenidos fueron segmentados en el sistema operativo DICOM e impresos a partir del CBCT.

Tomografía CBCT

A todos los pacientes se les realizó una CBCT, utilizando un tomógrafo marca I CAT con un Campo de Visualización de 25 cm. El escaneo se efectuó de acuerdo con las especificaciones de los fabricantes, el tamaño del voxel fue de 0.292 mm (120 Kv, 10 A) y los datos fueron exportados utilizando archivos DICOM que contaban con la misma distancia de corte del tamaño de cada voxel.

Después de la toma de la CBCT, se realizaron las extracciones de los órganos dentarios retenidos. Todos los dientes fueron sometidos a una limpieza con la finalidad de eliminar los restos de tejidos blandos, hueso, sangre y cálculo dental.

Segmentación e impresión

Los órganos dentarios que iban a ser extraídos fueron segmentados utilizando los archivos DICOM de la CBCT para posteriormente ser impresos para realizar el estudio comparativo.

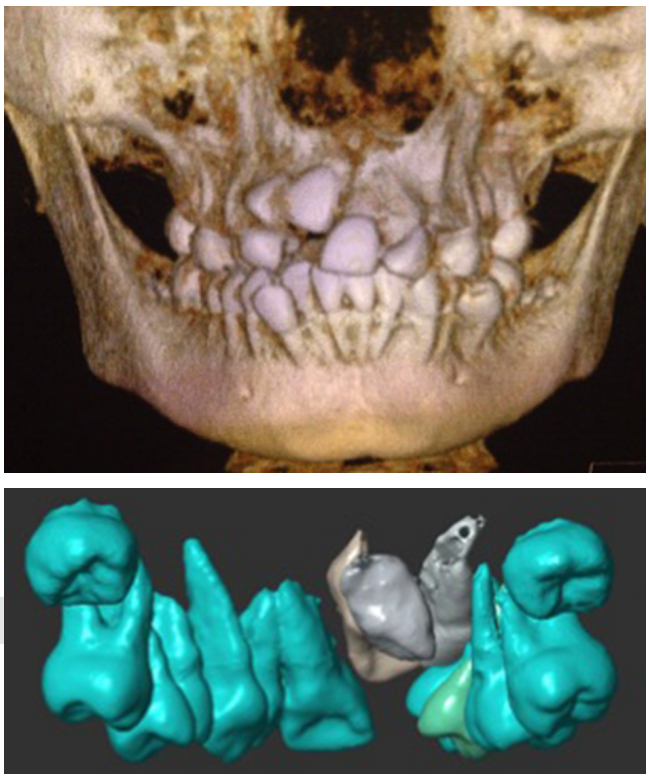

Figura 1: Órganos dentales segmentados tomografía computarizada de haz de cono.

Segmented dental organs of cone-beam computed tomography.

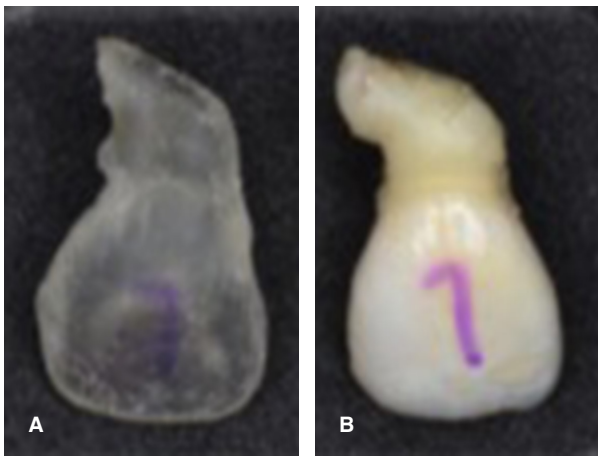

Figura 2: Comparación entre órgano dental real **(A)** e impreso **(B)**.

*Comparison of real teeth **(A)** versus printing teeth **(B)**.*

Segmentación de los dientes

Se realizó la segmentación de los dientes en el programa abierto diseñado para segmentación InVesalius 3, este programa cuenta con un menú de densidades disponibles que permite una selección mayor de un número de voxels con valores de grises para realizar la segmentación. Los valores pueden ser definidos para determinar los valores de grises absolutos o relativos. La segmentación es semiautomática con ajustes manuales para definir secciones *(Figura 1)*.

La función de alisado fue utilizada después de calcular la segmentación, se seleccionó el umbral de densidades que se quiere trabajar, y se guardaron tanto la versión sin alisado (2A) y con alisado (VB), para su comparación. Con la finalidad de diferenciar cada una de estas versiones, se realizó la coloración de cada uno de los dientes para poder identificarlos, y fueron guardados en formato STL para su impresión *(Figura 2)*.

Impresión 3D

Los archivos de los dientes alisados se imprimieron utilizando la impresora VIDA de EnvisionTEC con un fotopolímero OP 13, E-Model 3SP de la misma marca.

Se realizaron las medidas lineales en los órganos dentarios extraídos utilizando un calibrador digital de los diámetros mesiodistales, diámetros bucolinguales y altura total. Todas las medidas fueron realizadas y registradas por un solo examinador. Asimismo, se realizaron las mismas mediciones en los órganos dentarios impresos digitalmente calculando los diámetros y la altura total y fueron registradas también por un solo examinador.

Análisis estadístico

Todos los datos fueron ingresados a un programa de hoja de cálculo Excel 2003 (Microsoft, Redmond, Wash). Se realizó un análisis estadístico por medio de SPSS, 22.0 (IBM®, Chicago, Illinois), el cual fue efectuado en el mismo programa en donde se aplicó la prueba t de Student para determinar si existieron diferencias estadísticamente significativas entre las variables estudiadas. Se utilizó estadística descriptiva. Para las variables cuantitativas se emplearon medidas de tendencia central y dispersión. Se realizó un análisis de homogeneidad de las variables mediante el estadístico Levence, por lo que se utilizó estadística paramétrica.

RESULTADOS

Se concluyó que la muestra tiene libre distribución, probablemente por el tamaño de la muestra,

Tabla 1: Análisis estadístico prueba t Student.
Statistical analysis, t-Student test.

Medida	Técnica empleada	n	Media ± DE	t	p	Intervalo de confianza (95%)	
						Superior	Inferior
Vestíbulo lingual	Manual CBCT	4	(8.2150 ± 0.59629) (7.6800 ± 0.71012)	1.154	0.292	0.59948	1.66948
Mesiodistal	Manual CBCT	4	(7.3850 ± 0.25929) (6.7700 ± 0.27833)	3.233	0.018	0.14960	1.08040
Apicoincisal	Manual CBCT	4	(23.3125 ± 2.53915) (22.6875 ± 2.48072)	0.352	0.737	3.71805	4.96805

CBCT = *cone-beam* computed tomography.

por lo que se decidió hacer el análisis de la U de Mann-Whitney, la cual se basa en la diferencia de rango y es contraparte de la t de Student que se utiliza en variables cuantitativas con distribución normal *(Tabla 1)*.

En este estudio se realizaron medidas lineales utilizando un vernier digital *(Figuras 3 a 5)*.

En todas las comparaciones de las medianas de las medidas apicoincisales, mesiodistales y vestíbulo-linguales, el OD real siempre fue el de mayor tamaño; sin embargo, desde el punto de vista estadístico esta diferencia no fue significativa en todos los casos.

DISCUSIÓN

El desarrollo de la tecnología ha hecho que los ortodoncistas se involucren cada día más en el uso de la CBCT y en otras aplicaciones de ésta como lo es la impresión digital.[12-14] Aunque en la actualidad el proceso de segmentación no es un proceso sencillo de realizar, éste depende de muchos factores, como lo son las diferencias del operador en la ubicación, saber diferenciar correctamente los tejidos para su segmentación, el grado de experiencia del operador, la capacidad de ampliar la imagen, la manipulación de contrastes y colores, así como del criterio propio del operador, todo ello conlleva una curva de aprendizaje importante.

Esta investigación, donde se utilizaron CBCT con un campo de visión grande, trajo como consecuencias algunos problemas para poder realizar una segmentación adecuada.[3] Se considera que un campo de visión grande como el que regularmente utilizamos los ortodoncistas presenta poco contraste, creando dificultades para poder realizar el proceso de segmentación de una forma más precisa y correcta.

Los resultados obtenidos en general en este estudio muestran que los dientes segmentados y alisados, y posteriormente impresos al medirlos linealmente con un vernier digital, en comparación con los dientes reales, tanto las medidas mesiodistales, vestíbulo-linguales como apicoincisales presentaron desde el punto de vista estadístico poca diferencia significativa. Estos resultados contrastan con los de otros estudios, donde mencionan que el simple hecho de someter a un alisado los dientes, y realizando una medición volumétrica, puede llegar

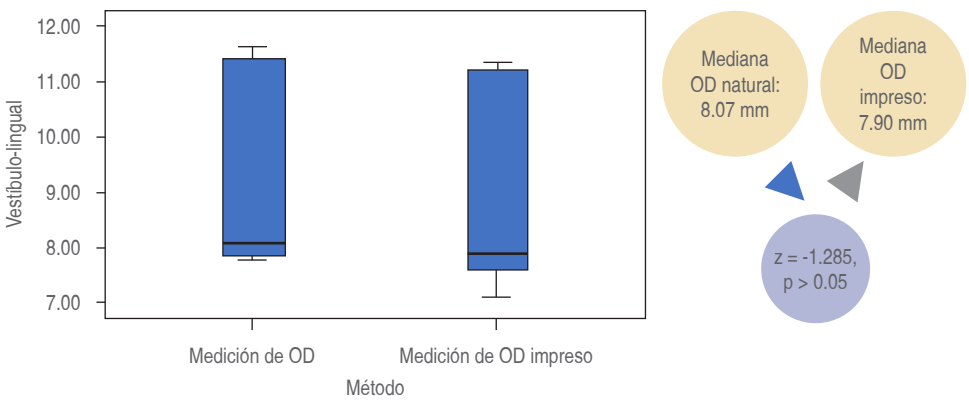

Figura 3:

Comparación entre las medias de las medidas vestíbulo-lingual, órganos dentales reales versus órganos dentales impresos.

Comparison between mean of vestibulo-lingual dimensions, real teeth versus printing teeth.

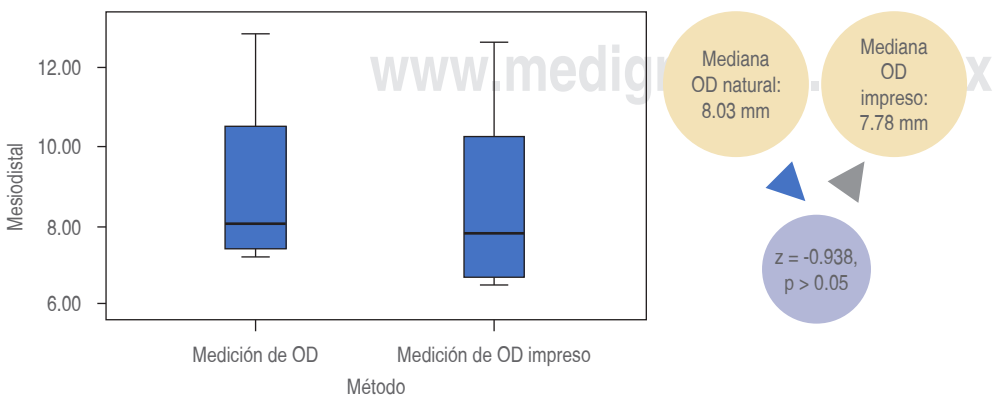

Figura 4:

Comparación entre las medias de las medidas mesiodistales, órganos dentales reales versus órganos dentales impresos.

Comparison between mean of mesio-distal dimensions, real teeth versus printing teeth.

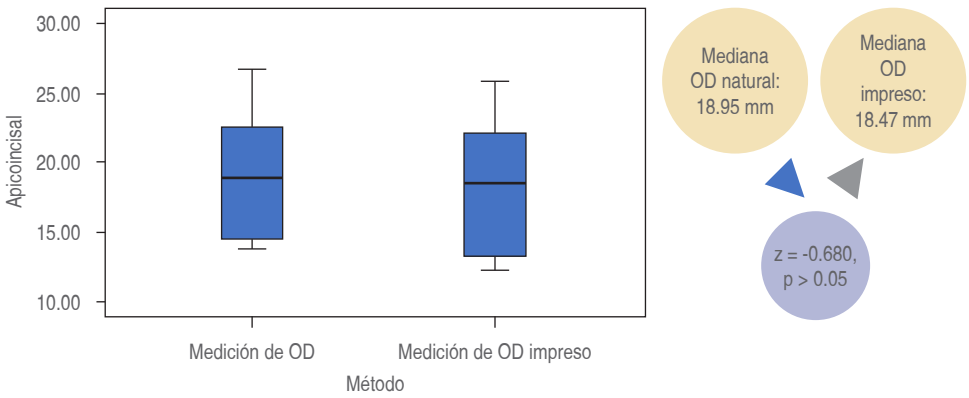

Figura 5:

Comparación entre las medias de las medidas apicoincisal, órganos dentales reales versus órganos dentales impresos.

Comparison between mean of apical-incisal dimensions, real teeth versus printing teeth.

a presentar diferencias de 4-7% al medir los dientes alisados y no alisados;[11] asimismo, Nimbalkar[15] menciona que, dependiendo del programa utilizado para la segmentación, pueden existir diferencias estadísticamente significativas en las medidas volumétricas.

Han surgido nuevas tecnologías que permiten mejorar las imágenes generadas por las CBCT, éstas básicamente consisten en modificar el tamaño y hacer más uniforme los voxeles[16] y, por lo tanto, generan un proceso de segmentación más efectivo del que se puede obtener un modelo 3D más similar al tamaño del modelo original.

En este estudio las medidas lineales obtenidas de las muestras de dientes impresos en comparación con los reales fueron similares; sin embargo, es necesario realizar medidas volumétricas, así como mejorar la calidad de imágenes en las CBCT para obtener resultados que muestren la efectividad de la CBCT y obtener modelos en 3D que puedan ser utilizados clínicamente con éxito, y para ello el uso de la CBCT podría ser de utilidad ya que no solamente sería posible el uso en la medida de estructuras duras, sino también blandas como la lengua.[17]

CONCLUSIONES

1. En las mediciones lineales realizadas no hubo diferencia estadísticamente significativa entre los dientes reales y los impresos a partir de los datos de una CBCT.
2. El uso de la CBCT es una herramienta valiosa no solamente para el diagnóstico sino también al obtener réplicas impresas que abren la posibilidad de su uso en otros procedimientos odontológicos como los casos de autotransplantes.
3. Se sugiere la medición en volumen para verificar la similitud entre los dientes reales y las réplicas impresas en 3D.

Original research

Comparative study of natural teeth and 3D printed teeth using a *cone-beam* computed tomography

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ABSTRACT

Aim: To determine the accuracy of measurements of both in vivo teeth and teeth printed with data obtained using a computed tomography (CBCT) *cone-beam* computed tomography (CBCT). **Material and methods:** For orthodontic purposes, linear measurements of 15 extracted teeth were made using a CBCT. The information obtained was recorded in the Invesalius 3 software for segmentation; then they were printed with an Envision Tech 3D printer with a polymer. All data were collected in SPSS version 22 software. To determine the statistical difference between variables, the Student t test was used. **Results:** median in vestibular-lingual in teeth in vivo was 8.07 mm and for 3D printed teeth was 7.90 mm. The mesio-distal median was 8.03 mm for teeth in vivo and for 3D printed teeth was 7.78 mm and for incisal-apical median was 18.95 mm to *in vivo* teeth and 18.47 mm to 3D printed teeth. **Conclusions:** there were no statistical differences between the measurements of the *in vivo* teeth and those of the 3D printed teeth, which could affect the treatment plans. However, these minor differences may have clinical implications.

Keywords: Tooth segmentation, 3D printed, *cone-beam* computed tomography.

INTRODUCTION

The success of orthodontic treatments is based on both a detailed diagnosis and a detailed treatment plan. An essential factor in the orthodontic diagnosis and treatment plan is the ability to predict the real size of the teeth, which are sometimes found within the jaws

due to natural or pathological situations. An accurate prediction of the dimensions of these teeth helps determine if there is enough room for their eruption or traction for proper alignment within their arches.

For many years, only two-dimensional radiographic (orthopantomography and periapical radiographic) were available to evaluate the size and shape of the dental organs, both those that had already erupted and those that were about to do so.

With the appearance of computerized axial tomography (CT) in the 1970s, the diagnosis and prediction of the size and shape of dental organs evolved and thus it was possible to obtain information more precise on their shape and location.

In the dental area, the use of CT was limited by its high cost. With the development of *cone-beam* computed tomography (CBCT), its cost decreased considerably, making it more accessible. A CBCT scan consists of several exportable DICOM files (digital imaging and communications in medicine) a term adopted in the early 1980s. From a CBCT it was possible to observe all the structures of the oral cavity in three dimensions; to isolate each of the desired elements, the image segmentation process was developed. This process generates multiple regions of a digitized image to simplify the image and turn it into an easy-to-analyze object of relevance.[1,2]

The segmentation of teeth from a CBCT allows virtual modeling of the entire dentition, showing the anatomy of the dental root and the supporting bone in a more complete model, compared to traditional plaster models. This makes it possible to observe all the anatomical structures that surround a dental organ in isolation or as a whole and in the matter of orthodontics to assess the anchorage of the teeth, according to the volume of the dental roots.[3,4]

An additive manufacturing process, known as 3D (third dimension) printing, must be done to convert a digital image into a physical model. Several 3D printing techniques have been described in the orthodontic literature.[5,6]

Some studies have shown that certain 3D printers may be accurate to reproduce models that can replace traditional dental models for diagnosis and treatment planning. This is because it will be possible to determine the shape, size, and exact location of each structure that makes up the oral cavity. It will also allow isolating and modeling each of these structures. This, in turn, gives rise to a wide range of treatments that range from predicting the size of teeth in mixed dentition, to get an exact replica of an organ to be implanted[6-9] and even elaborating a setup to create custom parts[10] so we can accurately determine the position of the dental roots.

Liu et al.[11] used the water displacement system to measure the volumes obtained from natural teeth compared to those of teeth printed from a CBCT and concluded that the printed teeth showed small differences.

This paper aims to determine if the 3D printing files obtained from the segmentation of the dental organs in a CBCT are similar in shape and size to those of natural teeth, using linear measurements with a digital caliper.

MATERIAL AND METHODS

Fifteen unerupted dental organs, from any jaws, belonged to patients who attended the Graduate program of Orthodontics, Technologic University of México (Postgrado de Ortodoncia, Universidad Tecnológica de México), México.

Whose extraction was indicated in the treatment and that their extraction was diagnosed using a CBCT, were selected. Subsequently, the unerupted dental organs were surgically removed. In parallel, these teeth were segmented in the DICOM operating system and printed from the CBCT.

Cone beam computed tomography

All patients underwent a CBCT using an I CAT scanner with a field of view of 25 cm. The scan was carried out according to the manufacturers' specifications; the voxel size was 0.292 mm (120 Kv, 10 A) and the data was exported using DICOM files that had the same cutting distance of the size of each voxel.

Afterward, the unerupted teeth were extracted and cleaned to remove the remains of soft tissue, bone, blood, and dental calculus.

Segmentation and printing

Dental organs to be extracted were segmented using the DICOM files to print them and perform the comparative study.

Segmentation

Dental segmentation was performed in the open program designed for segmentation InVesalius 3; this program has several densities available, which means having more voxel possibilities with gray values to perform segmentation. Values can be defined to determine absolute or relative gray values. Segmentation is semi-automatic with manual adjustments to define sections *(Figure 1)*.

After calculating the segmentation, the smoothing function was used, the density threshold to be worked on was selected, and both the version without smoothing (2A) and with smoothing were saved for comparison. To differentiate each of these versions, each tooth was stained to be able to identify them, and they were saved in STL format for printing *(Figure 2)*.

3D printing

The files of the smoothed teeth were printed using the EnvisionTEC VIDA printer with a photopolymer OP 13, E-Model 3SP, same brand.

Linear measurements in the extracted teeth were made using a digital caliper of both mesiodistal and buccolingual diameters and total height. All measurements were performed and recorded by a single examiner. Likewise, the same measurements were made in the digitally printed dental organs, calculating the diameters and the total height, and were also recorded by a single examiner.

Statistical analysis

All of the data were entered into a spreadsheet of the Excel 2003 program (Microsoft, Redmond, Wash). Statistical analysis was carried out using PSS (Version 12.0, SPSS, Chicago, Ill). The database was prepared in the SPSS version 22 program. Descriptive statistics were used. For the quantitative variables, measures of central tendency and dispersion were used. A homogeneity analysis of the variables was performed using the Levence statistic, so parametric statistics were used. The statistical analysis was carried out in the same program, applying the t Student test to determine if there were statistically significant differences between the variables studied.

RESULTS

The sample has a free distribution, probably due to the size of the sample, so it was decided to do the Mann-Whitney U analysis, which is based on the difference in rank and is a counterpart of the Student t test which is used in quantitative variables with a normal distribution *(Table 1)*.

In this study, linear measurements were made using a digital vernier *(Figures 3 to 5)*.

When comparing all medians, it was found that the real teeth were always the largest. Although, from a statistical point of view this difference was not significant.

DISCUSSION

The development of technology has made orthodontists increasingly involved in the use of CBCT and its applications, such as digital printing.[12-14] The segmentation process is not easy, and it depends on many factors, such as operator differences in location, correctly differentiating tissues, operator experience, ability to enlarge the image, manipulation of contrasts and colors, as well as the operator's criteria. All of this implies a significant learning curve.

In this study, CBCTs with a large field of view were used, which caused some problems with proper segmentation.[3] A large field of view (such as that regularly used by orthodontists) is considered to have little contrast, creating difficulties in performing segmentation more accurately.

The results obtained in general in this study show that the segmented and smoothed teeth, and subsequently printed when measured linearly with a digital vernier, compared to the real teeth, the mesiodistal, vestibular-lingual, and apical-incisal measurements showed little significant difference, in statistical terms.

These results contrast with those of other studies that report that only smoothing the teeth and performing a volumetric measurement can produce differences of 4-7% when measuring smoothed and non-smoothed teeth.[11] Likewise, Nylbankar[15] points out that the program used for segmentation can lead to statistically significant differences in volumetric measurements.

Nowadays, new technologies have emerged that allow improving the images generated by CBCTs. They mainly consist of modifying the size and making the voxels more uniform[16] which makes a more effective segmentation process that can generate a 3D model more like the size of the original model.

In this study, the linear measurements obtained from the printed teeth compared to the measurements from the real teeth were similar. However, it is necessary to perform volumetric measurements and improve the quality of the images obtained using the CBCT. The results would show its effectiveness in obtaining 3D models that could be used clinically with success. In this way, the CBCT could be more useful since it would not only be possible to use it to measure hard structures but also soft ones, such as the tongue.[17]

CONCLUSIONS

1. In the linear measurements performed there was no statistically significant difference between the real teeth and those printed from the data of a CBCT.

2. CBCT is a valuable tool not only for diagnosis but also for obtaining printed replicas that open the possibility of using it in other dental procedures, such as autotransplantation cases.
3. Volumetric measurements are suggested to verify the similarity between real teeth and 3D printed replicas.

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ARTÍCULO ORIGINAL

Evaluación de la actividad antibacterial de ionómeros de vidrio modificados por la incorporación de clorhexidina y su impacto sobre la resistencia a la compresión y a la adhesión

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RESUMEN

Introducción: Se ha demostrado que los cementos de ionómero de vidrio no poseen actividad antimicrobiana suficiente a pesar de poseer excelentes propiedades que lo hacen un material con muy diversas aplicaciones clínicas. **Objetivo:** Determinar si la incorporación de clorhexidina a los cementos de ionómero de vidrio les proporciona mayor actividad antimicrobiana y si esta incorporación afecta su resistencia a la compresión y a la adhesión. **Material y métodos:** Se incorporaron diferentes proporciones de clorhexidina al 0.2% a ionómeros tipo I y II. Se realizaron pruebas de difusión en agar y de resistencia a la compresión y a la adhesión a la dentina. **Resultados:** Se observó un aumento estadísticamente significativo en la actividad antimicrobiana de los cementos al incorporar la clorhexidina y no se encontraron diferencias significativas en la resistencia a la compresión ni a la adhesión a la dentina. **Conclusión:** La incorporación de clorhexidina en las proporciones estudiadas parece ser una opción para proveer de una mayor actividad antimicrobiana a los cementos de ionómero de vidrio sin afectar algunas de sus propiedades físicas.

Palabras clave: Cemento de ionómero de vidrio, clorhexidina, *S. mutans*, resistencia a la compresión, resistencia a la adhesión.

INTRODUCCIÓN

En la odontología actual los cementos de ionómero de vidrio (CIV) son ampliamente utilizados en los tratamientos preventivos y restaurativos, su uso extendido es gracias a sus excelentes propiedades que lo hacen un material versátil y con muy diversas aplicaciones clínicas.[1]

Su bajo pH durante el fraguado y la liberación de iones de flúor son los responsables de contribuir en la remineralización de la dentina y de su efecto antibacteriano.[2,3] Sin embargo, se ha demostrado que este efecto no es suficiente para evitar la adherencia o formación de biopelículas, principalmente por el *Streptococcus mutans*.[4,5]

Así como ésta se han descrito algunas otras limitantes de los CIV, y desde hace tiempo se han realizado diversos trabajos en busca de perfeccionarlos, mejorar aquellas pocas propiedades que resultan deficientes al incorporarles diferentes aditivos como el quitosano,[6] caseína,[7] hidroxiapatita,[8] partículas bioactivas de vidrio,[9] zirconia[10] y clorhexidina (CHX),[11-15] con esta última se busca principalmente un incremento en sus propiedades antibacteriales.

La CHX es una sustancia antiséptica ampliamente utilizada en la odontología, posee un amplio espectro antibacterial, tanto para Gram positivos como para Gram negativos e incluso contra algunos hongos. Es considerada un compuesto seguro con mínimos efectos adversos. Se puede encontrar en diversas presentaciones, las principales son en líquidos, geles y aerosoles.[16] Además de sus usos comunes también ha sido agregada a diversos materiales, incluidos los CIV, en un intento de proveerlos de una mejor actividad antimicrobiana. Sin embargo, estas incorporaciones de otras sustancias muchas veces han alterado otras propiedades de los CIV, principalmente físicas y/o mecánicas.[12,15,17]

Debido a que en los estudios disponibles en donde a los CIV les incorporan CHX tipo grado reactivo y/o

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en formulaciones que no están fácilmente al alcance del odontólogo es que se decidió utilizar para este estudio CHX comercial y de uso odontológico para así determinar si esta mezcla de materiales comunes presenta mayor actividad antimicrobiana y si esta incorporación de CHX afecta su resistencia a la compresión y a la adhesión.

MATERIAL Y MÉTODOS

Los materiales utilizados para esta investigación fueron los CIV tipo I (GC Gold Luting & Lining Cement®) y tipo II (GC Gold Label Universal Restorative®), y la CHX al 0.2% (Viarclean-up®). Las preparaciones fueron realizadas conforme a las instrucciones del fabricante, para el cemento tipo I (1:2) y para el tipo II (1:1). Para lograr esto con exactitud se pesaron polvos y líquidos.

Todas las preparaciones se realizaron en el Laboratorio de Investigación Odontológica Multidisciplinaria a 25 ± 1 °C y humedad relativa de 50 ± 10%. Para cada prueba se realizaron especímenes distintos y con las características necesarias para cada una, éstas se detallan más adelante. En cada prueba y para cada tipo de CIV se analizaron cuatro grupos: el grupo 1 en donde los materiales no incluyeron la incorporación de CHX; en el grupo 2 se incorporó 5% (v/v) de CHX al líquido del CIV justo antes de la mezcla; en el grupo 3 se le añadió 10% (v/v) y en el grupo 4, 15% (v/v) de CHX.

Actividad antibacterial

Para la evaluación de la actividad antibacterial se utilizó la prueba de difusión en agar, la cual es y ha sido ampliamente utilizada para determinar el potencial antibacterial que tienen los materiales.[18]

Se utilizaron 20 cajas de cultivo (10 para evaluar al CIV tipo I y 10 para el tipo II) con agar cerebro corazón. La cepa seleccionada fue el *Streptococcus mutans* (ATCC 35665) a partir del cual se cultivó en 10 mL de infusión cerebro corazón (BHI) a 37 °C. Veinticuatro horas después se ajustó la suspensión con una turbidez comparable con la escala 0.5 de McFarland que corresponde a aproximadamente 1.5×10^8 UFC/mL, la cual se verificó usando un espectrofotómetro.

Se procedió a colocar 300 µL de la suspensión en cada una de las cajas y a distribuirlo de manera uniforme sobre la superficie, dejándolo durante 30 minutos a temperatura ambiente mientras se pesaban los componentes de todas las mezclas de los CIV. Una vez realizada cada una de las mezclas se empaparon por un solo lado discos de papel filtro de 6 mm de diámetro. Se colocó un disco correspondiente a cada grupo por caja de cultivo, posteriormente en el centro de cada una de las cajas se colocó un papel filtro con 6 µL de CHX como control.

Todas las cajas se colocaron en un recipiente con cierre hermético y anaerobiosis parcial a 37 °C durante 24 horas. Una vez concluidas se midieron los halos de inhibición de cada una de las mezclas y los valores fueron registrados en una base de datos.

Resistencia a la compresión

Se fabricaron 48 especímenes cilíndricos (seis especímenes por grupo para cada CIV) de 4 mm de diámetro y 6 mm de espesor. Para la elaboración de los mismos se utilizó un molde prefabricado de aluminio en el cual se compactaron los materiales inmediatamente después de la mezcla e incorporación (en su caso) de la CHX. Una vez que los especímenes fraguaron se retiraron del molde y se revisaron en un microscopio estereoscópico en busca de irregularidades o defectos en su superficie, se descartaron aquellos especímenes defectuosos. Cada espécimen fue pesado en una balanza analítica y también fueron descartados aquellos cuyo peso fuera ± 0.005 g del promedio de cada grupo. Posterior a ello cada espécimen fue transferido a un tubo Eppendorf con 1 mL de agua destilada estéril y mantenido a 37 °C durante 24 horas.

Cumplidas las 24 horas cada muestra se colocó entre los aditamentos de compresión de la máquina universal de pruebas (CMS Metrology), la cual se programó a una velocidad de crucero de 1 mm/min. La fuerza de compresión máxima que se registró en Newtons (N) fue hasta la fractura del espécimen y esa se consideró como la «resistencia a la compresión» de cada uno.

Resistencia de adhesión a la dentina

Para esta prueba se utilizaron 40 dientes anteriores maxilares y mandibulares íntegros, los cuales fueron donados por pacientes de las clínicas odontológicas de la Facultad de Medicina de la UAQ (durante 2018-2019) que requirieron extracciones por motivos periodontales y/o protésicos. Todos fueron almacenados en agua destilada hasta completar el número final. Se excluyeron dientes con fisuras y/o fracturas y aquellos con caries o restauraciones en la superficie vestibular. Los dientes extraídos se colocaron en moldes de plástico y fueron recubiertos con acrílico autocurable, dejando la porción coronaria libre para realizar el desgaste y exposición de la dentina. Se utilizó una pieza de alta velocidad con una fresa de carburo troncocónica de 0.4 mm de diámetro para estandarizar el desgaste. Después, se utilizó un disco de carburo de

3.6 mm de diámetro para uniformar la superficie de la dentina. Todo el proceso de desgaste se llevó a cabo con irrigación constante y dentro de una campana de extracción. Cada diente fue evaluado en un microscopio estereoscópico para verificar que la superficie fuera uniforme y no quedaran restos de esmalte. Se lijaron con una lija de grano extrafino del «600» en sentido vertical de manera uniforme durante 30 segundos y con irrigación constante, se lavaron y colocaron en tina ultrasónica con agua destilada estéril durante 10 minutos.

Se diseñaron cuadrados de 1.5 cm por lado en cera rosa de 3 mm de espesor y en el centro se realizó una perforación circular de 3 mm de diámetro con ayuda de una punta estandarizada. Usando estos moldes sobre la superficie de la dentina se colocaron y compactaron las diferentes mezclas de CIV respectivas.

Por último, las piezas dentales con su «incremento» de CIV se mantuvieron sumergidas en agua destilada estéril a 36 °C durante 24 horas. Transcurrido este tiempo se procedió a realizar la prueba de resistencia a la adhesión (cizallamiento). Se aplicó una carga de corte en la unión entre el CIV y la dentina a una velocidad de crucero de 0.5 mm/min, registrando los Newtons (N) de fuerza necesarios hasta el desprendimiento total.

Se calculó la resistencia a la adhesión en megapascales (MPa), de acuerdo con la fórmula: resistencia a la adhesión = F/A, en la que F es la fuerza registrada en N y A es el área en mm^2 de la superficie del CIV colocado sobre la dentina.

Una vez realizadas las pruebas se inspeccionaron las superficies de dentina en donde se colocó el CIV, se utilizó el microscopio estereoscópico y se clasificaron en tres de acuerdo con el tipo de falla presente: 1. Falla adhesiva, en la que se observó de 0-5% de remanente de CIV sobre la superficie de la dentina, 2. Falla cohesiva, en donde se contempló más del 90% de la superficie de la dentina un remanente de CIV, y 3. Falla mixta, en la cual se advirtió entre seis y 89% de remanente de cemento sobre la dentina.

Análisis estadístico

Todos los resultados fueron recolectados en una base de datos. Se determinó la distribución de los valores cuantitativos a través de la prueba de Kolmogorov-Smirnov. Los resultados se presentan como promedios, desviación estándar y rango en tablas y gráficas. Para determinar la existencia de diferencias estadísticamente significativas entre los grupos se aplicó ANOVA y la prueba *post hoc* de Tukey. Para la única variable cualitativa (tipo de falla) se presenta frecuencia y porcentaje. Se consideró significancia estadística cuando $p \leq 0.05$.

RESULTADOS

Los resultados de la prueba de actividad antibacterial por difusión en agar se muestran en la *Figura 1*, en la cual se puede observar que ambos CIV sin CHX poseen nula inhibición del crecimiento de *Streptococcus mutans* (se reportan los 6 mm de diámetro del disco solamente), esta inhibición fue detectable a partir de la incorporación de CHX al 5%; sin embargo, esto no fue estadísticamente significativo. A partir de la incorporación de 10% de CHX se observó un aumento estadísticamente significativo en la actividad antibacterial frente a *Streptococcus mutans*, siendo la incorporación de CHX al 15% la que presentó mayor inhibición; sin embargo, no existió diferencia estadísticamente significativa entre la inhibición mostrada con 10 y 15%. El control con CHX mostró la mayor inhi-

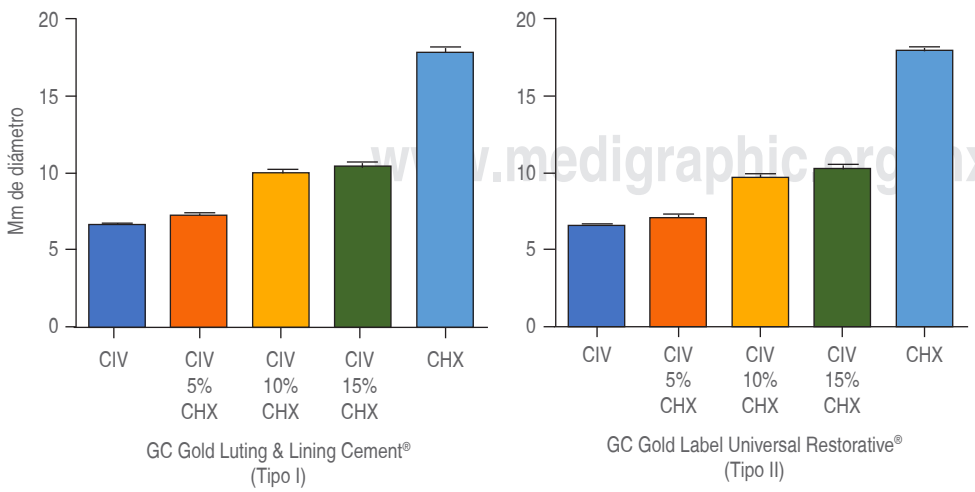

Figura 1:

Prueba de actividad antibacterial por difusión en agar.

Results of agar diffusion test for antibacterial activity.

Tabla 1: Comparación de la resistencia a la compresión (N) y la resistencia a la adhesión (MPa) de los dos tipos de cementos de ionómero de vidrio sin clorhexidina y con las tres diferentes concentraciones.
Comparison of the compressive strength (N) and the bond strength (MPa) of the two types of glass ionomer cements without chlorhexidine and with the three different concentrations.

	Control (n = 6)	CHX 5% (n = 6)	CHX 10% (n = 6)	CHX 15% (n = 6)	p
Resistencia a la compresión	Media ± DE (rango)				
Tipo I	620 ± 136 (444-750)	612 ± 93 (468-745)	634 ± 200 (279-699)	513 ± 151 (208-633)	0.5268
Tipo II	633 ± 247 (481-1,077)	618 ± 161 (465-697)	543 ± 286 (256-946)	750 ± 133 (598-930)	0.4416
Resistencia a la adhesión	Media ± DE (rango)				
Tipo I	6.86 ± 0.22 (6.66-7.20)	6.71 ± 0.73 (5.66-7.70)	6.46 ± 0.72 (5.66-7.46)	5.96 ± 1.17 (4.70-7.66)	0.2479
Tipo II	6.30 ± 0.86 (5.33-7.42)	6.23 ± 0.62 (5.43-6.99)	5.79 ± 0.48 (5.12-6.32)	5.84 ± 0.84 (4.98-7.23)	0.5137

DE = desviación estándar. ANOVA.

bición siendo diferente estadísticamente de todos los grupos.

En la *Tabla 1* se muestra la comparación entre los diferentes grupos con respecto a la resistencia a la compresión (N) y a la adhesión (MPa) de ambos cementos con la incorporación de los diferentes porcentajes de CHX, para ningún caso existió diferencia estadísticamente significativa.

El 87 y 95.8% de las pruebas realizadas con los CIV tipo I y con tipo 2, respectivamente, presentaron fallas adhesivas, mientras que el resto fueron mixtas y en ningún caso se presentó falla cohesiva.

DISCUSIÓN

La incorporación de compuestos antibacteriales en los CIV es prometedora y con mucho potencial, pues traería diversos beneficios para los pacientes, se lograría prevenir caries recurrentes, sobre todo en los márgenes de la restauración, se inhibiría la formación de placa en sus superficies y en superficies dentales cercanas a la restauración, e incluso se contribuiría a reducir el número de bacterias en la saliva y en la cavidad oral en general.[15]

La incorporación de CHX parece ser una buena opción pues se han realizado diversos reportes en donde al incorporarla al CIV le confiere propiedades antibacteriales, aunque de manera controvertida algunos autores han reportado que esta incorporación perjudica algunas de sus propiedades físicas.[12]

Dos de las propiedades físicas más importantes del CIV son la resistencia a la compresión y la resistencia a la adhesión, la primera proporciona información acerca de la resistencia que tendrá el material frente a las fuerzas de la masticación, y la segunda permite dar una idea de la adecuada retención a la estructura dental, además está directamente relacionada con el sellado marginal y, por lo tanto, con evitar la microfiltración marginal.

Es bien sabido que las propiedades físicas de los CIV están influenciadas por cómo los cementos son preparados, incluyendo la relación polvo-líquido, el tamaño de partícula en el polvo e incluso el envejecimiento de los especímenes. Además de que cada marca de CIV presenta variaciones en sus componentes y éstas podrían incluso variar en una misma marca con diferentes lotes de producción. Por todo esto, se debe tener cuidado al generalizar acerca de las propiedades de los CIV, sobre todo cuando se le incorporan productos o son modificadas sus proporciones de mezcla.

En esta investigación, al utilizar los CIV tipo I GC Gold Luting & Lining Cement® y tipo II GC Gold Label Universal Restorative® en preparación estricta a como lo indica el fabricante y con la incorporación de CHX al 0.2% (Viarclean-up®) en diferentes proporciones, observamos que se obtuvo un efecto antibacterial que fue incrementando conforme aumentaba la proporción de CHX, esto coincide con reportes previos de Botelho[11] y Ribeiro,[14] pero no con Jedrychowski[15] ni con Takahashi.[19] Sin embargo, aunque se observó que el efecto aumentaba, este aumento no fue estadísticamente significativo para todos los casos, lo que indicaría que la proporción ideal a incorporar sería el 10% para ambos CIV.

Por otro lado, la misma incorporación de CHX no mostró cambios estadísticamente significativos en la resistencia a la compresión ni en la adhesión. Nuestros resultados son distintos a lo reportado por Palmer y colaboradores,[12] quienes reportaron que conforme aumenta la cantidad de CHX incorporada a los CIV se observa disminución de la fuerza a la compresión de los mismos.

Es una realidad que los estudios realizados *in vitro* no contemplan todas las variables presentes en la

boca, y por lo tanto los resultados que éstos generan no pueden ser extrapolados a una situación clínica, por lo que más estudios *in vitro* que consideren otras variables y que evalúen otras propiedades físicas que podrían verse alteradas deben ser realizados, además de ser necesaria la realización de ensayos clínicos para considerar efectuar esta práctica de incorporar CHX durante la preparación de estos CIV.

Por lo pronto, los CIV tipo I GC Gold Luting & Lining Cement® y tipo II GC Gold Label Universal Restorative® modificados por la incorporación de CHX 0.2% (Viarclean-up®) parecen ser una opción prometedora que les provee propiedades antibacteriales significativas sin alterar su resistencia a la compresión ni a la adhesión a la dentina de forma significativa.

CONCLUSIÓN

La incorporación de CHX al 0.2% (Viarclean-up®) al cinco, 10 o 15% incrementa la actividad antibacterial de los cementos de vidrio tipo I GC Gold Luting & Lining Cement® y tipo II GC Gold Label Universal Restorative® sin comprometer de manera significativa la resistencia a la compresión ni la resistencia a la adhesión a la dentina.

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Original research

Evaluation of the antibacterial activity of glass ionomers modified by the incorporation of chlorhexidine and its impact on the compressive strength and bond strength

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ABSTRACT

Introduction: Even though glass ionomer cements have excellent properties for various clinical applications, they have been shown not to have sufficient antimicrobial activity. **Objective:** To determine if the incorporation of chlorhexidine into glass ionomer cements provides them with greater antimicrobial activity and if this incorporation affects their bond strength and compressive strength. **Material and methods:** Different proportions of 0.2% chlorhexidine were incorporated to ionomers type I and II. Compressive strength, bonding to dentin and agar diffusion tests were performed. **Results:** When incorporating chlorhexidine, a statistically significant increase in the antimicrobial activity of the cements was observed and no significant differences were found in compressive strength or bonding to dentin. **Conclusion:** The incorporation of chlorhexidine in the proportions studied seems to be an option to provide greater antimicrobial activity to glass ionomer cements without affecting some of their physical properties.

Keywords: Glass ionomer cement, chlorhexidine, *S. mutans,* compressive strength, bond strength.

INTRODUCTION

Glass ionomer cement (GICs) are widely used in preventive and restorative dental treatments, as their excellent properties make them a versatile material with very diverse clinical applications.[1] The fluoride ions they release and their low pH during setting contribute to the remineralization of dentin and its antibacterial effect.[2,3]

However, it has been shown that this effect is not sufficient to prevent adherence or formation of biofilms, mainly due to *Streptococcus mutants*.[4,5]

For a long time, various works have been carried out in order to improve GICs by incorporating different additives such as chitosan,[6] casein,[7] hydroxyapatite,[8] bioactive glass particles,[9] zirconia,[10] and chlorhexidine (CHX),[11-15] the latter mainly seeking to increase their antibacterial properties.

CHX is an antiseptic substance widely used in dentistry. It has a broad antibacterial spectrum, both for Gram-positive and Gram-negative and even against some fungi. It is considered a safe compound with minimal adverse effects. It can be found in various presentations, the main ones being liquids, gels, and

aerosols.[16] However, these incorporations of other substances have often altered other properties of GICs, mainly physical and/or mechanical.[12,15,17]

Available studies reporting the incorporation of CHX to GICs use reagent grade CHX and/or in formulas that are not easily available to the dentist. For this paper, it was decided to use commercial dental CHX in order to determine if this mixture of common materials has greater antimicrobial activity and if it affects its bond strength and compressive strength.

MATERIAL AND METHODS

The materials used for this research were type I GIC (GC Gold Luting & Lining Cement®) and type II GIC (GC Gold Label Universal Restorative®) and CHX at 0.2% (Viarclean-up®). The preparations were made according to the manufacturer's instructions: for cement type I (1:2) and type II (1:1). To achieve this accurate powders and liquids were weighed.

All preparations were made in a multidisciplinary dental research laboratory at 25 ± 1 °C and relative humidity of 50 ± 10%. Different specimens were used for each test and with the necessary characteristics for each one, which are detailed further on.

In each test and for each type of GIC, 4 groups were analyzed. Group 1 in which CHX was not incorporated into the materials; group 2 in which 5% (w/w) of CHX was incorporated to the GIC liquid just before mixing; group 3 to which 10% (w/w) was incorporated and group 4, to which 15% (w/w) of CHX was incorporated.

Antibacterial activity

To evaluate the antibacterial activity, the agar diffusion test was used, widely used to determine the antibacterial potential of the materials.[18]

Twenty culture boxes (10 to evaluate type I and 10 for type II GIC) were used with brain-heart agar. *Streptococcus mutans* (ATCC 35665) were grown in a 10 mL infusion at 37 °C. 24 hours later, the suspension was adjusted to turbidity comparable to McFarland's 0.5 scale corresponding to approximately 1.5×10^8 CFU/mL, which was verified with a spectrophotometer.

300 uL of the suspension was placed in each of the boxes and distributed evenly on the surface, left for 30 minutes at room temperature while the components of all the GIC mixtures were weighed. 6 mm diameter filter paper discs were soaked on one side with each of the mixtures. A disc corresponding to each group was placed per culture box. Subsequently, in the center of each of the boxes, a filter paper with 6 μL of CHX as control, was placed.

All boxes were placed in a hermetically sealed container with partial anaerobiosis at 37 °C for 24 hours and then the inhibition halos of each of the mixtures were measured and the values were registered in a database.

Compressive strength

48 cylindrical specimens (6 specimens per group for each GIC) of 4 mm in diameter and 6 mm thick were manufactured using a precast aluminum mold in which the materials were compacted immediately after mixing and incorporation (if applicable) of the CHX. Once the specimens had been set, they were removed from the mold and checked under a stereomicroscope for irregularities or defects on their surface, discarding those defective specimens.

Each specimen was weighed on an analytical balance and those whose weight was ± 0.005 g of the average of each group were also discarded. After that, each specimen was transferred to an Eppendorf tube with 1 mL of sterile distilled water and kept at 37 °C for 24 hours.

After 24 hours, each sample was placed between the compression attachments of the universal testing machine (CMS Metrology) which was programmed at a cruising speed of 1 mm/min. The maximum compression force that was recorded in Newtons (N) was until the specimen fracture and this was considered as the «compressive strength» of each one.

Bonding to dentin

For this test, 40 intact maxillary and mandibular anterior teeth were used, which were donated by patients from the dental clinics of the *Facultad de Medicina de la Universidad Autónoma de Querétaro* (during 2018-2019) that required extractions for periodontal and/or prosthetic reasons. All were stored in distilled water until completing the final number.

Teeth with fissures and/or fractures and those with caries or restorations on the vestibular surface were excluded.

Extracted teeth were placed in plastic molds and covered with auto-curing acrylic, leaving the coronal portion free to wear and expose the dentin.

A high-speed part with a 0.4 mm diameter frustoconical carbide bur was used to standardize wear.

Subsequently, a 3.6 mm diameter carbide disc was used to uniform the dentin surface. The entire wear process was carried out with constant irrigation and inside an extraction hood.

Each tooth was evaluated under a stereomicroscope to verify that the surface was uniform and that there

were no traces of enamel. They were sanded with a fine-grit «600» sandpaper vertically and uniformly for 30 seconds and with constant irrigation, they were washed and placed in an ultrasonic tub with sterile distilled water for 10 minutes.

1.5 squares per side were designed in 3 mm thick pink wax and a 3 mm diameter circular perforation was made in the center using a standardized tip. Using these molds on the dentin surface the different respective GICs mixtures were placed and compacted.

Finally, the teeth with GICs were immersed in sterile distilled water at 36 °C for 24 hours. And then the bonding strength test (shear) was carried out.

A shear load was applied at the junction between the GICs and the dentin at a cruising speed of 0.5 mm/min, recording the Newtons (N) of force required until total detachment.

The bond strength was calculated in MPa, according to the formula: bond strength = F/A, where F is the force recorded in N and A is the area in mm^2 of the surface of the GIC placed on the dentin.

Once the tests had been carried out, the dentin surfaces where the GICs was incorporated were inspected using the stereomicroscope and classified according to the type of failure: 1. Adhesive failure, where 0 to 5% of the remaining GIC was observed on the dentin surface. 2. Cohesive failure, where a remnant of the GICs was observed over 90% of the dentin surface, and 3. Mixed failure where between 6 and 89% of the cement remainder on the dentin was observed.

Statistical analysis

All the results were collected in a database. The distribution of quantitative values was determined through the Smirnov Kolmogorov test. The results are presented as means, standard deviation and range in tables and graphs.

To determine statistically significant differences between the groups, ANOVA and Tukey's post hoc test were applied. For the only qualitative variable (type of failure) frequency and percentage are presented. Statistical significance was considered when $p \leq 0.05$.

RESULTS

The results of the agar diffusion test for antibacterial activity are shown in *Figure 1*, where it can be seen that both GIC without CHX have zero inhibition of the growth of *Streptococcus mutans* (the 6 mm disc diameter is only reported). This inhibition was detectable from 5% CHX incorporation. However, this was not statistically significant.

From 10% CHX incorporation, a statistically significant increase in antibacterial activity against *Streptococcus mutants* was observed, and it was the 15% CHX incorporation that presented the greatest inhibition. However, there was no statistically significant difference between the inhibition shown with 10 and 15%. The control with CHX showed the highest inhibition, being statistically different from all of the groups.

Table 1 shows the comparison between the different groups regarding the compressive strength (N) and the bond strength (MPa) of both types of cements with the incorporation of the different percentages of CHX. In no case was there a statistically significant difference.

87% and 95.8% of the tests carried out with type I GICs and type 2 GICs, respectively, presented adhesive failures, while the rest were mixed, and in no case did the cohesive failure occurs.

DISCUSSION

Incorporating antibacterial compounds in GICs is promising and has great potential, as it would bring several benefits to patients. Recurrent caries would be prevented, especially on margins of restoration; the formation of plaque on their surfaces and dental surfaces close to the restoration would be inhibited, and it would even contribute to reducing the number of bacteria in saliva and the oral cavity in general.[15]

Several studies have been carried out that report that incorporating CHX into GICs confers them antibacterial properties. However, other investigations have concluded that it damages some of their physical properties.[12]

Two of the most important physical properties of GICs are compressive strength and bond strength. The first one provides information about the resistance that the material will have against the forces of mastication. The second one allows to have an idea of adequate retention to the dental structure and is also directly related to marginal sealing and therefore avoiding marginal microfiltration.

It is known that the physical properties of GICs can be affected by the way in which the cements are prepared, including the powder-liquid ratio, the particle size in the powder, and even the aging of the specimens. Besides, each GIC commercial brand presents variations in its components and could even vary in different production batches of the same brand. For all this, care must be taken when generalizing about properties of the GICs, especially when products are incorporated or their mixing proportions are modified.

In this research, the GICs type I GC Gold Luting & Lining Cement® and type II GC Gold Label Universal Restorative® were used in strict preparation, as indica-

ted by the manufacturer and with the incorporation of CHX at 0.2% (Viarclean-up®) in different proportions, an antibacterial effect was obtained that increased as the proportion of CHX increased. This is consistent with previous reports by Botelho[11] and Ribeiro[14] but not with Jedrychowski[15] or Takahashi.[19]

It was observed that although the effect increased, this was not statistically significant for all the cases, which would indicate that the ideal proportion to incorporate would be 10% for both GICs.

On the other hand, the same incorporation of CHX did not show statistically significant changes in compressive strength or bond strength. Our results are different from those reported by Palmer et al.[12] who concluded that as the amount of CHX incorporated into GICs increases, a decrease in compressive strength is observed.

As for the in vitro studies, these do not contemplate all the variables present in the mouth, so their results cannot be extrapolated to a clinical situation, so more in vitro studies should be carried out that consider other variables and that evaluate other physical properties that could be altered. Clinical trials are also necessary to consider carrying out the practice of incorporating CHX during the preparation of these GICs.

At the moment, the GIC type I GC Gold Luting & Lining Cement® and GIC type II GC Gold Label Universal Restorative® modified by the incorporation of CHX at 0.2% (Viarclean-up®) seem to be a promising option that provides them with important antibacterial properties without altering their compressive strength and dentin bond strength significantly.

CONCLUSION

Incorporating CHX at 0.2% (Viarclean-up®) at 5%, 10%, or 15% increases the antibacterial activity of type I glass cements GC Gold Luting & Lining Cement® and type II GC Gold Label Universal Restorative® without significantly compromising the compressive strength and dentin bond strength.

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CASO CLÍNICO

Endocoronas, una opción de tratamiento restaurador

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RESUMEN

Las endocoronas son restauraciones indirectas que mediante la adhesión dentinaria con cementos poliméricos pueden reconstruir y restaurar un diente, con un solo componente de diversos materiales, principalmente cerámicos. Ofrecen resultados reportados muy favorables en dientes posteriores, considerándola como una alternativa más conservadora a la reconstrucción con endoposte intrarradicular-núcleo y su restauración con una corona completa. Los requerimientos mínimos indispensables son: dientes con tratamientos de conductos exitosos, al menos tres paredes remanentes con una altura mínima de 2 mm, un espesor regular de 3 mm del tejido cervicorradicular remanente y paredes internas del espacio de la cámara pulpar con divergencia de 5 a 8 grados. Se presentan tres casos clínicos de tratamiento con endocoronas en dientes con diferentes diagnósticos, materiales utilizados y pronóstico.

Palabras clave: Adhesión, endocorona, rehabilitación dental, corona dental.

INTRODUCCIÓN

Los dientes tratados endodóncicamente pueden tener diferentes características y propiedades a los dientes vitales en cuanto a su estructura, resistencia, integridad e hidratación. La pérdida de estructura dental por diversas razones, entre ellas su desgaste durante la preparación, afecta la solidez, reduce su resistencia a la fractura y consecuentemente limita su pronóstico[1] que según Meyenberg,[2] Shemesh[3] y Kishen[4] es predisponente directo a la formación de fisuras o agrietamientos tanto en el esmalte como en la dentina y éstas a su vez a la posible creación de fracturas, que pueden ser ocasionadas por remoción extensa y rápida del tejido durante el tratamiento de conductos o durante la colocación del endoposte, debilitamiento por interacción excesiva con irrigantes o medicación intraconductos como el hipoclorito de sodio y el hidróxido de calcio, efectos corrosivos de algunos materiales restauradores como el ácido grabador en exceso y fuerzas oclusales excesivas cuyo efecto se potencializa por la reducción de propiocepción que presentan los dientes desvitalizados.[2-4]

PRESENTACIÓN DE CASOS CLÍNICOS

Con el mejoramiento y desarrollo de la adhesión polimérica en esmalte y dentina en sus más de 60 años de estudio,[5] se puede confiar en el sellado marginal, retención y estabilidad de restauraciones indirectas parciales o totales, así surgen las endocoronas, restauraciones adhesivas posteriores unitarias que abarcan hasta las paredes de la cámara pulpar en un solo bloque, reemplazando las reconstrucciones intracoronarias y las restauraciones totales. Entre los materiales disponibles para su realización, existen: cerámicas, resinas y silicatos *(Tabla 1)*.[6]

La principal indicación de las endocoronas es en dientes con poco remanente coronario. Los principios biomecánicos indican que la resistencia estructural de un diente depende de la cantidad y proporción de los tejidos remanentes y la integridad de la forma anatómica. Las variaciones en la calidad del tejido después del tratamiento endodóncico demostraron tener una influencia no significativa en el comportamiento biomecánico del diente.[7,8]

El espacio interoclusal limitado es también una indicación para las endocoronas puesto que no requieren más de 3 mm de altura oclusal para poseer propiedades ideales que presentan las preparaciones para coronas convencionales.[7,9] Otra indicación para las endocoronas son dientes con raíces en las que no se pueda colocar endopostes, por curvaturas en su tercio medio o dilaceraciones, conductos muy estrechos o

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muy amplios, donde un poste no ofrezca un pronóstico favorable, conductos en forma de C y también en accidentes operatorios con gran pérdida de tejidos como las perforaciones de piso de cámara.[6] En situaciones de pérdida de tejido coronal severo, la principal opción es realizar un tratamiento de poste-núcleo, pero éstos disminuyen la resistencia a fracturas y también requieren remoción de tejido sano, incrementando un riesgo de perforación.[6,9] Desde una perspectiva clínica, el diseño de la endocorona parece tener ventajas prácticas sobre restauraciones con poste-núcleo: es más económica, requiere menor tiempo de elaboración y no existe contracción de resina asociada con la técnica.[9]

Se seleccionaron tres pacientes que acuden a la Especialidad de Odontología Restauradora Avanzada del Postgrado de la Facultad de Odontología de la UNAM, con diferentes características clínicas, diagnósticos y pronósticos, de género femenino entre 45 y 55 años de edad, con dientes tratados endodónicamente, los cuales coadyuvaron para el desarrollo y realización del tema de este artículo.

Caso 1

Mujer de 46 años de edad que acude a la Clínica de Odontología Restauradora Avanzada en el Postgrado de Odontología de la Facultad de Odontología de la UNAM, con el motivo de consulta de restaurar los dientes 36 y 37 *(Figura 1A)*, despulpados, con restauraciones provisionales, lesiones de caries recidivante y espacio interoclusal disminuido en relación con sus antagonistas, tejido remanente coronario limitado en ambos dientes, pero en especial en el diente 36 y con un mínimo grosor a nivel de la furca, se indica su extracción para posterior colocación de implante. En el análisis del diente 37, éste contaba con altura de 4 mm y un grosor de 3 mm en todas sus paredes, por lo cual se determina la realización de una endocorona *(Figura 1B)*.

Con aislamiento absoluto, se procede a la preparación del espacio de la cámara pulpar, para crear divergencia oclusal entre 5 y 8 grados, descontaminación con hipoclorito de sodio al 5% y compensación de socavados con resina fotocurable Filtek™ Z350 (3M-ESPE) brindando paredes rectas y lograr la divergencia mencionada, se sellaron los accesos de conductos con cemento polimérico RelyX™ U200 (3M-ESPE), se procedió a tomar impresión con polivinil siloxano (PVS), Elite HD+ (Zhermack) *(Figura 1C)* y se realiza la obturación temporaria con Systemp onlay (Ivoclar Vivadent). El material restaurativo de elección fue cerómero SR Nexco (Ivoclar Vivadent) por sus características en general y en especial por su resiliencia, resistencia a la fractura y bajo costo *(Figura 1D)*.

En la segunda cita se retira el restaurador temporario, se coloca el aislamiento absoluto, limpieza de la cavidad con clorhexidina en pasta al 2% Consepsis™ Scrub (Ultradent), se comprueba la adaptación y la altura oclusal de la restauración y se procede a la cementación con RelyX™ U200 (3M-ESPE), se procede a la remoción de excedentes después de un prepolimerizado de 3 segundos, se retira el aislamiento absoluto, se comprueba la oclusión con papel articular de 12 μm, se realizó el pulido con gomas y pasta de pulido para resinas *(Figura 1E-F)*.

Caso 2

Mujer de 48 años con síndrome de Sjögren secundario acude a consulta para tratamiento integral a la misma clínica de la misma institución. Para rehabilitar los dientes 37 y 36, se eliminan las obturaciones previas y la remoción de lesiones de caries circundante y en cervical del diente 36 *(Figura 2A)*, donde se evidencia gran pérdida de tejido tanto coronal como radicular, con el diagnóstico endodóncico de pulpitis irreversible asintomática, se procede a realizar el tratamiento

Tabla 1: **Nombres comerciales y estructuras de diferentes materiales usados para la fabricación de endocoronas.**[6]
Trade names and structures of different materials used for the fabrication of endocrowns.[6]

Designación comercial - marca	Estructura
VITA Mark II - VITA Zahnfabrik	Cerámica feldespática
e.max CAD - Ivoclar Vivadent AG	Cerámica vítrea con refuerzo de disilicato de litio
Lava Ultimate - 3M ESPE	Resina de nanorrelleno
CERASMART - GC	Resina de nanorrelleno
ENAMIC - VITA Zahnfabrik	Red cerámica con infiltración de polímeros PICN
SUPRINITY - VITA Zahnfabrik	Silicato de litio con refuerzo de zirconia
Celta Duo - Densply Sirona	Silicato de litio con refuerzo de zirconia
InCoris TZI - Densply Sirona	Zirconia

PICN = *polymer infiltrated ceramic network.*

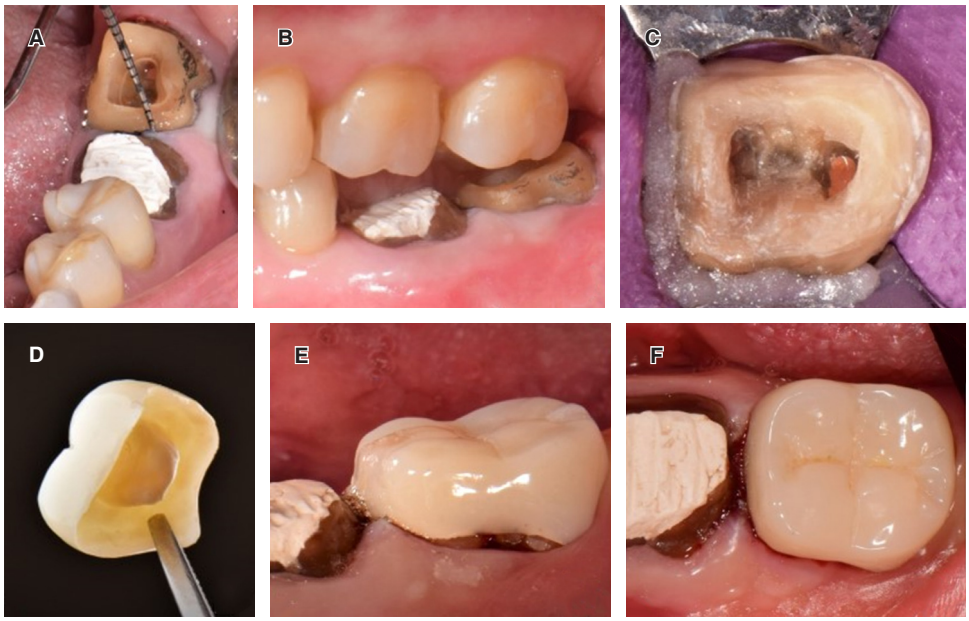

Figura 1:

A) Estado inicial de diente 37. **B)** Espacio interoclusal limitado que indica la realización de una endocorona. **C)** Divergencia de 5º a 8º con resina. **D)** Vista interna de la incrustación de cerómero. **E y F)** Vista vestibular y oclusal respectivamente de la endocorona ya cementada.

A) *Initial aspect of tooth 37.* ***B)*** *Limited interocclusal space indicating the need to an endocrown to rehabilitation.* ***C)*** *Divergence of 5º to 8º with resin.* ***D)*** *Internal view of the ceromer inlay.* ***E and F)*** *Vestibular and occlusal view respectively, of cemented endocrown.*

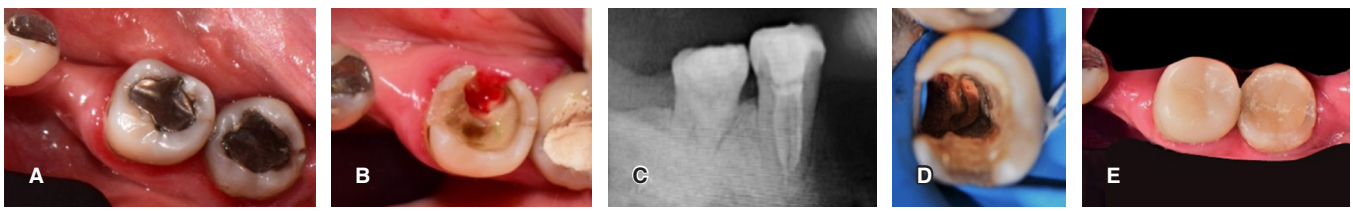

Figura 2: A) Restauración de amalgama previa en diente 36. **B)** Una vez retirada la obturación y remoción de caries en zona lingual comprometida. **C)** Radiografía final del diente después de realizar el tratamiento de conductos y restauración temporal. **D)** Conductos en forma en C, antes de sellar su acceso con ionómero de vidrio. **E)** Restauración ya cementada después de verificada la oclusión.

A) *Previous amalgam restoration on tooth 36.* ***B)*** *The filling has been removed and caries removed in the compromised lingual area.* ***C)*** *Final X-ray of the tooth after root canal treatment and a temporary restoration.* ***D)*** *C-shaped conduits, before sealing their access with glass ionomer.* ***E)*** *Restoration already cemented after verifying the occlusion.*

de conductos, se observa una raíz cónica y una disposición de conductos en C *(Figura 2B-C)*. Terminado el tratamiento de conductos, se determina la colocación de una endocorona ante la imposibilidad de retención de un poste intrarradicular por la disposición de los conductos y el grosor de las paredes radiculares. Se sella el tercio cervical con ionómero de vidrio fotopolimerizable Vitrebond™ (3M-ESPE) *(Figura 2D)*.

En la siguiente cita, se conforman las paredes intrapulpares y la zona lingual comprometida con fresa troncocónica 856 *(Figura 2B)*, se eliminó todo tejido remanente frágil y se terminó la preparación coronal y se obtuvo la impresión con PVS Virtual® XD (Ivoclar Vivadent), determinando como material restaurativo final cerómero y se coloca obturación temporal. En la tercera cita, se procede con la prueba y consecuente cementación de la restauración de SR Nexco (Ivoclar Vivadent) con cemento RelyX™ U200 (3M-ESPE), se realizó la remoción de excedentes, el control de oclusión y pulido final *(Figura 2E)*.

Caso 3

Mujer de 57 años de edad, acude también a la misma clínica a consulta para cambio por desajuste de restauraciones metálicas de amalgama e incrustación metálica en dientes 36 y 37 respectivamente *(Figura 3A)*. Después de la remoción de las restauraciones metálicas y la limpieza de éstas se evidencia la necesidad de tratamiento de conductos en diente 36 por diagnóstico de pulpitis irreversible asintomática. Durante la permeabilización de los conductos se produjo

una perforación del piso pulpar, el cual se procede a sellar con un sustituto bioactivo de dentina con base en silicato tricálcico, Biodentine™ (Septodont) y se prosiguió con el tratamiento de conductos, dejando en observación el diente por una semana *(Figura 3B)*.

En la segunda cita, los signos y síntomas permitieron terminar el tratamiento de conductos y sellar la cavidad pulpar con una capa de ionómero vítreo Vitrebond™ (3M-ESPE) de 2 mm de espesor, por el poco remanente dentario y la imposibilidad de colocar un endoposte por la nula existencia de paredes axiales para su retención, se decide realizar una endocorona de disilicato de litio e.max CAD (Ivoclar Vivadent AG) en el diente 36 y un onlay convencional en diente 37, se procede a tomar impresión con PVS Elite HD+ (Zhermack) y se coloca resina C&B como obturación temporal *(Figura 3C-E)*.

En la tercera cita se eliminaron las obturaciones temporales, se prueban las restauraciones cerámicas definitivas, comprobando su adaptación, áreas de contacto del diente 36, contactos interoclusales en posición céntrica, excursiones laterales y protusiva para después proceder a la desinfección del tejido remanente con pasta de clorhexidina al 2% Consepsis™ Scrub (Ultradent), se procede al grabado de las restauraciones con ácido fluorhídrico al 9% Porcelain Etch (Ultradent) durante 20 segundos,[10,11] neutralización con ácido ortofosfórico al 35% (3M), y colocación de silano por 1 minuto; la cementación fue igualmente con cemento polimérico dual RelyX™ U200 (3M-ESPE), se removieron excedentes y se realizaron los ajustes necesarios de oclusión *(Figura 3F)*.

DISCUSIÓN

La importancia de los casos que presentamos concuerda con los parámetros propuestos por Pissis[12] en 1995 al fabricar restauraciones cerámicas libres de metal que abarcaban las paredes de la cámara pulpar en un solo bloque, denominándolas «endocoronas».[13] A partir de ello, diversos autores usan estos principios con gran heterogeneidad en cuanto a la técnica, la metodología y materiales empleados y los parámetros estudiados y comparados, entre ellos los principales son: tasas de supervivencia, modelos de falla, y criterio clínico.[6] Los dientes posteriores con tratamiento de conductos requieren un recubrimiento total para minimizar el riesgo a fracturas al tener tejido remanente frágil, promover un sellado coronal para prevenir contaminación bacteriana y devolverles la función,[14] como los casos presentados no eran candidatos a una rehabilitación convencional de endoposte-núcleo-corona por diversas situaciones, se siguieron los parámetros propuestos por Fages,[7] Menezes Silva,[8] Taha[9] y Einhorn[14] entre otros, realizando endocoronas, obteniendo éxito en la restauración a corto plazo, esperando

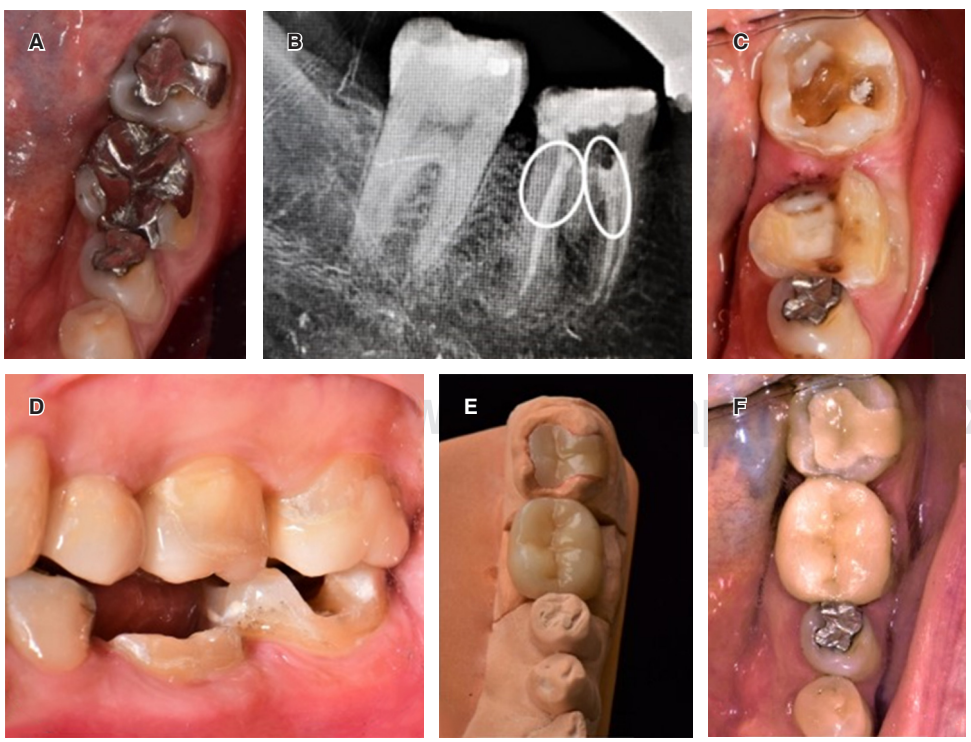

Figura 3:

A) Restauraciones preexistentes de dientes 36 y 37. **B)** Obturación de conductos y sellado de la perforación de furca con Biodentine™ (Septodont). **C)** Sellado con ionómero de vidrio y preparación para la endocorona. **D)** Comparativa de estructura remanente entre 36 y 37. **E)** Endocorona y onlay de disilicato de litio en modelo. **F)** Restauraciones cementadas.

A) *Pre-existing restorations of teeth 36 and 37.* ***B)*** *Canal filling and sealing of the furcation perforation with Biodentine™ (Septodont).* ***C)*** *Sealing with glass ionomer and preparation for endocrown.* ***D)*** *comparison of the remaining structure between pieces 36 and 37.* ***E)*** *Endocrown and lithium disilicate onlay in the model.* ***F)*** *Cemented restorations.*

uno a mediano y largo plazo como los obtenidos por Borgia en 2016 que indicó un éxito de 90% en casos con hasta 19 años de control, mencionando que el remanente coronario es el factor más importante en el éxito de las endocoronas.[13]

Según Sedrez-Porto en su revisión sistemática y metaanálisis de 2016 revisó un total de 102 dientes en cinco estudios donde se realizaron endocoronas en molares y premolares con diversos materiales como cerómeros, resinas y cerámicas cementados con cementos duales convencionales y de autograbado, los cuales no dieron relevancia significativa en su comparación.[15]

En cuanto a estudios con dientes con pérdida de remanente coronario se encontró un índice de éxito menor en los dientes no tratados endodóncicamente (62%), un 80% de éxito en los que se usó endoposte de fibra de vidrio[9,14] y un éxito del 90 al 94% de éxito de las endocoronas pero se precisan más estudios para aseverar la gran capacidad de éxito que presenta esta técnica.[9,15]

En cuanto a la adhesión, existe controversia sobre la eficacia de los sistemas de autograbado. Algunas investigaciones muestran que proporcionan una fuerza de unión de la dentina comparable a la obtenida con el sistema de grabado y enjuague, mientras que otras han observado una fuerza de unión significativamente menor.[6,15]

CONCLUSIONES

Las endocoronas son una alternativa al tratamiento convencional, puesto que están dirigidas hacia la tendencia de odontología adhesiva que permite ser más conservador en situaciones como las presentadas en los casos clínicos. Sin embargo, conocer sus ventajas e inconvenientes tanto como sus indicaciones logra que el tratamiento sea predecible y asegura así un éxito a largo plazo.

Clinical case

Endocrowns, a restorative treatment option

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ABSTRACT

Endocrowns are indirect restorations that, through bonding to dentin with polymeric cements, can rebuild and restore a tooth with a single component of various materials, mainly ceramic. Very favorable results in posterior teeth have been reported, considering them a more conservative alternative to reconstruction with endopost-core and its restoration with a complete crown. Requirements to carry them out are a tooth with successful root canal treatment, at least 3 walls with a minimum height of 2 mm, a thickness of 3 mm, and pulp walls with angles from 5º to 8º. This paper presents three clinical cases of endocrowns in teeth with a different diagnosis, materials used, and prognosis.

Keywords: Adhesion, endocrown, dental rehabilitation, dental crown.

INTRODUCTION

Endodontically treated teeth might have different characteristics and properties than those of vital teeth in terms of structure, strength, integrity, and hydration.

For several reasons, the tooth structure loss, including its wear during preparation for rehabilitation, affects its firmness, reduces its fracture resistance, and consequently limits its prognosis.[1] According to Meyenberg,[2] Shemesh,[3] and Kishen[4] this loss directly predisposes to the formation of fissures or cracks in both enamel and dentin.

Fissures in turn can cause fractures weakening (due to extensive and rapid removal of tissue during root canal treatment or during endopost placement) produced by excessive interaction with irrigants or intracanal medications (such as sodium hypochlorite and calcium hydroxide) corrosive effects of some restorative materials (such as excess acid etching) and excessive occlusal forces, whose effect is reinforced by the reduction of proprioception exhibited by devitalized teeth.[2-4]

PRESENTATION OF CLINICAL CASES

With the improvement and development of polymeric bonding to enamel and dentin in more than 60 years of study,[5] it is possible to rely on the marginal sealing, retention, and stability of indirect restorations, partial or total. This is the way endocrowns arose, unitary posterior adhesive restorations that span up to the walls of the pulp chamber in a single block, replacing intracoronal reconstructions and total restorations. Among the materials available for its realization there are ceramics, resins, and silicates study *(Table 1)*.[6]

Endocrowns are mainly indicated for teeth with a little coronal remnant. Biomechanical principles indicate that the tooth structural strength depends on the amount and proportion of the remaining tissues

and the integrity of the anatomical shape. Variations in tissue quality after endodontic treatment were shown to have a non-significant influence on the biomechanical behavior of the tooth.[7,8]

Endocrowns do not require more than 3 mm occlusal height to offer the properties of conventional crown preparations, so limited interocclusal space is not an obstacle to their usage.[7,9]

Endocrowns are also indicated in cases of the roots of teeth in which endoposts do not offer a favorable prognosis due to curvatures in the middle third or dilacerations, very narrow, very wide or C-shaped canals, or in cases of surgical accidents with large tissue loss, such as chamber floor perforations.[6]

In situations of severe loss of coronal tissue, the main option is a post-core treatment, but this one decreases the resistance to fractures and requires the removal of healthy tissue, increasing the risk of perforation.[6,9] From a clinical perspective, the endocrown design seems to have practical advantages over post-core restorations: it is cheaper, requires less elaboration time, and there is no resin shrinkage associated with the technique.[9]

Three female patients 45 to 55 years of age were selected, attended the Advanced Restorative Dentistry Specialty of the Postgraduate School of the *Facultad de Odontología de la UNAM*, with different clinical characteristics, diagnoses, and prognosis, with endodontically treated teeth.

Case 1

A 46-year-old female patient who consulted about the restoration of pulpless teeth 36 and 37 *(Figure 1A)* with provisional restorations, recurrent caries lesions, and narrowing of the interocclusal space relative to its antagonists; limited coronal remnant tissue in both teeth, especially in tooth 36 and with a minimum thickness at the level of the furcation. Its extraction is indicated for subsequent implant placement.

Regarding tooth 37, 4 mm high and 3 mm thick in all its walls, an endocrown was determined *(Figure 1B)*. Absolutely isolated, the pulp chamber was prepared to create an occlusal divergence between 5º and 8º. It was decontaminated with 5% sodium hypochlorite and undermines were compensated with photocurable resin Filtek™ Z350 (3M-ESPE®) creating straight walls. Canal accesses were sealed with polymer cement RelyX™ U200 (3M-ESPE®); then an impression was taken with polyvinyl siloxane (PVS) Elite HD + (Zhermack®) *(Figure 1C)* and temporary sealing with Systemp Onlay (Ivoclar Vivadent®) was made. The restorative material of choice was ceromer SR Nexco (Ivoclar Vivadent) due to its characteristics in general and especially for its resilience, fracture resistance, and low cost *(Figure 1D)*.

During the second appointment, the temporary restorer was removed; the cavity was absolutely isolated and then it was cleaned with Consepsis™ Scrub 2% chlorhexidine paste (Ultradent), the adaptation, and the occlusal height of the restoration were verified and then cemented with RelyXTM U200 (3M-ESPE) cement. The surpluses were removed and after a 3-second pre-polymerization, the insulation was removed. Then, the occlusion was checked with a 12 μm articulating paper. Finally, the polishing was carried out with rubber and polishing paste for resins *(Figure 1E-F)*.

Case 2

A 48-year-old female patient with secondary Sjögren's syndrome attended consultation for comprehensive treatment.

To rehabilitate teeth 36 and 37, previous fillings and surrounding caries lesions were removed. In the cervical area of tooth 36 *(Figure 2A)* a great loss of both coronal and root tissue was evident. With an endodontic diagnosis of asymptomatic irreversible pulpitis, the canal was treated, a conical root and a C-shaped canal arrangement were observed *(Figure 2B-C)*.

Subsequently, given the impossibility of retention of an intraradicular post due to the arrangement of the canals and the thickness of the root walls, it was decided to place an endocrown. The cervical third was sealed with Vitrebond™ (3M-ESPE) light-curing glass ionomer *(Figure 2D)*.

At the next appointment, the intrapulpal walls and the compromised lingual area were shaped with a frusto-conical bur 856 *(Figure 2B)*, all remaining fragile tissue was removed and the coronal preparation was completed. Afterward, the impression was obtained with VPS Virtual® XD (Ivoclar Vivadent) applying ceromer as the final restorative material, and a temporary filling was placed.

During the third appointment, we proceeded with the test and subsequent cementation of the SR Nexco (Ivoclar Vivadent) restoration with RelyX™ U200 (3M-ESPE) cement; immediately, the surpluses were removed and the occlusion control and final polishing were carried out *(Figure 2E)*.

Case 3

A 57-year-old female patient consulted for a change due to a mismatch of metal amalgam restorations and metal inlay on teeth 36 and 37, respectively *(Figure 3A)*.

After removing the metal restorations and cleaning them, it was observed that the root canal in tooth 36 needed treatment, due to the diagnosis of asymptomatic irreversible pulpitis.

While the canal was permeabilized, perforation of the pulp floor was produced, which was sealed with a bioactive dentin substitute based on tricalcium silicate, Biodentine™ (Septodont), and the canal treatment was continued, leaving the tooth under observation for a week *(Figure 3B)*.

During the second appointment, the signs and symptoms made it possible to finish the root canal treatment and seal the pulp cavity with a glass ionomer layer of 2 mm thick, Vitrebond™ (3M-ESPE). Due to the fact that there were few tooth remnants and the impossibility of placing an endopost due to the null existence of axial walls for retention, it was decided to use a lithium disilicate endocrown e.max CAD (Ivoclar Vivadent AG) on tooth 36 and a conventional onlay on tooth 37; then, an impression with (PVS) Elite HD + (Zhermack) was taken and C&B resin was applied to temporary seal *(Figure 3C-E)*.

At the third appointment, the temporary fillings were removed and definitive ceramic restorations were tested, verifying their adaptation, tooth 36 contact areas, interocclusal contacts in centric position, lateral and protrusive excursions. The remaining tissue was then disinfected with 2% chlorhexidine paste Consepsis™ Scrub (Ultradent). The restorations were etched with 9% hydrofluoric acid porcelain (Ultradent) for 20 seconds,[10,11] neutralization with 35% orthophosphoric acid (3M), and silane placement for 1 minute. Cementation was also done with RelyXTM U200 (3M-ESPE) dual polymeric cement; afterward, surpluses were removed and the necessary occlusion adjustments were made *(Figure 3F)*.

DISCUSSION

The importance of the cases that we present agrees with the parameters proposed by Pissis[12] in 1995 when fabricating metal-free ceramic restorations that encompassed the walls of the pulp chamber in a single block, calling them «endo-crowns».[13]

Various authors use these principles with great heterogeneity in terms of the technique, methodology, materials used and parameters studied and compared. The main parameters are survival rates, failure models, and clinical criteria.[6]

Having fragile remaining tissue, root canal treatment posterior teeth require a total covering to minimize the risk of fractures, therefore a coronal seal is necessary to prevent bacterial contamination and restore function.[14]

Due to various situations, the cases presented were not candidates for conventional endopost-core-crown rehabilitation. For this reason, the parameters proposed by Fages,[7] Menezes Silva,[8] Taha,[9] and Einhorn[14] among others, were followed, performing endocrowns. The restoration was successful in the short term and awaiting medium and long term results such as those obtained by Borgia in 2016 which constituted a 90% success in cases that were monitored for a period of up to 19 years, mentioning that the coronal remnant is the most important factor in the success of endocrowns.[13]

In his 2016 systematic review and meta-analysis, Sedrez-Porto, in five studies, reviewed a total of 102 molars and premolars in which endocrowns of various materials such as ceromers, resins, and ceramics were used with self-etching cement and conventional dual cement. When comparing the results, the different materials did not produce any significant relevance.[15]

Regarding studies about teeth with loss of coronal remnant, a lower success was found in not endodontically treated teeth (62%); those in which a fiberglass endopost was used got 80% success[9,14] and the endocrowns got a 90 to 94% success, but more studies are required to confirm the great capacity for success of this technique.[9,15]

Relating to the adhesion factor, there is a controversy about the effectiveness of self-etching systems. Some researches show that they provide a dentin bond strength comparable to that obtained with the etching and rinse system, while others have observed a significantly lower bond strength.[6,15]

CONCLUSIONS

Endocrowns are an alternative to conventional treatment since they are directed towards the trend of adhesive dentistry that allows being more conservative in situations such as those presented in clinical cases. Knowing its advantages and disadvantages as well as its indications allows treatment to be predictable and ensure long-term success.

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CLINICAL CASE

Pemphigus vulgaris: the importance of stomatology findings in early diagnosis

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ABSTRACT

This paper aims to report a clinical case of pemphigus vulgaris, with oral and cutaneous manifestations, addressing the clinical and histopathological characteristics of this disease. The patient was a 41-year-old woman who attended the Reference Center for Oral Lesions at the Universidade Estadual de Feira de Santana, Brazil, reporting mouth and skin ulcers for eight months. Incisional biopsies of the oral lesions were performed, and the final diagnosis was pemphigus vulgaris. Treatment consisted of the use of corticosteroids. Currently, the patient uses an immunosuppressant, the lesions are still healed and there are no signs of recurrence. Oral lesions commonly precede cutaneous manifestations. It is concluded that the dentist plays an important role in the early diagnosis of pemphigus vulgaris and contributes to a better prognosis and more effective treatment.

Keywords: Pemphigus, diagnosis, oral medicine.

Pénfigo vulgar: la importancia de los hallazgos estomatológicos en el diagnóstico temprano

RESUMEN

El objetivo de este estudio es relatar un caso clínico de pénfigo vulgar, con manifestaciones orales y cutáneas, abordando las características clínicas e histopatológicas de esta enfermedad. Se trata de una mujer, 41 años, que acudió al Centro de Referencia en Lesiones Bucales, de la Universidad Estadual de Feira de Santana, Brasil, reportando úlceras en la boca y en la piel hace 8 meses. Se realizaron biopsias incisionales de las lesiones orales y el diagnóstico final fue de pénfigo vulgar. El tratamiento consistió en el uso de corticoides. Actualmente, la paciente utiliza un inmunosupresor y las lesiones siguen cicatrizadas, sin signos de reincidencia de la enfermedad. Las lesiones orales, comúnmente preceden la aparición de las manifestaciones cutáneas. De este modo, se concluye que el cirujano-dentista desarrolla un importante papel en el diagnóstico precoz del pénfigo vulgar, y así contribuye a un mejor pronóstico y un tratamiento más eficaz.

Palabras clave: Pénfigo vulgar, diagnóstico, medicina oral.

INTRODUCTION

Pemphigus vulgaris is a severe immune-mediated bullous disease that affects the skin and mucous membranes. It affects men and women indistinctly from the fourth to the sixth decades of life. Antibodies act against desmosomal plaque protein, causing cell junctions to break down, resulting in vesicles and blisters of bloody liquid content, which can become an ulcer.[1-4] The predisposition for this disease seems to be related to genetic conditions, immunological defects, or exogenous factors, such as viruses, drugs, or physical agents.[5,6]

The diagnosis is made from the anamnesis, the recognition of the lesions, the positive Nikolski's sign (detachment of the upper layers of the skin and formation of blisters, when the regions near the lesions are slightly rubbed)[7] although the precision is in immunological and histopathological examinations.[3,4]

Treatment includes systemic corticosteroid therapy, antibiotic therapy against secondary infections, and topical therapy for the lesions, to control pain, and may still be associated with immunosuppressive agents.[7-9] The early prognosis is favorable.

The aim of this study is to report a clinical case of pemphigus vulgaris, with oral and cutaneous

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manifestations, addressing the clinical and histopathological characteristics of this disease.

CLINICAL CASE REPORT

The patient is a 41-year-old woman who attended the Reference Center for Oral Lesions at the Universidade Estadual de Feira de Santana-Brazil, reporting mouth and skin ulcers for 8 months. In the anamnesis, the patient states that the lesions initially arose in the oropharynx, which led her to consult an otolaryngologist, who diagnosed her with *Candida albicans* and referred her to a specialist in infectology. She was tested for the Human Immunodeficiency Virus and the serology was negative.

Figure 1: Ulcerated and erythematous lesion on upper and lower lips.

Figure 2: Ulcerated and erythematous lesion on the palate.

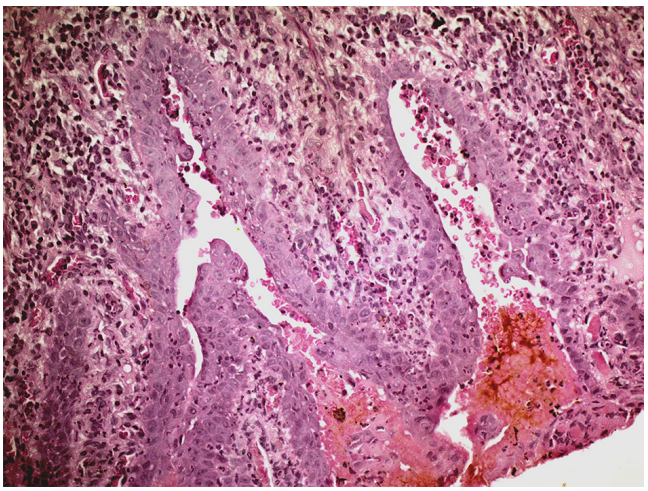

Figure 3: Photomicrography of the lesion with suprabasal intraepidermal cleft and basal cell acantholysis (20x).

Figure 4: Clinical evaluation after one year of monitoring.

Clinically, head, neck, face, and limb injuries were observed; in the mouth, they were located on the lips, tongue, jugal mucosa, and palate. These lesions were ulcerated, painful, erythematous, bleeding to the touch, and some bullous *(Figures 1 and 2)*.

Incisional biopsies of the oral lesions were performed, and the diagnosis was blistered with suprabasal acantholysis, which is compatible with pemphigus vulgaris *(Figure 3)*. Histological sections showed a typical intraepithelial cleft, with rounded acantholytic epithelial cells located within the cavity. A moderate underlying infiltration of inflammatory cells was observed. Tests were made for the research of autoantibodies, with negative results.

Dexamethasone rinse was prescribed, and the patient was referred to the Referral Service of the Hospital de las Clínicas-Salvador, Bahia, where she was treated with steroids and antifungals agents. Treatment with Prednisone (20 mg), Dapsone (100 mg), Fluconazole (150 mg), and Albendazole (400 mg) was started. Due to the persistence of lip lesions, Prednisone (60 mg) was administered, and the doses were gradually decreased until discontinued. Subsequently, pulse therapy with methylprednisolone (1 g) was performed for seven months.

The patient presented some collateral effects such as fluid retention, dizziness, amnesia, and fatigue. Currently, the patient uses the immunosuppressive agent Azathioprine (50 mg) and the lesions are still healed, without signs of recurrence of the disease and with complementary examinations according to the normality standards *(Figure 4)*.

DISCUSSION

The initially reported lesions arose in the oropharynx, which is consistent with the literature since it states that in most cases the oral manifestations precede the cutaneous manifestations.[2,7,10-12]

Clinical suspicions included bullous pemphigoid, recurrent aphthous stomatitis, and lichen planus. According to the literature, the differential diagnosis of pemphigus vulgaris includes bullous and ulcerative lesions, such as those initially suspected.[9]

Histopathological examination revealed a cleft between the basal layer of the epithelial tissue and the connective component, with inflammatory infiltrate and acantholysis between the epidermal cells -the main histopathological finding of pemphigus vulgaris- agreeing with the histological characteristics already described in the literature.[4,10-12]

According to the literature, the treatment of pemphigus vulgaris consists of the use of corticosteroids associated with immunosuppressive agents such as Prednisone and Azathioprine, used in this case.[1,4] It is necessary to gradually reduce the Prednisone amount to reach a maintenance dose to control the disease, with which several authors agree.[4,9,12] The faster the treatment is carried out, the lower the amounts of steroids prescribed.[10]

Since the first manifestations of pemphigus are generally found in the oral cavity, the relevance of this work is to show the importance that dentists know the clinical characteristics and the complementary examinations necessary to make the early diagnosis of pemphigus vulgaris and participate in the treatment, preservation, and referral to specialized service centers, to treat the disease in a multidisciplinary way, to control it.[3,13]

CONCLUSIONS

Studying and knowing pemphigus vulgaris is very important for dental professionals since its stomatological effects can precede systemic ones, which increases the responsibility of the dental surgeon in early diagnosis, allowing effective treatment actions to be planned. Finally, preservation must be highlighted as a fundamental stage to control therapy and act on possible recidivism.

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LITERATURE REVIEW

Biological indicators: the gold standard to verify the sterilization steam in dentistry

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ABSTRACT

Infection control in dental practice is a daily necessity, the correct way to ensure safe environments is to disinfect medical equipment and sterilize materials and instruments. There are common failures in sterilization cycles in dental offices, caused by various factors, mainly a mechanical failure, and human error. Biological indicators are prepared from thermo-resistant bacterial spores, used to determine the quality of the sterilization processes. There are different types of indicators on the market, however, it is necessary to promote and publicize the use of biological indicators as means of verification of the sterilization process, since their use is not frequent as indicated in the NOM-013-SSA2-2015, which must be every two months.

Keywords: Biological indicators, sterilization, verify, Dentistry, Mexico.

Indicadores biológicos: el estándar de oro para verificar la esterilización por vapor en odontología

RESUMEN

El control de las infecciones en la práctica Odontológica es una necesidad diaria, la forma correcta de asegurar ambientes inocuos son la desinfección de los equipos médicos y la esterilización de los materiales e instrumental. Comúnmente existen fallas en los ciclos de esterilización en consultorios dentales, causadas por diversos factores, principalmente fallos mecánicos y errores humanos. Los indicadores biológicos son preparados de esporas bacterianas termorresistentes, usados para determinar la calidad de los procesos de esterilización. Existen en el mercado diferentes tipos de indicadores, sin embargo, es necesario promover y dar a conocer el uso de los indicadores biológicos como medios de verificación del proceso de esterilización, debido a que su uso no es frecuente como lo indica la Norma Oficial Mexicana 013-SSA2-2015, el cual debe ser cada dos meses.

Palabras clave: Indicadores biológicos, esterilización, verificación, odontología, México.

INTRODUCTION

Odontology is a health science that consists of the improvement, prevention, and maintenance of the health of the stomatognathic system. This discipline must comply with regulations to maintain the hygiene of instruments and equipment to avoid contamination between patients since dental activities are carried out in environments highly contaminated by microorganisms. A drop of saliva can contain approximately six hundred thousand bacteria, the oral cavity provides characteristics that promote growth and proliferation. Infection control has become a critical part of dentistry.[1-4]

Infections can be transmitted from person to person in the following ways:

- Direct route: the infectious agent goes from the infected person to the susceptible person directly, without any vehicle. This is the most common form of transmission and can be by coughing, sneezing, or speaking, when body fluids come in contact with ocular, nasal, oral, or dermal tissues.
- Indirect route: the infectious agent goes from the infected person to the susceptible person through a transmission vehicle, usually an inanimate intermediate object contaminated with microorganisms. For example, gloves that do not change between patient and patient, dental instruments, contaminated water, and surfaces of dental equipment.
- Transmission route by air: it is the microbial spread suspended in the air and inhaled by the respiratory way.[5,6]

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Dental environments have work areas where activities present physical, chemical, and biological risks for patients and professionals who work there, which makes possible the incidence of cross infections. Infection prevention should focus on effective sterilization of medical materials, tools, and equipment and the right decontamination process that includes cleaning, disinfection and, use of protective barriers.[7] According to the previous context, who practices dentistry must adhere to standards the regulations for infection control within the dental clinic, preserving their safety, auxiliary staff, patients, and families.[8]

METHODS TO MONITOR THE EFFECTIVENESS OF STERILIZATION

Sterilization is the procedure responsible for the destruction of all forms of microbial life. Any instrument that has been in contact with the oral cavity after use must be adequately sanitized, removing existing remains with plenty of soap and water, before introduced into the sterilizer or autoclave.

Dentists must understand that sterilization techniques can be fallible and often fail.[9,10] The factors involved in the failure of the sterilization process are overload and mechanical defects, mainly. Many factors can influence a sterilization cycle to efficiently produce a package of sterile material, for example, steam penetration, drying time, and device settings (time, temperature, and pressure).[1,6,7] Because various factors directly influence the success of sterilization processes, and to guarantee their reliability, international organizations recommend monitoring these processes at least monthly or weekly and when equipment repair, or new staff are trained.[11,12]

Methods to monitor the effectiveness of sterilization may include physical indicators, chemical indicators, and biological indicators (BI). The resistance of microorganisms to sterilization ranges varies according to many factors, the most resistant are bacterial spores, which is why they are used for monitoring sterilization processes as biological indicators.[12]

BIOLOGICAL INDICATORS

The BI are liquid preparations or paper strips with a sufficient load of spores high resistance to sterilization. The use of BI is considered the most significant technique to verify sterilization cycles, because measures the destruction of highly resistant bacterial spores (lethality), if spores are destroyed, it can be assumed that all other microorganisms in dental instruments are also eliminated.[1-7]

Compliance with specific regulations and standards is very important to control and reduction of epidemiological risks. In the USA, ADA (American Dental Association), OSAP (Organization for Asepsis Safety and Prevention) and CDC (Centers for Disease Control and Prevention) recommend using weekly.[1-22]

In Mexico, the NOM-013-SSA2-2015 to Prevention and Control of Oral Diseases has developed guidelines with the purpose to reduce the risk of disease transmission (patient-dentist or dentist-patient) and establishes the use of every two months BI for control of sterilization cycles.[23] The norm says: «All sterilization techniques are fallible, apply biological controls every two months, as a quality control of the sterilization cycles and keep a record of the results, according to the Pharmacopoeia of the United Mexican States», comply with this standard is mandatory since it is published in the Official Newspaper of the Federation.[1-22]

Studies realized in different countries indicate an inappropriate knowledge and inadequate praxis on infection control in dental practice.[24] It is necessary to increase the importance of routine maintenance/calibration of autoclave and monitoring the efficacy of sterilization process with BI to avoid transmission of multiple infections.

A study realized in Tabriz, Iran (2011);[25] showed the use of BI in hospitals in 1997 was 0%, with reinforcement for use in 2011 proportion hospitals that used chemical indicators reached 100%, and BI reached 68% (25). Patiño,[15] a study realized in S.L.P, Mexico revealed of 230 verified sterilizers, 62 autoclaves, and 168 dry heat ovens, only 36% (22) of dentists with autoclaves and 17% (28) with dry heat use BI having a frequency of sterilization cycles once a day. It was identified 206 professionals who participated, only 22% (45) knew and used BI; consequently, 78% (161) had not performed corresponding quality control. Jihad Dagher, in Beirut, Lebanon with a sample of 134 autoclaves and 71 dry heat ovens, found few dental practices reported having preventive maintenance (17.9% for the autoclaves and 14.1% for the ovens). Routine monitoring of sterilizer efficacy was infrequently performed and was mostly conducted using physical indicators. The sterilization failure rate was higher for the ovens (16.9%) than for the autoclaves (7.5%), which identified the human error in setting sterilization cycle parameters as the predominant cause of failure.[26]

CONCLUSION

In recent years, the appearance of new infectious contagious diseases such as COVID-19, in addition

to thermo-resistant microorganisms found in the environment, increases interest in a quality health service and greater occupational protection, it is necessary to review and update procedures for the control of pathogenic microorganisms. Information is deficient on the use of BI to verify the quality of sterilization procedures, it is a current problem in Mexico because dentists do not routinely practice this type of control, even though its use is recommended by government health control regulations. It is also evident the lack of control by the health authorities that evaluated the risk of transmission of pathogen infections in the dental environment based on the official norm. Collaborative actions should be joined between health authorities, dental schools, and associations to propose and implement biological monitoring protocols mainly in developing countries.

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