Original Research Article

Marginal Microleakage in CL II Occlusal-Proximal Cavities sealed with different temporary filling materials: Study in vitro.

Abstract

Marginal microleakage is the process of mechanical micro-separation where the separation between the restorative material and the cavity walls is observed, causing the infiltration of salivary fluids. Therefore, the purpose of this study is to determine the marginal microleakage in Class II Occlusal-Proximal cavities sealed with different temporary filling materials. Sixty upper and lower premolars were divided into three groups: N=20 teeth for each group of temporary filling materials (C.I.V, IRM R, COLTOSOL). Prophylaxis was performed on each tooth using pumice stone and 0.12% chlorhexidine, followed by the preparation of Class II Occlusal-Proximal cavities. The cavities were disinfected with 0.2% chlorhexidine for one minute, air-dried, and sealed with Rapi Dry as a liner for 15 seconds, then immersed in 0.9% saline solution for 24 hours. The samples were dried on an absorbent surface, stained with 0.1% methylene blue for 48 hours at room temperature, washed, and dried on an absorbent surface for one hour. Sagittal cuts were made with abundant irrigation and constant air, and measurements were taken using a Wireless Digital Microscope with a zoom capacity of 50x-1000x and a resolution of 1920*1080. The images were adjusted to actual scale using Adobe Photoshop and Illustrator CS6. The results showed that C.I.V had lower marginal microleakage (G3 G0) and higher E.S.M.O.P. (12/20) than IRM R (G4, 9/20) and COLTOSOL (G4 G0, 8/20) in the teeth. Therefore, the temporary filling materials C.I.V and COLTOSOL exhibited less marginal microleakage in Class II Occlusal-Proximal cavities compared to IRM R.

Keywords: Microleakage, materials, temporary dental filling, Class II cavity preparation

Introduction

Dental caries lesions affect the dental cavity as a multifactorial infectious disease that involves dietary habits, bacteria, salivary fluids, and other influencing factors, causing an imbalance in the normal microbial flora within the cavity.[1] Cavity preparation involves the removal of deficient tissue and the shaping of the internal anatomy of the tooth, aiming to achieve filling and/or restoration through systems that allow the introduction of filling and/or restorative materials. Among cavity preparations, Class II preparations are described as cavities that occupy the interproximal surface of premolar and molar teeth, according to Dr. G.V. Black's classifications.[1,2]

Restorative dentistry focuses on employing and comprehensively analyzing the diagnosis, prognosis, and dental treatment for carious or non-carious lesions, with the aim of restoring function, stability, and aesthetics through restorative means. The materials and techniques used in current dentistry come into play where the oral cavity is affected, with the goal of restoring the lost structure, its anatomical function, and aesthetics.[3] In restorative dentistry, success depends not only on the material used but also on the durability of the work. Marginal microleakage directly affects the success or failure of restorative procedures. Microleakage is defined as a mechanical micro-separation between the tooth and the restorative material, resulting from the contraction of resin-based materials during polymerization or other materials, poorly adapted restorations, and defective cavity preparations.[4]

Temporary filling materials can achieve satisfactory results after the removal of carious tissue or endodontic treatment. They serve to prevent the introduction of bacteria and salivary fluids, thereby reducing contamination in the cavity and providing favorable conditions for excellent bonding between the tooth and the filling material. There are multiple cements used for temporary filling, including Zinc Oxide and Eugenol Reinforced Cement (IRM R), Glass Ionomer Cement (C.I.V), and COLTOSOL.[5] These cements were used to fill the Class II occlusal-proximal cavities in this research study.

Some studies have provided important data regarding the behavior of certain temporary filling materials, stating that provisional cements can vary in their performance. For example, IRM R has been reported to have a lower sealing capacity compared to others. However, IRM R has demonstrated the highest effectiveness in marginal microleakage.[6,7]

This study aims to determine the marginal microleakage of Class II occlusal-proximal cavities sealed with different temporary filling materials.

Problem Statement

Dental caries is a condition influenced by various factors such as diet, bacterial lesions, salivary compounds, and other influential factors within and outside the oral cavity.[17] It is characterized by the presence of cariogenic bacteria, mainly caused by sucrose, leading to the development of dental caries. Dental caries consists of different stages involving mineral loss and the process of remineralization on the enamel, which is covered by dental plaque that produces acids.[18]

Cavity removal, preparation, and shaping involve the elimination of deficient tissue and the creation of internal anatomy within the tooth, aiming to achieve filling and/or restoration through systems that allow the introduction of filling and/or restorative materials.[19]

According to Dr. G.V. Black[2], cavities are classified based on their location as Class I, Class II, Class III, Class IV, and Class V, with Class II cavities being in the interproximal areas of premolars and molars within the dental system.

Restorative dentistry is responsible for the correct diagnosis, prognosis, and treatment of dental lesions and other conditions. Carious and non-carious processes affect the aesthetics, function, and stability of the teeth. Restorative dentistry aims to restore stability, function, and aesthetics using dental biomaterials that meet the requirements of each patient's clinical condition. It is important to understand that teeth within the masticatory system are exposed to unique and special conditions due to the interaction of chewing, habits, and other factors that can affect their functioning. Microleakage is known as the process of mechanical micro-separation through which bacterial agents infiltrate between the filling material and/or restorative material, occurring at the occlusal or gingival margin.[7] The presence of microleakage, whether minimal or significant, directly interferes with the success or failure of the definitive filling and/or restoration procedure. Microleakage leads to a decrease in the chemical, physical, and mechanical characteristics of the filling and/or restoration.[14]

Ideal restorative dentistry aims to reduce or eliminate risk factors through preventive therapy.[1] Restorative dentistry faces multiple challenges during the diagnosis, prognosis, and restorative treatment of dental organs, including the preparation, shaping, and filling of Class II cavities. Difficulties include the complete removal of deficient tissue at the gingival floor level, restoration of proximal contour using dental materials, and achieving proper contact relationships with adjacent teeth, which can be challenging during filling and lead to problems in achieving marginal sealing in the proximal box. Due to these and other factors encountered during the operative time of the filling, the clinician must carefully select the ideal material for these procedures, guiding the decision to place an indirect restoration.[3]

Temporary fillings are vital in achieving success in previously endodontically treated teeth, teeth prepared for dental prostheses, pulp coverings, and other cases. These materials offer a provisional solution while maintaining occlusal stability, protection of the pulp-dentin complex, and dentin stability.[5,20] Currently, the use of these materials has increased in dental practice, playing an important role in the temporary protection of dental cavities.[5]

There are various types of temporary filling materials that provide different options for temporary treatment aimed at protecting the dentin-pulp complex. It is crucial to base the selection of the material on its chemical and mechanical properties to use the material with the best properties for a specific clinical condition.[13]

At the Dr. René Puig UNPHU dental clinic, where this research project takes place, commercial presentations of the following temporary filling materials are used (IRM R, C.I.V, COLTOSOL), and their use is determined by the professional based on the existing clinical condition. This research project aims to identify the temporary filling material that provides the best mechanical-chemical sealing property at the interface, considering the marginal microleakage at the occlusal and gingival margins.

The following research questions arise based on the identified problems and the project's objectives:

- Which of the different temporary filling materials exhibits marginal microleakage in Class II occlusal-proximal sealed cavities in an in vitro study?
- What degree of marginal microleakage is observed in Class II occlusal-proximal fillings sealed with IRM R?
- What degree of marginal microleakage is observed in Class II occlusal-proximal fillings sealed with Reinforced Glass Ionomer Cement (C.I.V)?
- What degree of marginal microleakage is observed in Class II occlusal-proximal fillings sealed with COLTOSOL?

Justification

This present study aimed to determine the marginal microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials in the preclinical area of the UNPHU School of Dentistry. [9,13] Given the issue of poor marginal sealing in provisional fillings (IRM R, C.I.V, and COLTOSOL) in Class II occluso-proximal preparations, this study aims to identify the temporary filling material with better properties for marginal sealing in dental operative procedures at the UNPHU School of Dentistry. [13] The results obtained from this study will have a significant impact on facilitating decisions for professionals and students in the clinical area who use temporary filling materials, with the goal of reducing the chances of treatment failure due to saliva leakage and other contaminants. [7]

Objectives

General Objective

To determine the marginal microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials.

Specific Objectives

- To determine the degree of marginal microleakage in Class II occluso-proximal fillings sealed with IRM R.
- To determine the degree of marginal microleakage in Class II occluso-proximal fillings sealed with C.I.V.

- To determine the degree of marginal microleakage in Class II occluso-proximal fillings sealed with COLTOSOL.

Proposal

Formulation of the Hypothesis

H1: The IRM R temporary filling material exhibits greater marginal microleakage in Class II occluso-proximal cavities than C.I.V and COLTOSOL.

H0: The C.I.V and COLTOSOL temporary filling materials have lower marginal microleakage in Class II occluso-proximal cavities than IRM R.

Variables and Operationalization of Variables

Dependent Variable

- Degree of Marginal Microleakage
- Marginal Sealing of Temporary Filling Materials Independent Variable
- Premolar Teeth
- Temporary Filling Materials (C.I.V, IRM R, COLTOSOL)

Operationalization of Variables

List 1. Operationalization of Variables

Variable	Definition	Indicator	Dimension
Marginal Microfilming	These are the different values of filtration that temporary filling materials can exhibit.	Level of penetration of staining on the dental surface	-Grade 0 (G0): without filtration. -Grade 1 (G1): microleakage in the enamel -Grade 2 (G2): Microleakage beyond the amelodentinal junction. -Grade 3 (G3): Microleakage in the axial wall -Grade 4 (G4): Microleakage towards the pulp.

Temporary filling materials	These are the materials that allow for temporary filling.	Types of materials.	(C.I.V.) Glass Ionomer Cement. (IRM R) Zinc Oxide Eugenol Cement reinforced with Synthetic Resin. (COLTOSOL) Zinc Oxide Without Eugenol.
Effectiveness of Marginal Sealing of Temporary Filling Materials (E.S.M.O.P).	Distance of penetration of the staining substance between the temporary filling material and the tooth.	Measurement in millimeters of methylene blue microleakage.	Excellent: 0 mm Regular: 0.1-1 mm Moderate: 1.1-2 mm Severe: 2.1 mm onwards
Posterior teeth	Set of teeth responsible for grinding food, they receive a higher occlusal load.	Premolars	-1st upper premolars -2nd upper premolars -1st lower premolars -2nd lower premolars

Methodological Framework

Study Type

This is an in vitro experimental study conducted in a non-living organism environment to analyze the effectiveness of three temporary filling materials (C.I.V, IRM R, COLTOSOL), with a sample selection of posterior teeth (upper and lower premolars).

Location and Time

This experiment was conducted at the School of Dentistry in the preclinical dental operative laboratories of the Universidad Nacional Pedro Henríquez Ureña, Santo Domingo, Dominican Republic, in 2020.

Population and Sample

Population

Upper and lower premolars, both first and second premolars, obtained according to the required criteria for the study.

Sample

A total of 60 premolars were included in the study: 16 upper first premolars, 5 upper second premolars, 27 lower first premolars, and 12 lower second premolars.

Unit of Statistical Analysis

The unit for statistical analysis was the marginal microleakage in Class II occluso-proximal fillings using the temporary filling materials (C.I.V, IRM R, COLTOSOL).

Inclusion and Exclusion Criteria

Inclusion Criteria

- Upper premolars.
- Lower premolars.
- Premolars without previous restorations.
- Premolars without previous cavity preparations
- . ● Premolars without structural or shape dental anomalies.

Exclusion Criteria

- Fractured premolars.
- Premolars with structural or shape dental anomalies.
- Premolars with previous cavity preparations.
- Fillings with bubbles or previous fractures before the analysis.
- Burned or damaged teeth during the sample preparation.

● Molars.

Data Collection Techniques and Procedures

A total of 60 natural teeth were used, which were divided into three groups of 20 each, with 20 samples assigned to each group of temporary filling materials (C.I.V, IRM R, COLTOSOL).

Pilot Test

Supervised by Dr. Nayeris Valdez, a total of 12 human teeth were collected for this pilot test. Six intact upper and lower premolar human teeth were selected, considering their similar crown diameter based on the inclusion criteria of the study. The sample collection involved visiting various dental clinics and purchasing the missing teeth. After obtaining the samples, they were disinfected with 2.25% sodium hypochlorite for 24 hours and kept in physiological saline solution until use.

Figure 1. Six premolar teeth mounted

in a wax mold. Source: Author's own.

The samples were divided into three groups, and the teeth were prepared occlusally and proximally by creating Class II occluso-proximal cavities measuring four millimeters in the mesiodistal direction (with smooth pulpal floor walls and rounded axiogingival angles). This was done using high-speed diamond round burs with a diameter of ½. One bur was used in the mesiodistal direction, creating a cavity depth of three millimeters to the pulpal floor using anterior burs. Finally, high-speed diamond pear-shaped burs numbered 329 and 330 were used to prepare the axial wall, working from the gingival wall at a depth of one millimeter per millimeter. The sequence of high-speed burs was

replaced every five clinical uses. The preparation area was disinfected with 0.2% chlorhexidine using a cotton pellet for one minute, and the cavity was then dried.

Figure 2. High-speed milling for cavity

preparation of premolar teeth. Source: Author's own.

The premolars previously prepared in groups of three (N: 20) were filled with three temporary filling materials (C.I.V, IRM R, COLTOSOL) manipulated according to the manufacturer's instructions. After filling the Class II occluso-proximal cavities with temporary filling materials, the teeth were sealed with a Rapi Dry or ultra-drying nail polish from Miss Marion to be used as a cavity liner for 15 seconds. This was done to waterproof the root portion and a part of the coronal portion without touching the cavity margins to avoid affecting the study.

Figure 3. Rapi Dry or ultra-drying nail

polish from Miss Marion. Source: Author's own.

One hour was allowed to pass before performing the staining method on the previously filled teeth to ensure the setting of the temporary filling material. The filled teeth were immersed in physiological saline solution (sodium chloride/saline solution 0.9%) for 24 hours and dried on all surfaces by placing them on an absorbent surface for one hour to

remove moisture. They were then immersed in 0.1% methylene blue solution for external use for 48 hours, washed with tap water from the municipal system, and dried.

Figure 4. Staining method

protocol.Source: Author's own.

After completing the staining method with its corresponding times, the teeth were cut using a transverse (horizontal) cut to separate the coronal portion from the root. Another sagittal cut with a slight inclination (vertical) was made using a fine-grained (blue) metal cutting disc designed for prosthetics. This was done using a low-speed rotary instrument with constant irrigation of water and air.

Figure 5. Sagittal cut with a standard-sized metallic

prosthetic disc to a premolar tooth. Source: Author's own.

Microfiltration was then visualized, evaluated, and measured using the magnification loop of the compound optical microscope at 10x magnification with 2x zoom. Subsequently, images taken by the microscope's camera were measured to assess the degree of microfiltration and the effectiveness of the sealing of the temporary filling materials.

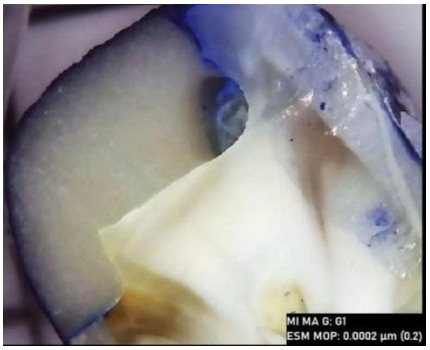


Figure 6. Microscopic view of a premolar tooth with temporary filling material C.I.V. Source: Author's own.

Figure 7. Microscopic view of a premolar tooth with temporary filling material IRM R. Source: Author's own.

Figure 8. Microscopic view of a premolar tooth with temporary filling material COLTOSOL. Source: Author's own.

The results obtained from the pilot test were presented in a table, showing the diameter of the cavity preparation, the total area of the temporary filling material, the degree of maximum microleakage, and the effectiveness of the temporary filling material sealing. The following data were obtained:

List 2. The diameter of the cavity preparation, the total area of the temporary filling material, the degree of maximum microleakage, and the effectiveness of the temporary filling material sealing.

	Pilot Test			
Sample quantity	Cavitary preparation depth to pulp floor / Axial wall (mm)	Provisional filling material (mm)	Mazimun grade of microleakage (mm)	Effectiveness of temporary filling material sealing
C.I.V	3 / 1	3 / 1	G1	200 µm (0.2 mm)
C.I.V	3 / 1	3 / 1	G1	100 µm (0.1 mm)
IRM R	3 / 1	3 / 1	G4	500 µm (0.5 mm)
IRM R	3 / 1	3 / 1	G4	400 µm (0.4 mm)
COLTOSOL	3 / 1	3 / 1	G1	1000 µm (1 mm)
COLTOSOL	3 / 1	3 / 1	G1	1000 µm (1 mm)

Sample preparation

The premolars were subjected to an artificial simulation, which aimed to mimic the routine behavior of the oral environment, achieved through an in vitro study. The premolars were free of caries and were extracted beforehand. A preoperative prophylaxis was performed using pumice and 0.12% chlorhexidine.

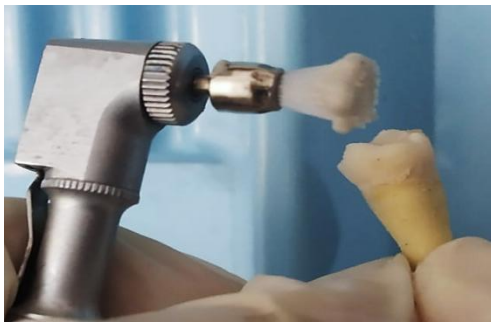


Figure 9. Prophylaxis of one of

the samples. Source: Author's own.

Cavity preparation

Class II occlusal-proximal cavities were created, measuring four millimeters mesio-distally, with a cavity depth of three millimeters to the pulpal floor, and the axial wall located in dentin was worked on at one millimeter per one millimeter of gingival wall. The cavity had a smooth floor, walls without irregularities, and rounded axiogingival angles for mechanical reasons. This was achieved using a sequence of high-speed burs, which were replaced after every five clinical uses.8 The first bur in the high-speed sequence was a round diamond bur with a diameter of ½, followed by the use of a rounded-tipped bur with a diameter of one, if necessary, for creating the four-millimeter mesio-distal cavity preparation and the three-millimeter cavity depth to the pulpal floor. Lastly, high-speed pear-shaped diamond burs numbered 329 and 330 were used for the axial wall located in dentin, working at one millimeter per one millimeter of the gingival wall.

Figure 10. Prior sounding for orientation

based on the difference in dental anatomy

depth of the cavities. Source: Author's own.

Figure 11. Preparation of Class II Occlusal-Proximal

cavities with different burs. Source: Author's own.

Figure 12. Sounding of Class II Occlusal-Proximal

cavities performed. Source: Author's own.

Disinfection was carried out using a cotton swab soaked in 0.2% chlorhexidine for one minute in the prepared cavity; then, drying of the prepared cavities was performed.

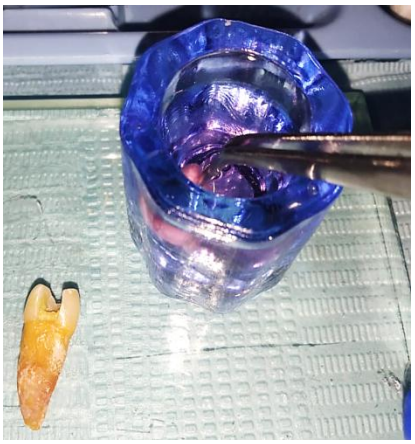


Figure 13. Disinfection with 0.2% chlorhexidine of

Class II Occlusal-Proximal cavities performed. Source: Author's own.

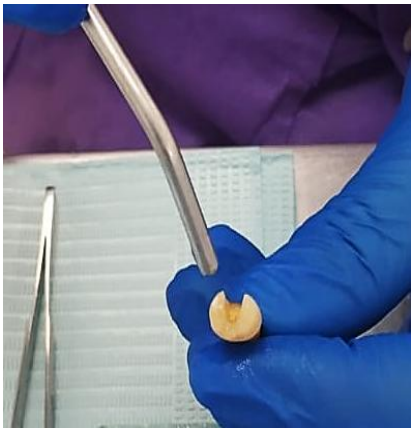


Figure 14. Air-drying of the Class II Occlusal-Proximal

cavities performed. Source: Author's own.

Cavity filling

The premolars were divided into three groups of (N: 20), each of which was filled using three different temporary filling materials.

Figure 15. Use of temporary filling materials for Class II

Occlusal-Proximal cavities performed. Source: Author's own.

The different temporary filling cements (C.I.V, IRM R, Coltosol) were mixed according to the manufacturer's instructions:

- The manipulation of Type II restorative C.I.V was done by mixing with a plastic cement spatula in a crushing manner on the wax paper on top of which it was mixed, as recommended by the cement manufacturer. The dosage was one portion of powder to two portions of liquid, depending on the material's instructions. It was divided into two parts, and the first half was mixed, followed by the second half.

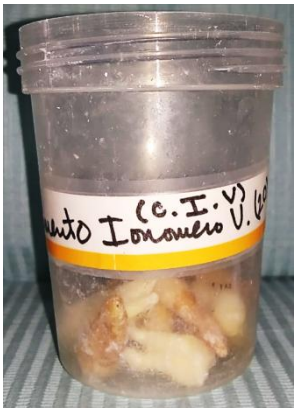


Figure 16. Sample of teeth with Class II Occlusal-Proximal cavities temporarily filled with C.I.V. Source: Author's own.

- For the IRM R, the amount used was measured, considering an equal proportion of powder and liquid: one portion of powder and one portion of liquid. The measurements were taken as directed by the manufacturer.

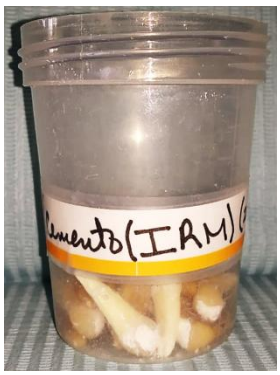


Figure 17. Sample of teeth with Class II Occlusal-Proximal cavities temporarily filled with Reinforced IRM. Source: Author's own.

- For COLTOSOL, the appropriate amount of the putty to be used was taken according to the cavity to be filled, giving it the desired shape and anatomy.

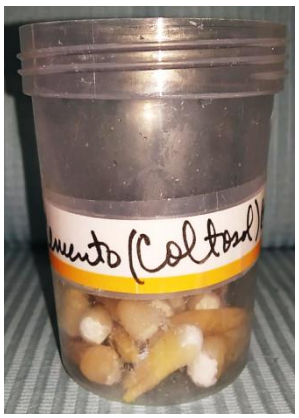


Figure 18. Sample of teeth with Class II Occlusal-Proximal cavities temporarily filled with COLTOSOL. Source: Author's own.

- The teeth were then sealed using Rapi Dry or ultra-drying nail polish from Miss Marion to serve as a cavity liner. The Rapi Dry was applied for 15 seconds to waterproof the root portion and a part of the coronal portion without touching the cavosurface margins of the restoration to avoid affecting the study.

Figure 19. Placement of Rapi Dry as a liner in Class II Occluso-proximal restorations. Own source of the author.

Staining Method

One hour was allowed to pass before carrying out the staining method on the previously obturated teeth to ensure the setting of the provisional obturating material. The obturated teeth will be submerged in physiological saline solution (0.9% sodium chloride/saline solution) for 24 hours and then dried on all surfaces by placing them on an absorbent surface for one hour to remove the moisture from the surfaces.

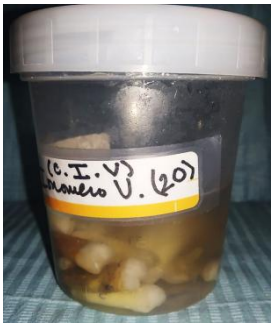


Figure 20. Obturated teeth submerged in 0.9% physiological saline solution in Class II Occluso-proximal cavities performed with Composite Intermediary Varnish (C.I.V). Own source of the author.

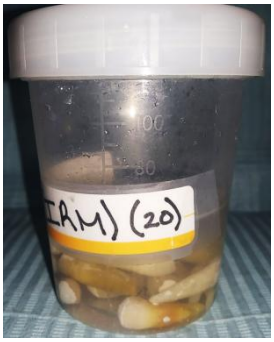


Figure 21. Obturated teeth submerged in 0.9% physiological saline solution in Class II Occluso-proximal cavities performed with I.R.M. R. Own source of the author.

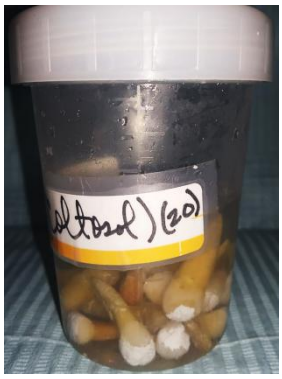


Figure 22. Obturated teeth submerged in 0.9% physiological saline solution in Class II Occluso-proximal cavities performed with COLTOSOL. Own source of the author.

They were submerged in 0.1% methylene blue for 48 hours, which should have been at room temperature. Afterward, they were washed with ordinary tap water and dried. Sagittal cuts were made at the cervical third in the mesio-distal direction, dividing the crown and root of the teeth as needed.

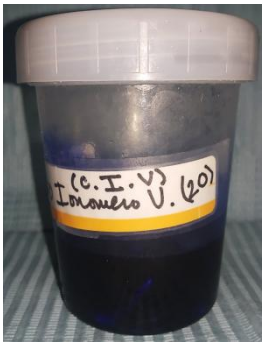


Figure 23. Obturated teeth submerged in methylene blue in Class II

Occluso-proximal cavities performed with Composite Intermediary Varnish (C.I.V).

Own source of the author.

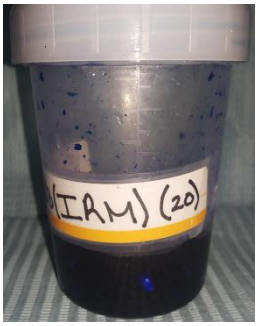


Figure 24. Obturated teeth submerged in methylene blue in Class II Occluso-proximal cavities performed with Reinforced IRM. Own source of the author.

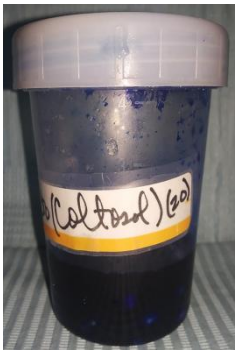


Figure 25. Obturated teeth submerged in methylene blue in Class II Occluso-proximal cavities performed with COLTOSOL. Own source of the author.

The procedure was carried out using a metallic prosthodontic cutting disc with a fine standard grit (blue). Transverse cuts (horizontal) were made to divide the coronal portion of the root, and other sagittal cuts were made with a slight inclination (vertical) using low-speed rotary instruments at 35,000 rpm with constant water and air irrigation.

Figure 26. Metallic prosthodontic cutting disc with fine standard grit

used for Class II Occluso-proximal cuts. Own source of the author.

The instrument used for the convenience of the study to evaluate and measure microfiltration was a wireless digital microscope with a zoom capability of 50x-1000x and a resolution of 1920*1080P (which serves the same purpose as the 10x compound optical microscope provided by the Department of Biology at the Universidad Nacional Pedro Henríquez Ureña). It was standardized with a horizontal and vertical resolution of 96 DPI (Dots Per Inch) and a depth of 24 bits, using the Smart digital microscope camera.

Figure 27. Use of provisional obturator materials for Class II

Occluso-proximal cavities performed. Own source of the author.

The images of all the samples were edited and cropped using Adobe Photoshop CS6 and Adobe Illustrator CS6 programs. With the help of the ruler tool, the desired portion of each of the total samples of the study (N:60) was measured, and the measurements were brought to real scale using a digital grid of 5x5 mm digitized at real scale. This process allowed standardizing the total samples of the study (N:60) through precise calculations and exact numbers provided by the study.

The formula used for the conversion was as follows: 1 pixel (Px) = 0.264583 mm; 1 mm = 3.779528 Px; 1 mm = 1000 µm.

Example being: 1 Px = 264.5833333 µm = 0.2445833333 (0.2) mm

Figure 28. Digital microscopic image of a fragment of sagittal cuts in Class II Occluso-proximal with Composite Intermediary Varnish (C.I.V). Own source of the author.

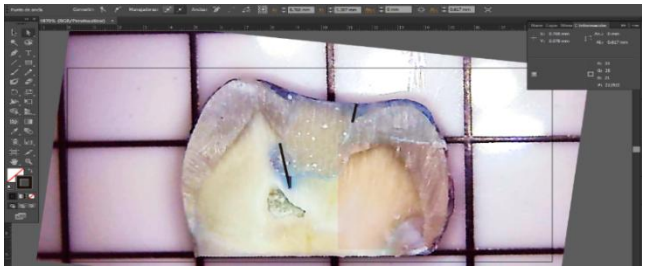


Figure 29. Adobe Illustrator CS6 program of a digital microscopic image of a fragment of sagittal cuts in Class II Occluso-proximal with Composite Intermediary Varnish (C.I.V). Own source of the author.

The control group consisted of five teeth that were not provisionally obturated but were submerged in the contrast medium. They were observed according to the research criteria.

Figure 30. Tooth from the control group. Own source of the author.

Statistical plan for data analysis

After obtaining the results, a dataset was generated and analyzed using Microsoft Excel. The data was presented in tables and frequency charts for a better understanding of the outcomes.

Ethical aspects involved in the research

Throughout this investigation, materials and instruments were used following ethical principles to ensure no harm to the interests of the university. All relevant measures were taken to avoid any risks. There were no conflicts of interest with the brands of the materials used, as they were provided by the researcher.

Results and Data-analysis

Study results:

The data obtained from the study was analyzed through tables and graphs to determine the different degrees of Marginal Microleakage and Effectiveness of Marginal Seal of Provisional Restoration (E.S.M.O.P) according to the tooth type for the provisional obturation cements such as C.I.V, IRM R, and COLTOSOL.

Table 1. Degree of Marginal Microleakage according to the tooth type for C.I.V cement in sealed Class II Occluso-proximal cavities.

	Tipo de diente				
	Superior		**Inferior**		
Microleakage Grade	**First Premolar**	**Second Premolar**	**First Premolar**	**Second Premolar**	**TOTAL**
No Microleakage	1 (5%)	1 (5%)	1 (5%)	1 (5%)	4 (20%)
Microleakage on the enamel	2 (10%)	1 (5%)	3 (15%)	1 (5%)	7 (35%)
Microleakage beyond the amelodentinal junction	1 (5%)	1 (5%)	2 (10%)	1 (5%)	5 (25%)
Microleakage on the axial wall	0 (0%)	2 (10%)	1 (5%)	1 (5%)	4 (20%)
Microleakage into the dental pulp.	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
TOTAL		**5 (25%)**	**7 (35%)**	**4 (20%)**	**20**

	4 (20%)				**(100%)**

Source. Author's own.

G0= No microleakage, G1= Microleakage on the enamel, G2= Microleakage beyond the amelodentinal junction, G3= Microleakage on the axial wall, G4= Microleakage on the dental pulp.

In Table 1, data of marginal microleakage for a total of 20 (100%) samples of C.I.V cement (nine upper premolars and 11 lower premolars) are observed, corresponding to the degrees of microleakage (G0, G1, G2, G3, G4). G1, with enamel filtration, had the highest value of 7 (35%), while G3 with axial filtration and G0 with no filtration had the lowest value (20%).

Table 2. Degree of Marginal Microleakage according to the tooth type for IRM R cement in sealed Class II Occluso-proximal cavities.

	Type of teeth				
	Superior		**Inferior**		
Microleakage Grade	**First Premolar**	**Second Premolar**	**First Premolar**	**Second Premolar**	**TOTAL**
No Microleakage	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Microleakage on the enamel	0 (0%)	0 (0%)	5 (25%)	1 (5%)	6 (30%)
Microleakage beyond the amelodentinal junction	5 (25%)	0 (0%)	3 (15%)	3 (15%)	11 (55%)
Microleakage on the axial wall.	1 (5%)	0 (0%)	1 (5%)	0 (0%)	2 (10%)
Microleakage into the dental pulp.	0 (0%)	0 (0%)	1 (5%)	0 (0%)	1 (5%)

TOTAL	**6 (30%)**	**0 (0%)**	**10 (50%)**	**4 (20%)**	**20 (100%)**

Source. Author's own.

G0= No microleakage, G1= Microleakage on the enamel, G2= Microleakage beyond the amelodentinal junction, G3= Microleakage on the axial wall, G4= Microleakage on the dental pulp.

In Table 2, data of marginal microleakage for a total of 20 (100%) samples of IRM R cement (six upper premolars and 14 lower premolars) are observed, corresponding to the degrees of microleakage (G0, G1, G2, G3, G4). The highest value of microleakage beyond the amelodentinal junction was in G2 with 11 (55%) occurrences, while the lowest value was in G4 with 1 (5%) occurrence, representing leakage into the dental pulp.

Table 3. Degree of Marginal Microleakage according to the tooth type for COLTOSOL cement in sealed Class II Occluso-proximal cavities.

	Type of teeth				
	Superior		**Inferior**		
Microleakage Grade	**First Premolar**	**Second Premolar**	**First Premolar**	**Second Premolar**	**TOTAL**
No Microleakge	0 (0%)	0 (0%)	1 (5%)	0 (0%)	1 (5%)
Microleakage on the enamel	0 (0%)	0 (0%)	4 (20%)	1 (5%)	5 (25%)
Microleakage beyond the amelodentinal junction	5 (25%)	0 (0%)	3 (15%)	3 (15%)	11 (55%)
Microleakage on the axial wall	1 (5%)	0 (0%)	1 (5%)	0 (0%)	2 (10%)
Microleakage into the	0 (0%)	0 (0%)	1 (5%)	0 (0%)	1 (5%)

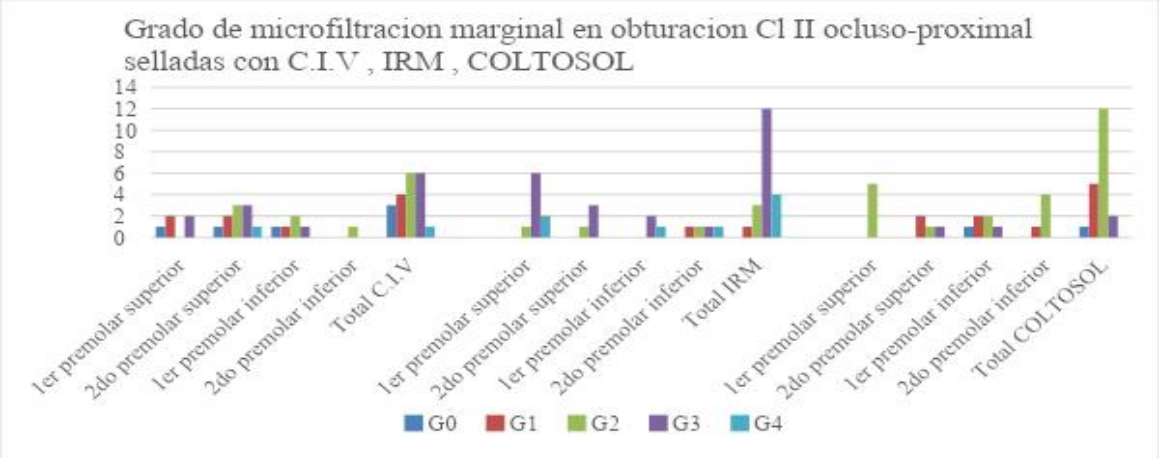
dental pulp					
TOTAL	**6 (30%)**	**0 (0%)**	**10 (50%)**	**4 (20%)**	**20 (100%)**

Source. Author's own.

G0= No microleakage, G1= Microleakage on the enamel, G2= Microleakage beyond the amelodentinal junction, G3= Microleakage on the axial wall, G4= Microleakage on the dental pulp.

In Table 3, data of marginal microleakage for a total of 20 (100%) samples of COLTOSOL cement (six upper premolars and 14 lower premolars) are observed, corresponding to the degrees of microleakage (G0, G1, G2, G3, G4). The highest value of microleakage beyond the amelodentinal junction was in G2 with 11 (55%) occurrences, while the lowest value was in G4 and G0 with 1 (5%) occurrence each, representing leakage into the dental pulp.

Graph 1. Bar chart of samples showing the Degree of Marginal Microleakage according to the type of premolars in sealed Class II Occluso-proximal cavities using C.I.V, IRM R, and COLTOSOL.



Source. Author's own.

G0= No microleakage, G1= Microleakage on the enamel, G2= Microleakage beyond the amelodentinal junction, G3= Microleakage on the axial wall, G4= Microleakage on the dental pulp.

In Graph 1, all the data from the total of the three groups, each consisting of 20 (100%) samples of C.I.V, IRM R, and COLTOSOL cements, are observed. The data corresponds

to the degrees of microleakage (G0, G1, G2, G3, G4), and there are four groups for the upper first premolars, upper second premolars, lower first premolars, and lower second premolars.

Table 4. Effectiveness of Marginal Seal of Provisional Restoration (E.S.M.O.P) for the three materials C.I.V, IRM R, and COLTOSOL in sealed Class II Occluso-proximal cavities.

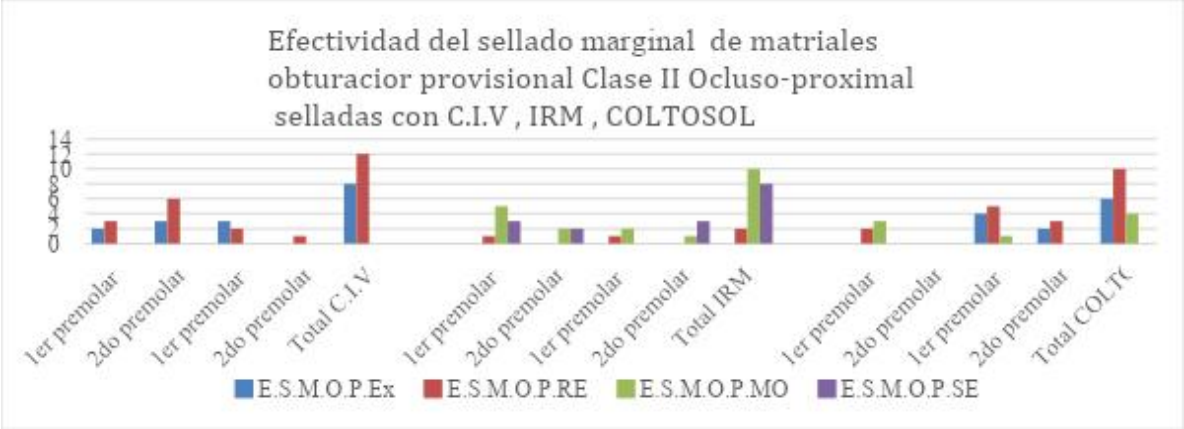
Sealing effectiveness	Type of material			TOTAL
	C.I.V	IRM R	COLTOSOL	
Excellent: 0 mm	8 (14%)	0 (0%)	7 (12%)	15 (25%)
Regular: 0.1-1 mm	12 (19%)	3 (5%)	8 (14%)	23 (39%)
Moderate: 1.1-2mm	0 (0%)	9 (14%)	5 (7%)	14 (21%)
Severe: 2.1 mm onwards	0 (0%)	8 (14%)	0 (0%)	8 (14%)
TOTAL	**20 (33%)**	**20 (33%)**	**20 (33%)**	**60 (100%)**

Source. Author's own.

Effectiveness of Marginal Sealing of Temporary Filling (E.S.M.O.P); E.S.M.O.P Ex = Excellent, E.S.M.O.P RE = Regular, E.S.M.O.P MO = Moderate, E.S.M.O.P SE = Severe.

In Table 4, the data of the Effectiveness of Marginal Seal of Provisional Restoration (E.S.M.O.P) for the three materials are observed. The total comprises 60 (100%) samples of C.I.V (33%), IRM R (33%), and COLTOSOL (33%). The data corresponds to the Effectiveness of Marginal Seal of Provisional Restoration (E.S.M.O.P) classified as Excellent, Regular, Moderate, and Severe. The E.S.M.O.P Regular had the highest value with 23 (39%) occurrences, while the E.S.M.O.P Severe had the lowest value with 8 (14%) occurrences in teeth.

Graph 2. Bar chart of samples showing the degree of marginal microleakage according to the type of premolars in sealed Class II Occluso-proximal cavities using C.I.V, IRM R, and COLTOSOL.



Source. Author's own.

Effectiveness of Marginal Sealing of Temporary Filling (E.S.M.O.P); E.S.M.O.P Ex = Excellent, E.S.M.O.P RE = Regular, E.S.M.O.P MO = Moderate, E.S.M.O.P SE = Severe.

In Graph 2, all the data from the total of the three groups are observed, comprising 60 (100%) samples of C.I.V, IRM R, and COLTOSOL cements. The data corresponds to the Effectiveness of Marginal Seal of Provisional Restoration (E.S.M.O.P) classified as Excellent, Regular, Moderate, and Severe. There are four groups for the upper first premolars, upper second premolars, lower first premolars, and lower second premolars.

Discussion

Restorative dentistry is responsible for employing and comprehensively analyzing the diagnosis, prognosis, and dental treatment, among other causes, with the aim of restoring function, stability, and aesthetics through restorative means in cases of carious or non-carious lesions. The materials and techniques used in the present day come into play when the oral cavity is affected, with the purpose of restoring the lost structure, its anatomical function, and aesthetics.In restorative dentistry, success does not solely depend on the material, although the material's durability is related to it. For this reason, this research aims to evaluate marginal microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials: an in-vitro study.

Therefore, the results were compared with those of other authors.

Regarding the Degree of Marginal Microleakage in Class II occluso-proximal cavities sealed with CIV, IRM R, COLTOSOL:

The Zinc Oxide Reinforced with Resin IRM R cement showed higher Marginal Microleakage at the Amelodentinal Junction level (55%) and lower in the pulp (5%), which coincides with Espinosa's study (7). In their samples, IRM R presented a higher marginal microleakage at the Amelodentinal Junction in G2 (52%).

The Glass Ionomer Cement C.I.V presented higher Marginal Microleakage in Enamel (35%) and lower in the Axial level and No Leakage (20%), which coincides with Caraballo's study (12). In their samples, C.I.V showed a higher microleakage in the enamel (30%).

The Zinc Oxide Cement COLTOSOL presented higher Marginal Microleakage at the Amelodentinal Junction level (55%) and lower in the pulp (5%), which coincides with Espinosa's study[7]. In their samples, they used zinc oxide-based cements like OBTUR® and CAVIT®, and the sample with the highest microleakage was at the Amelodentinal Junction.

Regarding the Effectiveness of Marginal Sealing of Temporary Filling (E.S.M.O.P) according to the temporary filling material with C.I.V, IRM R, COLTOSOL:

The IRM R (15%) showed higher E.S.M.O.P in the "Moderate" category and (0%) in the "Excellent" category, coinciding with Espinosa's study[7] where the Zinc Oxide Reinforced with Resin IRM R presented lower E.S.M.O.P than COLTOSOL.

The Glass Ionomer Cement C.I.V (20%) showed higher Effectiveness of Marginal Sealing of Temporary Filling in the "Regular" category and lower (0%) in the "Moderate" category. The Zinc Oxide Cement COLTOSOL (13%) presented higher E.S.M.O.P in the "Regular" category and (0%) in the "Severe" category. This differs from Caraballo's study[12], where the Glass Ionomer Cement C.I.V presented lower E.S.M.O.P than the Zinc Oxide Cement COLTOSOL and higher microleakage.

As for the limitations of the study, initially, the use of a thermocycler was planned but not achieved. This apparatus is responsible for aging the samples by subjecting them to different temperature changes with distinct cycles to simulate the temperature changes experienced by human teeth. Additionally, there were difficulties with complementary equipment of the optical microscope at UNPHU, so it was substituted with a personal use

WiFi digital microscope, which was previously analyzed and approved by the Operative Dentistry area of Dr. René Puig Bentz Clinic (UNPHU).

Conclusion

After conducting and analyzing the present research results, the following conclusions were obtained regarding marginal microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials: an in-vitro study.

- Regarding the degree of Marginal Microleakage in Class II occluso-proximal cavities sealed with C.I.V, IRM R, COLTOSOL; IRM R showed the highest degree of microleakage, with 11 out of 20 teeth at the Amelodentinal Junction level (G2) and the lowest degree of microleakage, with 1 out of 20 teeth at the Pulpal level (G4).
- Regarding the degree of Marginal Microleakage in Class II occluso-proximal cavities sealed with C.I.V; it presented the highest degree of microleakage, with 7 out of 20 teeth at the Enamel level (G1), and the lowest degree of microleakage, with 4 out of 20 teeth at the Axial level (G3) and no leakage (G0).
- Regarding the degree of Marginal Microleakage in Class II occluso-proximal cavities sealed with COLTOSOL; it presented the highest degree of microleakage, with 11 out of 20 teeth at the Amelodentinal Junction level (G2), and the lowest degree of microleakage, with 1 out of 20 teeth at the Pulpal level (G4) and no leakage (G0).
- In terms of the effectiveness of Marginal Sealing of Temporary Filling (E.S.M.O.P) in Class II occluso-proximal sealed cavities; C.I.V showed the highest effectiveness, with 12 out of 20 teeth rated as "Regular," and the lowest effectiveness, with 0 out of 20 teeth rated as "Moderate." IRM R showed 9 out of 20 teeth rated as "Moderate" and 0 out of 20 teeth rated as "Excellent." COLTOSOL, on the other hand, showed 8 out of 20 teeth rated as "Regular" and 0 out of 20 teeth rated as "Severe."
- In ascending order of hierarchy according to the choice based on the degree of Marginal Microleakage and the Effectiveness of Marginal Sealing of Temporary Filling (E.S.M.O.P), it is concluded that IRM R showed higher marginal

microleakage and lower E.S.M.O.P. COLTOSOL was an intermediate material, followed by C.I.V, which showed lower marginal microleakage and higher E.S.M.O.P.

Based on the results obtained in this research, the null hypothesis (H0) is confirmed, indicating that the temporary filling materials C.I.V and COLTOSOL exhibited lower marginal microleakage in Class II occluso-proximal cavities than IRM R.

Recommendations

Based on the results obtained in this research, the following recommendations are made:

- Conduct further research using a thermocycler to subject the samples of teeth with marginal microleakage and sealing effectiveness with temporary filling materials C.I.V, IRM R, and COLTOSOL to temperature variations.
- Utilize C.I.V as a temporary filling material in cases of Direct Pulp Capping (RPC) and subsequently obturate with Resin Composites in the area of Emergency and Operative Dentistry.
- Recommend the use of COLTOSOL as a temporary filling material in cases of Endodontic Treatments due to its rapid hardening capacity upon contact with saliva in Endodontic and Emergency areas.
- Investigate other commercial products that distribute different temporary filling materials to make comparisons according to relevant criteria for the specific study.
- These recommendations aim to improve the understanding and application of temporary filling materials and their effectiveness in various dental procedures. Further research and exploration of different materials will contribute to enhancing dental treatments and patient care.

Bibliographic references

1. Iliana G. Dental caries. Some factors related to their appearance in children. Scielo [Revista internet] 2008. [citado 12 de septiembre de 2019]; 45(1): 545. Disponible en: http:/scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0034-75072008000100004

2. Duran G. Cavidades de Black. Operatoria. Revista Cubana de estomatología [Revista internet]

2017. [citado 12 de septiembre de 2019]: 1-4. Disponible en: https://es.scribd.com/doc/38199901/cavidades-deblack-operatoria

3. Nocchi E. Odontología restauradora [Internet] 2008. [citado 12 de septiembre de 2019]: 473. Disponible en:https://books.google.com.do/books?id=iwceudulmlqc&pg=pa134&lpg=pa134&dq=los+principales+diluyentes+son:+el+tegdma+y+el+edma,+el+problema+que+presentan+los+diluyentes+es+que+aumentan+la+contracción+de+polimerización+de+las+resinas+compuestas. +ade#v=onep

4. Gil Lc, Acosta S, Jiménez L, Brache Aa, Grau P. Evaluación de la microfiltración marginal en técnicas de restauración de clase II con resina compuesta. Revista Nacional de Odontología [Revista internet] 2016. [citado 12 de septiembre de 2019]: 13. Disponible en: https://revistas.ucc.edu.co/index.php/od/article/view/578

5. Insignares S. Operatoria y materiales dentales. Dientes humanos, anatomía dental [Internet] 2016. [citado 12 de septiembre de 2019]: 113. Disponible en: https://es.scribd.com/document/327476273/operatoria-dental-unidad-5

6. Armijos X. Evaluación del grado de microfiltración coronal de tres materiales de obturación temporal (cavit, coltosol y cemento de ionómero de vidrio) [Internet] 2011. [citado 3 de abril de 2019]; 3: 9. Disponible en: http://repositorio.ucsg.edu.ec/bitstream/3317/837/1/t-ucsg-pre-med-odon-4.pdf

7. Espinosa P, Cruz A, Armas A, Carrera A, López E. Evaluación in vitro del grado de microfiltración de tres cementos provisionales. Odontología Sanmarquina [Revista internet] 2018. [citado 15 de marzo de 2019]; 21(2):87. Disponible en: Http://revistasinvestigacion.unmsm.edu.pe/index.php/odont/article/view/14768

8. Gélvez M, Velosa J. Durabilidad de las fresas de diamante tras realizar desgastes en dientes naturales, comparando 4 marcas comerciales, analizado en microscopía electrónica [Internet] 2017. [citado 31 de junio de 2019]; 36(77). Disponible en: https://www.researchgate.net/publication/327429978_durabilidad_de_las_fresas_de_diamante_tras_realizar_desgastes_en_dientes_naturales_comparando_4_marcas_comerciales_analizado_en_microscopia_electronica_durability_of_four_diamond_bur_brands_after_toot

9. Sanabria J, Schneegans T. Estudio in vitro del sellado marginal de cajones proximales en obturaciones clase II realizadas con técnica incremental en comparación con técnica incremental modificada [Tesis grado]. Nicaragua. Universidad Nacional Autónoma De Nicaragua; 2016.

[citado 21 de mayo de 2019]: 36-42. Disponible en: http://repositorio.unan.edu.ni/7388

10. Chaple A. Modification of class II technique of cavities restoration using composites. Scielo [Revista internet] 2015. Instituto Superior De Ciencias Médicas de la Habana [citado 3 de junio de 2019]: 2-4. Disponible en: http://scielo.sld.cuscielo.php?script=sci_arttext&pid=s1729519x201500030002

11. Mastach Lf, Roca Pc, Sierra Pr. Estudio in vitro de microfiltración en obturaciones de clase II de resina compuesta condensable. Scielo [Revista internet] 2015. [citado 31 de junio de 2019]: 3-5. Disponible en: http://scielo.isciii.es/pdf/odonto/v20n2/original3.pdf

12. Caballero Cs, García Cr, Untiveros G, Peruana U, Heredia Cs. Microfiltración coronal in vitro con tres materiales de obturación temporal utilizados en endodoncia. Revista Estomatológica Herediana [Revista internet] 2010. [citado 13 de agosto de 2019]; 2: 3-7. Disponible en: http://repositorio.ucsg.edu.ec/bitstream/3317/837/1/T-UCSG-PRE-MED-ODON-4.pdf

13. Ramirez R. Microfiltración en cavidades clase II restauradas con resinas compuestas de baja contracción [Internet] 2009. [citado 13 de agosto de 2019]: 1-6. Disponible en: https://www.actaodontologica.com/ediciones/2009/1/art-14/

14. Camejo A. Microfiltración coronaria en dientes tratados endodónticamente. Revisión de la literatura de Venezuela. Acta Odontología Venezuela [Revista internet] 2008. [citado 15 de agosto de 2019]. Disponible en: https://www.actaodontologica.com/ediciones/2008/4/art-27/

15. Gil Lc, Acosta S, Jiménez L, Brache Aa, Grau P. Evaluación de la microfiltración marginal en técnicas de restauración de clase II con resina compuesta. Revista Nacional Odontologica [Revista internet] 2013. [citado 21 de junio de 2019]; 9: 53–60. Disponible en: https://revistas.ucc.edu.co/index.php/od/article/view/578

16. Romero L, Ramirez O. Microfiltración marginal en sellantes de fosas y fisuras utilizando las técnicas convencional y suplementaria: estudio in vitro [Tesis grado]. Santo Domingo: Universidad Nacional Pedro Henríquez Ureña; 2017.

17. Perez J. Dental caries [Internet] 2008. [citado 12 de septiembre de 2019]. Disponible en: https://es.scribd.com/document/327476273/operatoria-dental-unidad-5

18. Núñez D. Biochemistry of dental caries. Scielo [Revista internet] 2010. [citado 12 de septiembre de 2019]; 3: 9. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1729-519X2010000200004

19. González A. Dental health: Relationship between dental caries and food consumption. Scielo [Revista internet] 2013. [citado 12 de agosto de 2019]: 28. Disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=s0212-16112013001000008

20. Camilo J, Polanco O, David A, Chávez L, Peláez A. Restauraciones provisionales y sistema cad/cam [Internet] 2015. [citado 15 de mayo de 2019]; 2: 4-7. Disponible en: http://bdigital.ces.edu.co:8080/repositorio/bitstream/10946/4109/1/restauraciones_provisionales.pdf

21. Cruz P, Armas V, Espinosa A, Carrera A, López E. Evaluación in vitro del grado de microfiltración de tres cementos provisionales. Odontología Sanmarquina [Revista internet] 2018. [citado 3 de abril de 2019]:12-17. Disponible en: http://revistasinvestigacion.unmsm.edu.pe/index.php/odont/article/view/14768

22. Corvera V, Mia I. Sistema Estomatognático [Internet] 2011. [citado 12 de agosto de 2019]. Disponible en: http://wwwestomaupao-ivana.blogspot.com/2010/06/el-esmalte.html

23. Esponda R. Anatomía dental [Internet] 2017. [citado 12 de septiembre de 2019]: 390. Disponible en: https://es.scribd.com/doc/30468426/anatomia-dental-esponda-vila

24. Rosa C. Histología oral – esmalte y lad [Internet] 2017. [citado 12 de septiembre de 2019]: 2-3. Disponible en: https://es.scribd.com/doc/76014340/histologia-oral-esmalte-y-lad

25. Campos G. Histología, embriología e ingeniería tisular bucodental [Internet] 2009. [citado 13 de septiembre de 2019]. Disponible en: https://www.academia.edu/36462380/histologia_embriologia_e_ingenieria_tisular_bucodental_1

26. Argudo P. Anatomía de los dientes: esmalte dental, dentina, cemento, pulpa [Internet] 2017. [citado 13 de septiembre de 2019]:2. Disponible en: https://www.onmeda.es/higiene_bucodental/anatomia_dientes.html

27. Ecured C. Cemento dental [Internet] 2017. [citado 13 de septiembre de 2019]. Disponible en: Https://www.ecured.cu/cemento_dental

28. Salvador J. Cavidades de Black: clase II [Internet] 2018. [citado 13 de septiembre de 2019]. Disponible en: http://cavidadesdeblack.blogspot.com/p/clase-ii.html

29. Ayala E. Materiales de obturación dental [Internet] 2018. [citado 13 de septiembre de 2019]. Disponible en: https://dvd-dental.com/blogodontomecum/materiales-de-obturacion-dental/

30. Pat V, Edwin C, Farfan J, Canul O, Pacheco V. Materiales de obturación [Internet] 2017. [citado 13 de septiembre de 2019]. Disponible en: www.slideshare.net/victorpachecovazquez/materiales-de-obturacion

31. Cov L. Biomateriales dentales [Internet] 2010. [citado 12 de septiembre de 2019]: 142-151-155-161. Disponible en: Https://Www.Libreriauniversalbooks.Com/Products/Biomateriales-Dentales-2e

32. Cemento ionómero de vidrio tipo II restauración pack, Casa GC Gold Label LC Mini. [Internet] 2016. [citado 13 de octubre de 2019]. Disponible en: https://www.google.com/search?q=Cemento+Ionomero+de+vidrio+Tipo+II+Restauración,+Casa+GC+Gold+Label+LC+Mini+Pack.&sxsrf=ACYBGNSpt3EPoyT7hqddnfXKnztAVLxsQ:1573662172960&tbm=isch&source=iu&ictx=1&fir=4yEgJpSKO4ptBM%253A%252C5QinTc2VrekjOM%252C_&vet=1&usg=A

33. Phillips J. Ciencia de los materiales dentales [Internet] 2010. [citado 13 de septiembre de 2019]: 480–489. Disponible en: books.google.com.do/books/about/phillips_la_ciencia_de_los_materiales_de.html?id=4unifbmauqec&printsec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false

34. Universidad Nacional Pedro Enríquez Ureña (UNPHU). Manual Odontológico de operatoria dental I. Preclínico. República dominicana; 2016: 44–46.

35. Casa comercial ZOER'S. Cemento óxido de zinc y eugenol reforzado con resina sintética (IRM) [Internet] 2014. [citado 13 de octubre de 2019]. Disponible en:https://www.google.com/search?q=(IRM).+Casa+comercial+ZOER&client=firefoxbd&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjlseyX9uflAhWnTd8KHSqwCFkQ_AUIESgB&biw=1366&bih=654#imgrc=Sm1KeI2kAziPiM

36. Casa comercial 3M ESPE, sistema masilla. Cemento óxido de zinc sin eugenol (Coltosol) [Internet] 2015. [citado 16 de octubre de 2019]. Disponible en: https://www.google.com/search?client=firefoxd&biw=1366&bih=654&tbm=isch&sa=1&ei=QV7MXevXOGn5wKPzrLoBA&q=coltosol+3M+ESPE%2C+Sistema+Masilla&oq=coltosol+3M+ESPE%2C+Sistema+Masilla&gs_l=img.3...4165.4165..43.0.0..0.130.130.0j1.....0....1..gwswizimg.udU2VdK2nk&ved=0ahUKEwir_IuflAhXh01kKHQnDE0Q4dUDCAY&uact=5#imgrc=Snjnk79Vz8PcfM

37. Yepes J. Coltosol [Internet] 2012. [citado 13 de septiembre de 2019]. Disponible en:

https://es.scribd.com/doc/70160259/coltosol

38. Arrobo P, Cruz A, Armas A, Carrera A, López E. Evaluación in vitro del grado de microfiltración de tres cementos provisionales. Odontología Sanmarquina Revista [Revista internet] 2011. [citado 23 de septiembre de 2019]; 2 :87. Disponible en: http://repositorio.ucsg.edu.ec/bitstream/3317/837/1/T-UCSG-PRE-MED-ODON-4.pdf

39. Reidl L. Instrumentos de medición [Internet] 2017. [citado 26 de septiembre de 2019]. Disponible en: http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-50572013000200007

40. Khan A. Introduction-to-cells, microscopy [Internet] 2016. [citado 26 de septiembre de 2019]:3-7. Disponible en: https://es.khanacademy.org/science/biology/structure-of-a-cell/introduction-to-cells/a/microscopy

41. Sanchez R, Oliva N. Historia del microscopio y su repercusión en la Microbiología [Revista internet] 2015. [citado 26 de septiembre de 2019]. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1727-81202015000200010

42. Martin R. Enciclopedia salud [Revista internet] 2016. [citado 15 de octubre de 2019];1. Disponible en: http://scielo.isciii.es/scielo.php?script=sci_arttext&pid=S1139-76322013000200002

43. Definicion C. Azul de metileno concepto general [Internet] 2015. [citado 15 de octubre de 2019]: 1. Disponible en: Https://conceptodefinicion.de/azul-de-metileno/

44. Oz M, Lorke D, Hasan M, Petroianu G. Cellular and molecular actions of methylene blue. Medicinal research reviews [Revista internet] 2011. [citado 15 de octubre de 2019] : 93–117. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/19760660

45. Khan A. Reacción en cadena de la polimerasa (PCR) [Internet] 2016. [citado 18 de octubre de 2019]. Disponible en: https://es.khanacademy.org/science/biology/biotech-dna-technology/dna-sequencing-pcr-electrophoresis/a/polymerase-chain-reaction-pcr

46. Allscience. Termociclador [Internet] 2013. [citado 26 de septiembre de 2019]. Disponible en: https://www.e-allscience.com/blogs/news/8477021-que-es-y-comofunciona-un-termociclador#targettext=un termociclador es un aparato,con el método de sanger.

47. Callister Wd. Introducción a la ciencia e ingeniería de los materiales [Internet] 2014. [citado 26 de septiembre de 2019]. Disponible en: https://jmcacer.webs.ull.es/ctmat/practicas laboratorio_archivos/traccion.pdf

48. Concepto D. Definición azul de metileno [Internet] 2018. [citado 26 de septiembre de 2019]. Disponible en: https://conceptodefinicion.de/azul-de-metileno

49. Valdez E. Cemento dental [Internet] 2014. [citado 26 de septiembre de 2019]. Disponible en: https://es.slideshare.net/erickalexis184/cemento-dental-32906704

50. Wordreference. Definición espectro [Internet] 2005. [citado 26 de septiembre de 2019]. Disponible en: https://www.wordreference.com/definicion/espectro

51. Rejumed C. Hidroxiapatita, clínica estética en marbella rejumed [Internet] 2017. [citado 26 de septiembre de 2019]. Disponible en: https://clinicarejumed.com

52. Significados. Significado in vitro [Internet] 2014. [citado 26 de septiembre de 2019].

Appendix

Exhibit 1. Letter of permission request

Permission Request Letter

Santo Domingo, October 2019.

Lic. Lourdes Rojas de Ortiz

Director of the Department of Biology, UNPHU

Subject: Request for Permission to Use Microscope

Through this letter, I am requesting permission to access one of your microscopes that allows me to project and immediately respond to prepare the results of the study through the images and measurements obtained. This is to analyze the samples for my thesis work proposal entitled: "Marginal Microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials: an in vitro study." I would like to inquire about the possibility of using the equipment and know the schedule during which I could have access to it.

Thank you in advance for your attention.

Best regards,

Ismael David Lama Taveras

Student ID: 14-1891

Exhibit 2. Data collection instrument

“Marginal Microleakage in Class II occluso-proximal cavities sealed with different temporary filling materials: an in vitro study."

ID: _____

Tooth:

- 1st upper premolars
- 2nd upper premolars
- 1st lower premolars
- 2nd lower premolars

Type of temporary filling material:

- C.I.V (Glass Ionomer Cement)
- IRM R (Zinc Oxide Eugenol Cement reinforced with Resin)
- COLTOSOL (Zinc Oxide Without Eugenol)

Mark the degree of microleakage (38):

- Grade 0: No leakage.
- Grade 1: Leakage in the enamel.
- Grade 2: Leakage beyond the amelodentinal junction.
- Grade 3: Leakage in the axial wall.
- Grade 4: Leakage towards the pulp.

Effectiveness of Marginal Sealing of Temporary Filling Materials E.S.M.O.P: ___ Millimeters (mm).

- Excellent: 0 mm
- Regular: 0.1-1 mm
- Moderate: 1.1-2 mm
- Severe: 2.1 mm and beyond.

Exhibit 3. Control of work carried out in the dental operative laboratory

Date	Procedure	Signature of present Dr.
*	CAVITY PREPARATION	*
20		
20		
20		
*	PLACEMENT OF MATERIALS	*
20		
20		
20		
*	STAINING	*
20		
20		
20		
*	FINAL OBSERVATION	*

20		
20		
20		
60		

Glosary

- Methylene Blue: It is a staining dye that can pigment parts of the bodies, achieving a surgical treatment. Some doctors use methylene blue as an antiseptic method and to cauterize the interior; it is also used as a stain in absorption studies conducted under the microscope. [48]
- Cementocytes: Their formation occurs when cementoblasts are embedded in the mineralized cementum. [49]
- Spectrum: It refers to a series of diverse microbes on which a drug is therapeutically active. [50]
- Hydroxyapatite: Ca10 [PO4]6 [OH]2, which are inorganic constituents of bone and dental structures. Hydroxyapatite can be found synthetically. Its primary use is in prosthetic coatings or implantology, as well as in filling substances. [51]
- In vitro: Refers to techniques that are performed outside of living organisms, typically within test tubes, using culture media, or in artificial environments. [52]