

INSTITUTO UNIVERSITÁRIO EGAS MONIZ

MESTRADO INTEGRADO EM MEDICINA DENTÁRIA

ESTUDO COMPARATIVO SOBRE OS PREPAROS DENTÁRIOS PARA COROA REVESTIMENTO TOTAL, REALIZADO POR ESTUDANTES DO MESTRADO INTEGRADO EM MEDICINA DENTÁRIA

Trabalho submetido por
Jean-Baptiste Fernand Marie RENOUARD
para a obtenção do grau de Mestre em Medicina Dentária

julho de 2024

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Trabalho orientado por
Prof. Doutor Sérgio Antunes Félix

e coorientado por
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julho de 2024

“Fail big! That’s right, fail big!

Today is the beginning of the rest of your life, and it can be very frightening. It’s a new world out there, it’s a mean world out there, and you only live once, so do what you feel passionate about, take chances, professionally (...), don’t be afraid to go outside the box, don’t be afraid to think outside the box, don’t be afraid to fail big to dream big but remember.

Dreams without goals are just dreams, and they ultimately fuel disappointment. So have dreams, but have goals, life goals (...) and understand that to achieve these goals, you have to apply discipline and consistency.”

Denzel Washington, Dillard University, 2015

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Une attention spéciale à ma mère Evelyne qui m'a soutenu depuis toujours quelques soient mes décisions. Merci à cette force de la nature qui s'est battue seule pour me permettre de réaliser mes objectifs de vie. Un accomplissement pas de tout repos qui est aussi le tien.

RESUMO

Introdução: A preparação dentária para colocação de uma coroa dentaria total é uma intervenção técnica do domínio da Reabilitação Oral (RO) que exige uma execução precisa. A aprendizagem repetida na prática pré-clínica, aumenta muito as chances de sucesso durante uma intervenção em situação real sobre paciente. É, portanto, primordial escolher o método mais eficaz e pedagógico para uma formação completa durante a aprendizagem dos estudantes de medicina dentária.

Objetivos: Em alunos do quarto ano do Mestrado Integrado em Medicina Dentária do Instituto Universitário Egas Moniz, comparar ao nível de dificuldade para a realização de preparo dentário para coroa total em primeiro molar sobre diferentes suportes, ou seja, Frasaco em visão direta e Frasaco montado em Phantoma em visão indireta realizada.

Materiais e Métodos: O estudo foi uma prática com um grupo de 20 participantes, que correspondem aos critérios de seleção, e no laboratório pré-clínico do Instituto Universitário Egas Moniz (IUEM). Foi pedido a todos os participantes que se munissem das suas turbinas e do seu Frasaco A-3 DA. Para limitar as margens de erro, cada participante recebeu dois dentes de Frasaco A-3 nº46 46A-3 e uma broca dentária FG diamante troncónica ponta arredondada 850.014 de Grao Normal/1 Edenta (ref: 806.314.199.524.014) nova. Foram igualmente colocados à disposição dos participantes Phantomas Frasaco PK-2 e espelho de exploração intraoral. As práticas foram divididas em dois grupos de 10 participantes durante dois dias durante 2h30 cada.

Resultados: O tempo de execução entre as duas medianas é insignificante e não permite estabelecer umnexo causal ($P=0,152$). A análise do questionário submetido aos estudantes revelou diferença estatisticamente significativa no nível de dificuldade referente ao preparo completo da coroa de um primeiro molar ($p < 0,001$) e na dificuldade de acesso ($p < 0,001$); entretanto, a visibilidade ($P = 0,263$) e a facilidade de instrumentação ($P=0,852$) não foram significativamente diferentes.

Conclusões: Os preparos dentários para coroa de revestimento total do dente foram os mais difíceis de realizar quando o Frasaco está montado no Phantoma, isto em comparação com o modelo de frasaco com visão direta, no entanto os alunos referem que os preparos realizados em Phantoma foram mais pedagógicos.

Palavras-chave: Preparo dentário, Frasaco, Phantoma, coroa total, visão direta, visão indireta, aprendizagem, Reabilitação Oral.

ABSTRACT

Background: Dental preparation for a total crown is a technical intervention in Oral Rehabilitation (OR) that requires precise execution. Repeated learning in preclinical practice dramatically increases the chances of success during an intervention in an actual situation on a patient. Therefore, choosing the most effective and pedagogical method to park complete training during dental students' learning is paramount.

Objectives: In students of the fourth year of the integrated master's degree in dental medicine of the Egas Moniz University Institute, compare to the level of difficulty for performing dental preparation for total crown in first molar on different supports, Frasaco in direct vision and Frasaco mounted in Phantoma in indirect vision.

Materials and Methods: A practice was performed in a group of 20 participants, corresponding to the selection criteria, in the Egas Moniz University Institute (IUEM) preclinical laboratory. All participants were asked to provide their turbines and their Frasaco A-3 DA. To limit the margins of error, each participant received two teeth of Frasaco A-3 n°46 46A-3 and a dental bur FG diamond Conical cone rounded tip 850.014 size Normal/1 Edenta (ref: 806.314.199.524.014). Phantoms Frasaco PK-2 and mirrors of intraoral exploration were also made available to participants. The practices were divided into two groups of 10 participants spanning two days for 2:30 hours each.

Results: The execution time between the two different medians is insignificant and does not allow us to establish a causal link ($P=0.152$). Analysis of the questionnaire submitted to students revealed a statistically significant difference in the level of difficulty relating to the full crown preparation of a first molar ($p < 0.001$) and the difficulty of access ($p < 0.001$); however, the visibility ($P=0.263$) and the ease of instrumentation ($P=0.852$) were not significantly different.

Conclusions: Full Dental crown preparations were the most difficult to perform when the Frasaco was mounted on the Phantoma, however, compared to the Frasaco with direct vision, students reported that the preparations performed in Phantoma were more pedagogical.

Keywords: Dental preparation, Frasaco Phantom, total crown, direct vision, indirect vision, learning, Oral Rehabilitation.

RÉSUMÉ

Introduction : La préparation dentaire pour couronne totale est une intervention technique du domaine de la Réhabilitation Orale (RO) qui nécessite une exécution précise. L'apprentissage répété en pratique préclinique augmente considérablement les chances de succès lors d'une intervention en situation réelle sur le patient. Il est donc primordial de choisir la méthode la plus efficace et pédagogique pour garantir une formation complète lors de l'apprentissage des étudiants en médecine dentaire.

Objectifs : Chez les étudiants de quatrième année du master intégrée en médecine dentaire de l'institut Universitaire Egas Moniz, comparer le niveau de difficulté pour la réalisation d'une préparation dentaire pour couronne totale sur première molaire et supports différents, Frasaco en vision directe et Frasaco monté sur Phantoma en vision indirecte.

Matériels et méthodes : Une pratique a été réalisée sur un groupe de 20 participants, qui répondent aux critères de sélection, dans le laboratoire préclinique de l'Institut universitaire Egas Moniz (IUEM). Il a été demandé à tous les participants de se munir de leurs turbines et de leur Frasaco A-3 DA. Pour limiter les marges d'erreur, chaque participant a reçu deux dents de Frasaco A-3 n°46 46A-3 et une fraise dentaire FG diamant tronco conique unique pointe arrondie 850.014 taille Normal/1 Edenta (réf : 806.314.199.524.014) neuve. Des Phantoms FRASACO PK-2 et des miroirs d'exploration intra-orale ont également été mis à la disposition des participants. Les pratiques ont été divisées en deux groupes de 10 participants sur deux jours pendant 2h30 chacune.

Résultats : Le temps d'exécution entre les deux supports n'est pas significatif et ne permet pas d'établir un lien de causalité ($p=0,152$). L'analyse du questionnaire a révélé une différence statistiquement significative dans le niveau de difficulté lié à la préparation ($p < 0,001$) et la difficulté d'accès ($p < 0,001$) ; cependant, la visibilité ($p = 0,263$) et la facilité d'instrumentation ($P=0,852$) n'étaient pas significativement différentes.

Conclusions : Les préparations dentaires pour couronne de revêtement total de la dent étaient plus difficiles à réaliser lorsque le Frasaco était monté sur Phantom, Cependant, par rapport au Frasaco en vision directe, les élèves rapportent que les préparations réalisées sur Phantom ont été plus pédagogiques.

Mots clés : Préparation dentaire, Frasaco Phantom, couronne totale, vision directe, vision indirecte, apprentissage, réhabilitation orale.

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ABBREVIATIONS

3D	Three dimensional
ADA	American Dental Association
ADEE	Association for Dental Education in Europe
BDA	British Dental Association
CAD	Computer-aided design
CAD/CAM	Computer-aided design/computer-aided manufacturing
ECTS	European Credits Transfer System
ENT	Ear, nose, and throat
ERAS	Adoption of enhanced recovery after surgery
ICC	Intraclass correlation coefficient
IOS	Intraoral scanner
IUEM	University Institute of Egas Moniz
MIMD	Integrated Master of Dental Medicine
PFM	Porcelain-fused-to-metal
SD	Standard deviations
SPSS	Statistics Package for the Social Sciences
TF	Taskforces
WHO	World Health Organization

I- INTRODUCTION

ORAL REHABILITATION

Oral Rehabilitation may have different definitions; indeed, many treatments today can be called «Mouth Rehabilitation» (Gordon J et al., 2004). Oral rehabilitation, also known as oral restoration, is a field of dentistry that aims to restore a person's function, aesthetics, and oral health by treating complex and extensive problems of the mouth, teeth, and surrounding structures. It can be qualified after simply restoring an existing tooth, repairing several existing teeth, or replacing one or more teeth (Vivek V Nair, 2020). Other definitions include biopsychosocial function and or prevention of factors aggravating disability (J Durham et al., 2010).

The World Health Organization (WHO) in 1946 defined health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (International Health Conference, 2002). It is important to note that oral rehabilitation results from multidisciplinary collaboration and the constant evolution of dentistry in response to patient needs and scientific and technological advances. By integrating this interdisciplinary approach, dental students can ensure a qualitative and responsible treatment for the patient's needs (Franks, 1976).

Nowadays, there are three types of partial or total dentures: removable, fixed, or mixed. A removable prosthesis can be removed anytime, depending on the patient's needs. They are made according to the functional, aesthetic, and number of teeth to be replaced (Lucie Dalibert et al., 2020). A partial removable denture replaces only one or more teeth. It is based on the gums (muco-litter) and on the remaining teeth (dento-supported), which allows adequate support (muco-dento-supported). The complete removable denture will replace all the teeth of the jaw and relies on the gums (muco-litter) or clipped to implants (implant-supported). Fixed prostheses are dental restorations designed to replace missing teeth permanently or part of the dental structure. They are fixed in place on teeth or dental implants, providing a durable and aesthetic solution to restore the function and appearance of teeth. The mixed or combined prosthesis consists of a fixed part (crown, bridge) and a removable part. The removable part on a metal plate, replacing the missing tooth or teeth, is connected to the remaining teeth using an

anchor element. These prostheses are generally used in patients for whom implantation cannot be performed or who cannot cover the cost of surgery (Öwall B et al., 1998).

Dental aesthetics is related to the main aspect of appearance that can be described as physical attractiveness. Throughout history, civilizations have improved their competence in the field of restorative and aesthetic dentistry. Cosmetic dentistry contributes to total dental health making it a major asset in oral rehabilitation. Aesthetic dentistry practitioners need to understand what patients mean in their particular words and take appropriate action in the context of ethics, correct judgment, and technological abilities. A practicing dentist should know some generalities about the psychological significance of the patient's mouth. Cosmetic dental treatment can improve a patient's image and personal perception of how they look and would like to look (Goldstein et al., 2018).

Over the last twenty years, advancements in dental materials and computer technology have propelled the effectiveness of modern dental computer-aided design/computer-aided manufacturing (CAD/CAM) technology. Numerous highly advanced CAD/CAM systems have been introduced and are either in development or refinement. Technologies that have long utilized three-dimensional (3D) digital scanners across various industries have undergone enhancements specifically tailored for dental applications (Liu P et al., 2005). Likewise, the continuous advancement of dental materials has played a pivotal role in the development of dental prostheses. In recent years, significant strides have been achieved in the composition, mechanical characteristics, and fabrication methods of ceramics. The latest breakthroughs in dental ceramics encompass monolithic zirconia, multilayer zirconia, polymer-infiltrated ceramics, and associated processing techniques (McLean et al., 2001). Over the past decade, there has been a significant surge in the demand for ceramic veneers and crowns, particularly for the restoration of aesthetically compromised anterior teeth (Stappert et al., 2005). High-quality ceramic materials enhance overall appearance by improving light transmission and translucency (Theng K.Y et al., 2013).

Certain dental conditions may necessitate oral rehabilitation to address issues such as shape, color, or dental damage. Dental shape alterations can arise from various factors, including developmental abnormalities, trauma, excessive wear, cavities, or previous dental treatments. These alterations encompass conditions like supernumerary or missing teeth, abnormally small (microdontia) or large (macrodontia) teeth, conical or peg-shaped teeth, fused or fused teeth, and pointed or irregularly shaped teeth. In such cases, various treatment options are available,

including orthodontic intervention to correct tooth position, aesthetic restorations like veneers or crowns to alter shape, surgical procedures to remove supernumerary teeth or address developmental anomalies, whitening procedures to lighten discolored teeth, endodontic treatment if the pulp is exposed or infected, and dentures to replace missing teeth (McKinney R et al., 2023).

Color alterations in teeth can stem from a range of factors, including intrinsic causes such as tetracycline staining, fluorosis, and aging, as well as extrinsic factors like tobacco use, consumption of coffee, tea, or red wine, and trauma such as tooth injury or pulp necrosis resulting from dental treatments like amalgam fillings or other restoration materials. The primary treatments for correcting tooth color alterations typically include bleaching, micro-abrasion, veneers, and crowns. The choice among these options depends on the underlying cause and the severity of the discoloration (Fons-Font A et al., 2006).

Coronal destruction refers to any alteration or damage to the visible part of the tooth. This damage can be caused by various factors, such as tooth decay, trauma, excessive wear, developmental abnormalities, or previous dental treatments. For mild to moderate cavities, a simple treatment of the dental filling may be enough to restore the crown structure and prevent any progression of the caries. However, in the event of larger damage, such as extensive fractures or deep cavities, a dental crown may be recommended to protect the tooth and restore its shape, function, and aesthetics. For damage to the aesthetics of the tooth, aesthetic restoration options such as veneers or ceramic restorations can be considered to improve the appearance of the dental crown (Mesko et al., 2016; Morimoto S et al., 2009).

Oral rehabilitation in Portugal provides patients with a comprehensive solution to restore both the health and aesthetics of their mouth. By integrating advanced techniques and employing a multidisciplinary approach, it aims to address the unique needs of each individual patient (Moreira A et al., 2018). In Portugal, the aging process is frequently associated with a degree of limitation or dependency among the elderly, characterized by a decline in capacity and the emergence of age-related conditions or pathologies. Despite advancements in preventive dentistry, edentulism and oral diseases persist as significant public health concerns in the country, particularly among older adults (Veiga N.J et al., 2017).

In France, oral rehabilitation programs encompass a range of facets, including prosthetic and/or maxillofacial rehabilitation following ear, nose, and throat (ENT) cancer. These initiatives are

designed to provide patients with removable or fixed prosthetic restorations that are stable and functional, often incorporating oral implantology to stabilize prostheses and facilitate patients' recovery process. Moreover, a national study has examined the adoption of enhanced recovery after surgery (ERAS) protocols in France, revealing divergent implementation rates between the public and private sectors. This underscores the necessity for heightened educational endeavors to enhance the implementation of such programs across the country (Delaunay L et al., 2024).

Crown longevity in the under-35 age group reached 89% after ten years, while it fell to 68% in the 55-age group. For direct restorations on molars, survival at ten years is 31% in the under 35 years, compared to only 17% in the 55 years. In contrast, premolars have survival rates of 61% and 23% respectively. Overall, the life of restorations decreases with age. The practical experience of the dentist also plays a crucial role. After five years, 44% of restorations supervised by general dentists survived, while this figure is 58% for those supervised by specialists. After ten years, these percentages are 32% and 49% respectively (Janus C.E et al., 2006).

FIXED PROSTHESIS

A fixed denture or prosthesis, also known as a dental crown or dental bridge, is a type of dental restoration used to replace one or more missing or damaged teeth. Unlike removable dentures, the fixed denture is designed to stay permanently in place in the mouth once it is placed by a qualified dentist or prosthodontist (American Dental Association). It is challenging to define the origin of fixed oral prostheses accurately. It is reported that the Mayans, as early as 3000BC, were known to have used shells that they hammered into the jaw. However, it was only in the 1500s that dentistry was recognised as more than just a practice based on extractions; it was seen as a speciality that included reconstruction. Then, prosthodontics took a significant turn with the publication in 1530 of the first book on teeth by «Artzney Buchlein» in German. It was not until 1685 that the first book in English appeared, «The Operator for the Teeth» by Charles Allen. It was at this time that the American Dental Association (ADA) recognised prosthodontics as "the dental speciality pertaining to the diagnosis, treatment planning, rehabilitation, and maintenance of oral function, comfort, appearance, and health of patients with clinical conditions associated with missing or deficient teeth and/or oral and maxillofacial tissues using biocompatible substitutes.". In 1975, J. Ben Stolpa described an adhesive

technique for fixed partial prostheses that marked the beginning of the era of fixed prosthodonty (Rajeev Gupta et al., 2016). Adhesive cementing allows better fatigue resistance of a total crown. It prevents possible cracks and their propagation. However, chemical conditioning of the work surface is necessary to obtain optimal efficiency (Campos F et al., 2017).

In fixed prosthodonty, different types of extra-coronary restorations are used, including total crowns, inlays, onlays, veneers, as well as implants (Kui A.I et al., 2023). Cumulative survival rates for all single crowns were 89.9% and 80.9% respectively after 5 and 10 years. After 15 and 20 years of operation, the cumulative survival rates for single crowns were 70.5% and 61.8% respectively. Over a follow-up of 134.8 80.2 months, SD (min–max, 6.0–360.7), 22.2% of failures were found. Loss of retention (26.5%), loss of teeth (13.5%) and fracture of teeth (12.6%) were the most common causes of single crown failure (Hawthorn M et al., 2022).

DENTISTRY COURSE

The independent European organisation, Association for Dental Education in Europe (ADEE), represents dental faculties and schools. It was founded in 1975 and has significantly improved the quality of education. Indeed, the profession of dental educator has grown and research in the education and training of oral health personnel has grown significantly. As a result, the reputation of the Association has spread internationally and has several members across Europe like dental schools, specialized societies and national associations related to dental training. In 1998, the European Union launched a call for projects and, as a result, a thematic network (DentEd) was created to bring together the different dental courses for all of Europe. This initiative took place over a period of nine years. Closely related programs have emerged such as DentEd (1998 - 2000), DentEd Evolves (2000 - 2002) and DentEd III (2004 - 2007). A network of dental educators was formed («Harzer 2017», «Reynolds 2008») with the same objectives as ADEE. Following the funding of the project «DentEd», steps were set by the Bologna Declaration, signed in 1999, for the harmonization of higher education systems in Europe, aligning with European legislation.

The Bologna Process has three main objectives:

1. Facilitate movement from one country to another within the European Higher Education Area, for study or work.

2. Strengthen the attractiveness of European higher education so that many people from non-European countries also come to study or work in Europe.
3. Provide Europe with a solid foundation of high-quality cutting-edge knowledge and ensure that Europe develops as a peaceful and tolerant community.

ADEE appointed working groups Taskforces (TF) for the following functions:

- TF1 (Profile and competences for the graduating European dentist Taskforce.
- TF2 (curriculum structure, Content, Learning & Assessment in European Undergraduate Dental Education Taskforce
- TF3 (Quality Assurance & Benchmarking.

TF1 was designed to provide a competency profile of a young graduate as a framework for student education and safe and effective patient care. TF3, in conjunction with TF2's modular curriculum, has established a quality assurance framework to ensure that dental education standards are high enough to ensure effective patient care. The 3 Working Groups were encouraged to develop documents that would serve as the basis for their own frameworks, programs, and recommendations. This approach, by working groups in Europe, is validated by other social partnerships of the same type with other partners.

Mission Strategic Plan 2022 to 2025:

- ADEE is committed to promoting the highest level of healthcare for all European citizens through its mission statements.
- Promote advancement and convergence towards high standards of dental education.
- Promote and help coordinate peer review and quality assurance in dental education and practice.
- Promote the development of assessment and review methods.
- Promote exchange of staff, students, and programs.
- Disseminate knowledge and understanding of education.
- Provide a European link with other educational institutions and specifically, dental.

(Association for Dental Education in Europe, 2022).

In Portugal there are seven universities dedicated to dentistry, four of which are public and three are private. They all offer an Integrated Master of Dental Medicine (MIMD) program. Admission to these faculties varies slightly from university to university, but in general, most require candidates to pass an entrance exam. This exam may cover topics such as biology, chemistry, mathematics, and possibly specific knowledge in dentistry. Some institutions may

also conduct interviews to assess the skills, motivation, and suitability of candidates for the programme. These universities are all governed by decrees submitted to the Coordinating Council of Higher Education, the National Council of Education, the Council of Rectors of Portuguese Universities, the Coordinating Council of Polytechnic Higher Institutes, the Portuguese Association of Private Higher Education, as well as higher education student associations and workers' representative unions (Diário da República, 2019).

The MIMD programme is spread over five years, each worth 60 European Credits Transfer System (ECTS), a total of 300 ECTS credits. The number of credits is allocated to each discipline according to its theoretical, practical, or theoretical-practical nature (Diário da República, 2019).

The Egas Moniz University Institute (IUEM), founded in 1999, organizes its courses in three parts: theoretical, practical, and theoretical-practical. Areas covered include dental science, general medicine, biology and biochemistry, psychology, mathematics and statistics, health, philosophy, and ethics, as well as personal development, from the first to the fifth year. A pedagogical council, aimed at fostering cohesion between professors, coordinating teaching, grading and evaluation of academic activities, is integrated into the university. The Scientific Council also plays a central role in the scientific orientation of the IUEM, examining issues related to the development and monitoring of the institution's scientific projects.

Although notions of dental science are covered in the first and second year, it is from the third year that the courses themselves of the dental science program occupy a predominant part of the annual curriculum. From the third year, students become familiar with oral rehabilitation, spread over two semesters. This discipline alone represents 97.5 hours (contact with students) per semester, including 39 hours of theoretical courses and 58.5 hours of practical laboratory work, a total of 195 hours in the third year. Students must have all the necessary tools for practical laboratory work, including a typodont, a turbine, a micromotor, burs, a dental cutter, and dental instruments. During these practices, they are initiated, among others, to fixed prosthesis, total prosthesis, and removable partial prosthesis. They must complete several practical assignments evaluated by the professors in order to perfect their skills before going to the university clinic.

On its campus, the Egas Moniz University Institute houses a university clinic with approximately 31,600 patients registered in its records. From the fourth year of study, students are assigned to both the university clinic and the practical laboratories until the end of their course. During their clinical period, dentistry students are supervised by highly qualified

professors in their respective field. They have the opportunity to put into practice the various dental specialties on patients, with a particular emphasis on oral rehabilitation, which occupies a predominant part in the organization of clinical activities (Egas Moniz School of Health and Science, 2022).

DENTAL CROWN PREPARATION

Dental preparation for a crown is crucial in installing a fixed denture (dental crown). This step aims to prepare the existing tooth, so the crown fits properly and offers functional and aesthetic restoration. Due to biological factors, improper dental preparation is the leading cause of premature failures (Ganesh Ramesh et al., 2020). Preserving the integrity of the dental structure goes beyond simply avoiding excessive destruction. It is also essential to design the restoration to strengthen and protect both the remaining enamel and dentin. Sometimes this involves sacrificing a small amount of additional dental structure on the occlusal surface to protect the underlying cusps (Herbert T et al., 1987). The dental preparation must respect precise geometric characteristics so that the final dental prosthesis (final crown) fits perfectly. It must be sufficiently retentive and resistant to withstand the forces exerted on the definitive crown over time (Ganesh Ramesh et al., 2020). This approach determines whether the cement in a specific area will be exposed to stress, shear, or compression forces (Herbert T et al., 1987). The use of several dental drills (burs) is carried out to respect adequate destruction of the tooth in preparation. Indeed, it is a precise operation that requires respect to the anatomical criteria of the tooth prepared according to the material used for the final crown (metallic-ceramic, porcelain, ceramics, etc.). Similarly, the termination line depends on several aesthetic factors, also on the resistance of the materials, and relies on the tooth's condition (C. Goodacre et al., 2001).

There are four factors under operator control during tooth preparation that affect retention:

- Degree of conicity.
- Total area in contact with cement film.
- Surface of cement being sheared.
- The roughness of the tooth surface.

To ensure effective retention, the walls of shorter teeth should be prepared near the parallel. It has been suggested that anterior teeth and premolars have a minimum occluso-cervical

dimension of 3 mm, while molars should have a minimum dimension of 4 mm (Herbert T et al., 1987). However, to avoid undercutting and allow complete placement of restoration during cementing, the walls must have some conicity. A conicity in the range of 2 to 6.5 degrees was considered optimal, not to exceed 10 degrees. This measurement is based on a tilt of about 3 degrees produced on each surface, external or internal, by the sides of a tapered instrument. The result would be a global cone or a convergence angle of 6 degrees (Herbert T et al., 1987; Clovis Pagani, 2017). The occlusal thickness varies depending on the restorative material used. Harder metals may require a little less space from 1.0 to 1.5 mm. If a porcelain veneer is applied to the occlusal surface, an additional gap of about 0.5 mm is required in comparison with metals, bringing the total thickness to about 1.3 to 2.0 mm (Herbert T et al., 1987; Clovis Pagani, 2017). Similarly, the margin angle must become quite sharp before the actual distance decreases significantly. An angle between 30 and 45 degrees is considered optimal (Herbert T et al., 1987). The cervical finish line can be prepared in different ways and classified as follows:

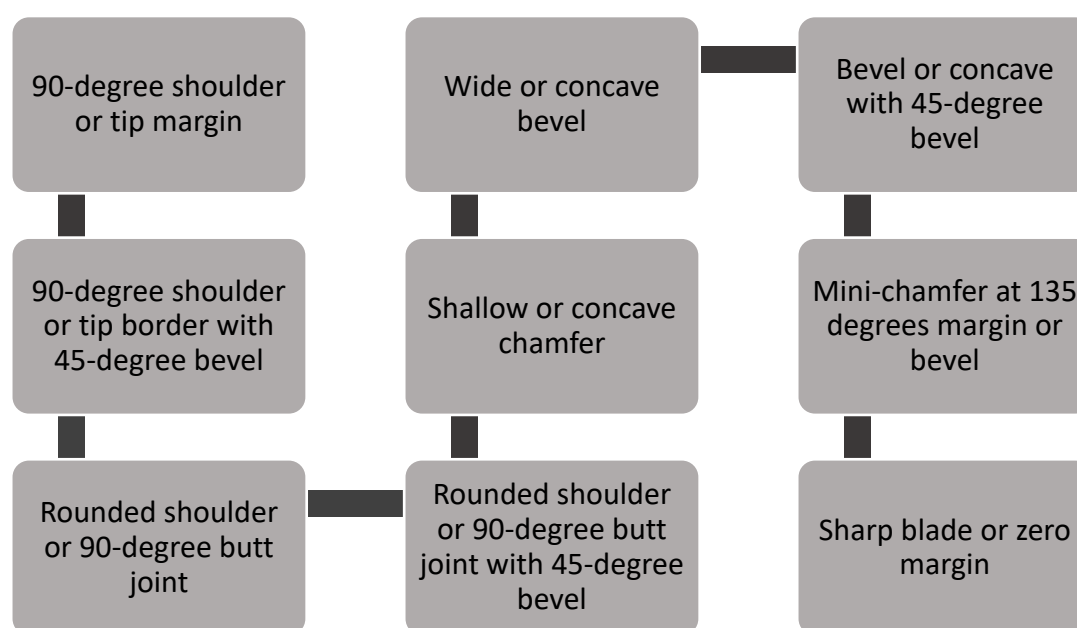


Figure 1. Classification of cervical finish line preparations (Herbert T et al., 1987; Clovis Pagani, 2017)

The shoulder is recommended for porcelain restorations only. The chamfer is widely considered the gingival finishing line of choice for most plated metal restorations (Herbert T et al., 1987; Clovis Pagani, 2017). A crown margin should not be placed more than 2.0 mm from the alveolar ridge, otherwise bone resorption may occur. The combined width of epithelial and conjunctival fasteners is normally about 2.0 mm. If the margin enters this "biological width", inflammation will result, and the bone will yield until it is again at least 2.0 mm from the crown margin

(Herbert T et al., 1987). The preclinical training of dental students is essential to acquire an adequate technique for tooth preparation (J. Hey et al., 2017).

Over a follow-up period of 134.8 80.2 months (minimum to maximum, 6.0 to 360.7), out of 836 crowns prepared and laid by students, 197 resulted in a failure, or 23.6%. In contrast, out of 201 crowns prepared and laid by general or specialist dentists, 33 resulted in a failure of 16.4% (Hawtham M et al., 2022).

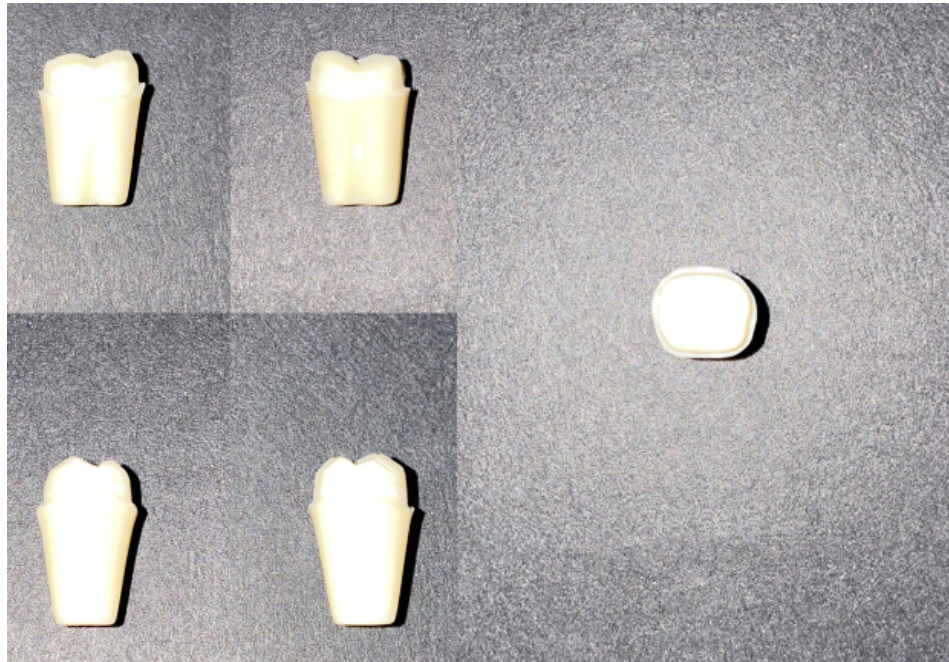


Figure 2. Crown preparation performed by a dental student on tooth 46 of Frasco A-3 n°46 46A-3.

I. DENTAL BURS

The dental burs, also called dental cutters (Figure 3 & 4), were discovered less than 300 years ago, revolutionising the dental medicine still used today. The dental cutter is composed of several parts: the shank, the head, and the neck, and generally produced in stainless steel, carbide, diamond particles or grains of different sizes depending on the surface and the desired level of abrasion. The dental cutter is mounted on a turbine or handpiece (Figure 4) to achieve a rotation speed of up to 500,000 rpm (rotation per minute). Dental Cutters exist in several shapes, such as conical or truncated-conical, to name a few. The dentist chooses the cutter's shape and level of abrasion according to the intervention he must perform (Ahmed et al., 2018). Flat-end tapered diamond for occlusal and axial reduction (fine $\varnothing = 0.8$ mm), Long-end round tapered diamond for occlusal and axial reduction and also for shoulder production (end $\varnothing = 1.1$ mm), long needle diamond for initial proximal reduction, chamfer diamond for chamfer

production (end $\varnothing = 1.0$ mm), tungsten carbide for chamfer and preparation finish, and large flame diamond or «rugby ball» for the production of lingual concavity are used for the preparation of complete plating crowns (Blair et al., 2002). The rotary instrument used for dental preparations had a significant influence on the surface characteristics of the axial wall of complete crown preparations. However, the interaction effect between the dental preparation finish and the sealing cement is not significantly different ($p = 0.685$). It appears that the completion of dental preparations with finishing burs improves the fit of complete crowns during the cementing procedure ($p < 0.001$) (Ayad et al., 2009). Dental cutters can be used several times but lose effectiveness over time, so changing them after five additional interventions is recommended, especially in prosthetic preparation (Emir, F et al., 2018).



Figure 3. Dental bur FG diamond Conical cone rounded tip 850.014 size Normal/1 EDENTA (ref: 806.314.199.524.014).

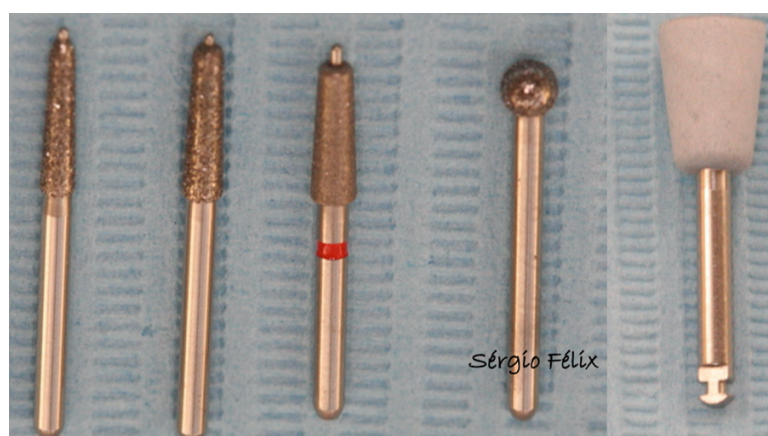


Figure 4. Diamond dental burs & polishing head (Sérgio Félix, 2024).



Figure 5. handpiece, micromotor and turbine (Sérgio Félix, 2024).

II. DENTAL CROWN

A dental crown is a dental restoration used to entirely cover or wrap a damaged or weakened tooth to restore its shape, size, and function. It may be necessary to rehabilitate a tooth that is severely decayed, devitalized, broken, or for aesthetic purposes (Forrai,J et al., 2023). The first dental crown was described by Jacob Horst in 1593, « The Boy with the Golden Tooth: A 1593 Case Report of the First Molded Gold Crown », in Europe on a six-year-old child (Spielman. A, 2009). It was not until the end of the 18th century that the dental crown underwent its first evolution with the use of porcelain by Dr Charles Land. The development of the dental crown continued in the early 19th century, with the help of steel alloy and, in the 1950s, the use of ceramics (Forrai,J et al., 2023). Today, the most used materials for manufacturing dental crowns are full metal, porcelain-fused-to-metal (PFM), all zirconia, layered zirconia, lithium disilicate, and leucite-reinforced ceramics. The choice of material used will depend on the position, anterior or posterior, of the previously prepared tooth. The tooth's position is an essential factor concerning the strength of the material and its aesthetic properties (Makhija, et al., 2016). Dental crown manufacturing is now facilitated with computer-aided design (CAD) software. This new technology makes it possible to carry out the intraoral impression, design the tooth

on the computer, and manufacture it thanks to the machine of type computer-aided design/computer-aided manufacturing (CAD/CAM) (Suganna, et al., 2022). The aesthetic aspect is greatly improved, as well as the adaptation of the crown to the gingival margin. Still, it also reduces the manufacturing time required compared to conventional prosthetic laboratory manufacturing (Hariri, et al., 2023).



Figure 6. Ceramic premolar crowns (Sérgio Félix, 2024).

III.DENTAL TYPODONT

The Typodont is a simulated educational device of the oral cavity used in the preclinical training of dental students. It reproduces anatomical characteristics comparable to those of the dental arch to allow effective practice (Sathvika, 2020). In the 1930s, the first working dental models were developed, featuring interchangeable individual teeth made of "hekolit" material. This period also saw the emergence of the manufacture of Frasco temporary crowns in the field of consumable dental materials. To date, different types of typodonts are available, adapted to each dental specialty, including periodontology, orthodontics, and implantology (Frasaco, 2018). The use of Typodont in learning dentistry has solved the problems associated with practical exams, improving the objectivity, compliance, safety, efficiency, and flexibility of the testing and evaluation process (Hill & Hampel, 1987). The use of Typodont is still widespread in the learning of dentistry, especially in the field of oral rehabilitation. The typography that allows the assessment of each tooth face to determine whether the preparation criteria have been correctly executed, and it allows students to improve their skills. The preparation of crowns for a total crown requires considerable training to reduce margins of error in real-life conditions on

a patient (Nunez, et al., 2012). The preparation of crowns for a total fixed prosthesis is differentiated according to the material intended to constitute the final crown. For ceramic crowns, an additional occlusal reduction of 0.5 mm is required compared to metal crowns (Herbert T et al., 1987; Clovis Pagani, 2017).

IV. DENTAL PHANTOM

Dental phantoms, also called dental mannequins or dental models, are anatomically accurate reproductions of the human oral cavity used for teaching, training, and practice in dentistry. They are essential for dentistry students to develop their practical skills before working directly on actual patients (Perry.S et al., 2015). In the 1920s, the Kings school said it had a room equipped with ten phantoms. It was then in 1894 that dentist Oswald Fergus, at the annual general meeting of the British Dental Association (BDA), presented his dental phantom for educational and demonstrative purposes (Rachel Bairsto, 2021). The use of the dental phantom is essential to the learning of future dental surgeons. It ensures confidence for patients and dentists (Fugill .M, 2013).



Figure 7. Phantoms FRASACO PK-2.

II- OBJECTIVE

In students of the fourth year of the integrated master's degree in dental medicine of the Egas Moniz University Institute, compare to the level of difficulty for performing dental preparation for total crown in first molar on different supports, Frasaco in direct vision and Frasaco mounted in Phantoma in indirect vision.

III- MATERIALS AND METHODS

DESIGN AND PARTICIPANTS

This study was carried out in the curricular unit of Oral Rehabilitation (preclinical) at the University, Institute of Egas Moniz (IUEM) with a group of 20 dental student volunteers. The Institutional Review Board approved this study (Ethics Committee of Egas Moniz, ID: 1050) that followed the Declaration of Helsinki of 1975, as revised in 2013.

Inclusion Criteria:

- Be an Integrated Master's student in Dentistry in the fourth year.
- Students must have their Frasaco model A-3 DA with tooth 46, opposite, and adjacent teeth (in distal and mesial).
- Students must have their own turbine.
- Dental bur FG diamond Conical cone rounded tip 850.014 size Normal/1 EDENTA (ref: 806.314.199.524.014) of the same brand and quality (provided by the investigator).
- FRASACO brand A-3 n°46 46A-3, 46 molar tooth (provided by the investigator).
- Intra-oral mirror (provided by the investigator).
- Sign the informed consent form provided by the investigator (Anexo 2).

Exclusion Criteria:

- Not be a fourth-year repeater or have failed the third-year Oral Rehabilitation Curriculum Unit I and II.
- Motor deficit.

An explanatory course on the realization of a total dental preparation on the posterior tooth was explained to each participant, and a presentation was given 30 minutes before the practice.

QUALITATIVE QUESTIONNAIRE

The short questionnaire is 16 items divided into four parts: Extracurricular activities (items 1 to 2) with 5-point Likert scale responses, arranged as follows: 0 = "never"; 1 = "rarely"; 2 = "sometimes"; 3 = "frequently"; and 4 = "very frequently"; Time of realization (items 3 and 8) with the open response from 0 minutes to 1 hour; Crown preparation direct and indirect vision

(items 4 to 7 and 9 to 12) with 10-point Likert scale responses, arranged as follows: 0 = unsatisfactory and 10 = highly satisfactory; General impressions of the study (items 13 to 16) with close responses “yes” or “no”.

The questionnaire was presented to the participants in Portuguese, and the results were processed in English. The 20 voluntary participants met the criteria for prior inclusion. They represent the equivalent of a group of students during standard preclinical practices of dental courses at the University Institute of Egas Moniz (IUEM). The study occurred in June 2023, and data validation and formatting were between June and September 2023.

VARIABLES

Qualitative ordinal data for items 1 to 2 were in the form of a Likert scale, whose results were obtained in percentages (%). We have included two questions on extracurricular tasks to determine if there is a difference between the difficulties of performing the total dental crown preparation (items 1 and 2). The interest is to know if handling machines (sander, grinder, drill, etc.) for some extracurricular act of everyday life (mechanical, craft, etc.) favours certain participants. Items 13 to 16 are closed questions to get an opinion on the experience and educational benefits.

Quantitative variable for items 3 and 8 that correspond to the time in minutes.

Qualitative ordinal data for items 4 to 7 and 9 to 12 corresponds to the difficulty level encountered as a Likert scale from 1 to 10.

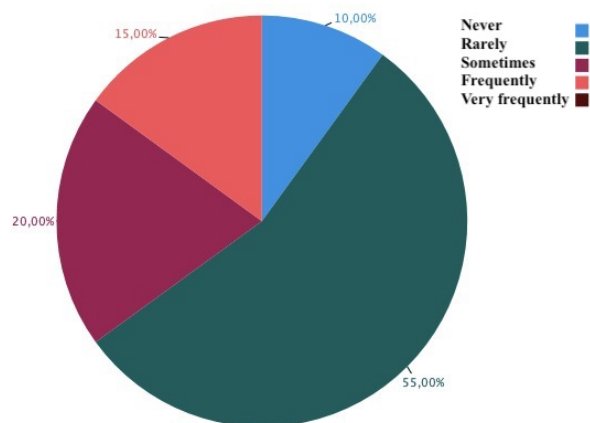
STATISTICAL ANALYSES

The results from the questionnaire were formatted in a Microsoft Excel table version 16.54 per participant (from 1 to 20) and per response to the themes (from 1 to 16). For statistical analysis, the data obtained was inserted in the computer program SPSS (Statistics Package for the Social Sciences) for macOS version 28 (SPSS, IBM, Ins, Chicago, IL, USA).

IV- RESULTS

EXTRACURRICULAR HABITS

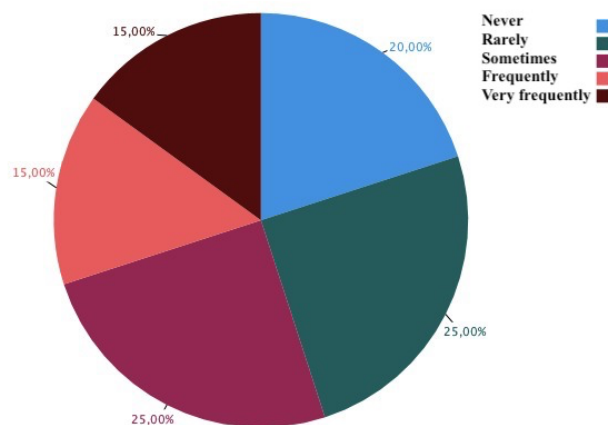
The results of the first item reveal that 65% of participants do not or very rarely perform extracurricular manual activities. Only 35% of them perform manual extracurricular activities sometimes or frequently.



Q1 - Do you or have you done manual tasks/activities (mechanical, craft)?

Figure 8. Result of the first item of the qualitative questionnaire (%).

The results of the second item reveal that 45% of participants have never or very rarely used rotary-type machines. Conversely, 55% of them occasionally, frequently, or very frequently use rotary-type machines.



Q2 - Do you use or have you used a rotary type machine (drills, grinder, sander, etc.)?

Figure 9. Result of the second item of the qualitative questionnaire (%).

EXECUTION TIME AND LEVEL OF DIFFICULTY BETWEEN THE TWO SUPPORTS

The average time recorded during practice for preparation on Frasaco in direct vision (column A) was 32.65 minutes (SD \pm 14.80), and for preparation on Frasaco mounted on Phantom in indirect vision (column B), 39.40 minutes (SD \pm 14.41). The execution time between the two different medians is insignificant and does not allow us to establish a causal link $P=0.152$ (Table 1).

The level of difficulty relating to the preparation of a first molar for full crown, items 4 and 9 (LK1), between A with a median score of 4.30 (SD \pm 1.56) and B with a median score of 7.90 (SD \pm 1.25) is significant with 95% confidence interval $P<0.001$ (Table 1).

The difficulty of access, items 5 and 10 (LK2), between A, with an average median score of 1.85 (SD \pm 0.88), and B with an average median score of 7.90 (SD \pm 1.29), is also significant at 95% confidence interval $P<0.001$ (Table 1).

The visibility, items 6 and 11 (LK3), between A, with an average median score of 5.15 (SD \pm 4.21), and B, with an average median score of 6.35 (SD \pm 2.08), does not allow us to establish a significant link $P=0.263$ (Table 1).

The ease of instrumentation, items 7 and 12 (LK4), between A with a median score of 6.15 (SD \pm 2.70) and B with a median score of 6.30 (SD \pm 2.34), does not allow us to establish a significant link $P=0.852$ (Table 1).

Table 1. ANOVA procedure for different preparation method.

Questions	Preparation method		
	A	B	
<i>Time</i>	32,65 \pm 14,80	39,40 \pm 14,41	$p=0,152$ ^(a)
<i>LK1</i>	4,30 \pm 1,56	7,90 \pm 1,25	$p<0,001$ ^{(a)(*)}
<i>LK2</i>	1,85 \pm 0,88	7,90 \pm 1,29	$p<0,001$ ^{(a)(*)}
<i>LK3</i>	5,15 \pm 4,21	6,35 \pm 2,08	$p=0,263$ ^(b)
<i>LK4</i>	6,15 \pm 2,70	6,30 \pm 2,34	$p=0,852$ ^(a)

(a) One-way ANOVA.

(b) One-way Welch ANOVA.

(*) Identifies a statistically significant difference for a 95% confidence interval.

* The p-values $P<0.001$ mean statistical significance, the null hypothesis between methods A and B is strongly rejected.

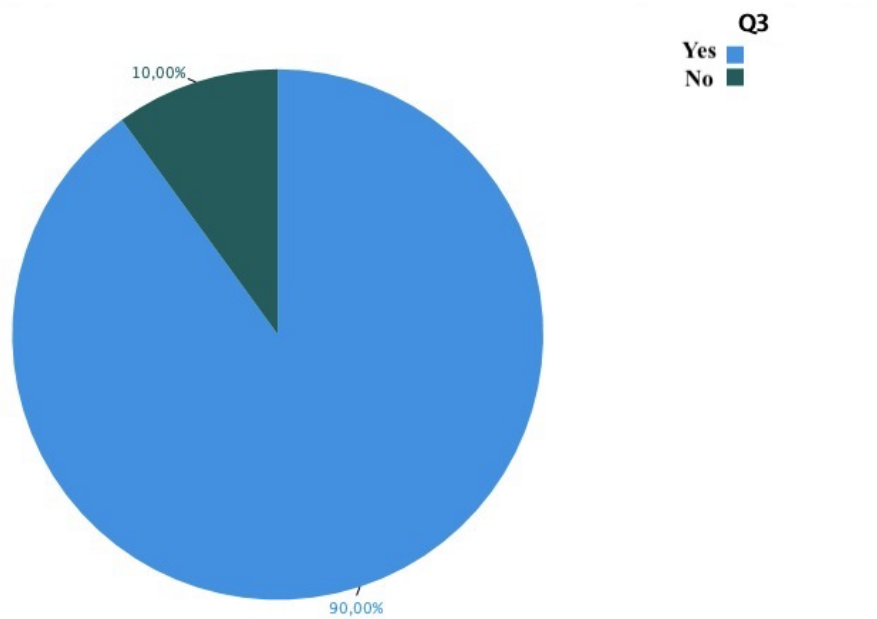
Excluding the time, the highest score was observed in items 4 and 9 (LK1 B and LK2 B) with 7.90 (SD ± 1.25) and 7.90 (SD ± 1.29), respectively, items 4 and 9 (LK1 A and LK2 A) had the lowest score with 4.30 (SD ± 1.56) and 1.85 (SD ± 0.88), respectively (table 2).

Table 2. Supplemental gaps means and standard deviations among preparation method for each item of the questionnaire and time.

	Method	Mean \pm Std. Deviation	Median	Minimum	Maximum
<i>Time</i>	<i>A</i>	32,65 \pm 14,80	36,50	10,00	60,00
	<i>B</i>	39,40 \pm 14,41	40,00	15,00	60,00
<i>LK1</i>	<i>A</i>	4,30 \pm 1,56	4,00	1,00	7,00
	<i>B</i>	7,90 \pm 1,25	8,00	5,00	10,00
<i>LK2</i>	<i>A</i>	1,85 \pm 0,88	2,00	1,00	4,00
	<i>B</i>	7,90 \pm 1,29	8,00	5,00	10,00
<i>LK3</i>	<i>A</i>	5,15 \pm 4,21	5,00	1,00	10,00
	<i>B</i>	6,35 \pm 2,08	7,00	3,00	10,00
<i>LK4</i>	<i>A</i>	6,15 \pm 2,70	7,00	1,00	10,00
	<i>B</i>	6,30 \pm 2,34	7,00	3,00	10,00

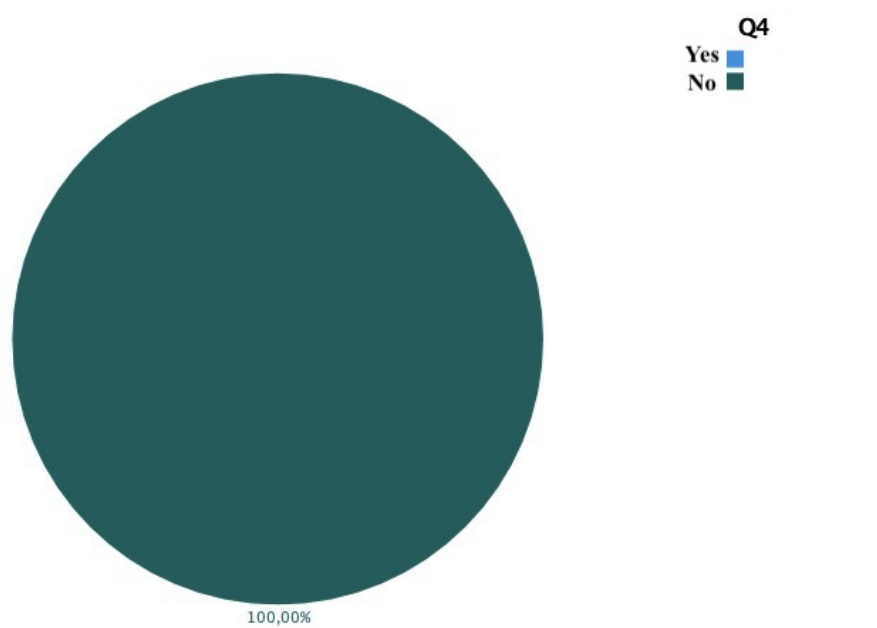
POST PRACTICAL CONSIDERATION

On the two questions concerning the realization of the dental full crown preparation on Frasaco not mounted on Phantom, items 13 and 14, 90% of the participants find it easier to realize but less educational (figure 10), and 100% of participants do not see it as more complicated but more educational (figure 11).



Q3 - The crown preparation on Frasaco no mounted in Phantoma is easier to achieve, but less pedagogical

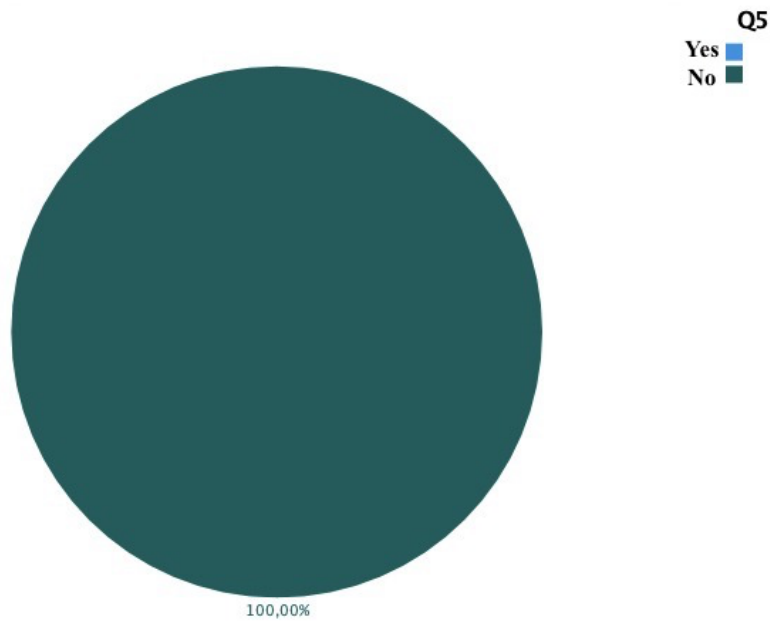
Figure 10. Result of the 13th item of the qualitative questionnaire (%).



Q4 - The crown preparation on Frasaco no mounted in Phantoma is more difficult to achieve, but more pedagogical

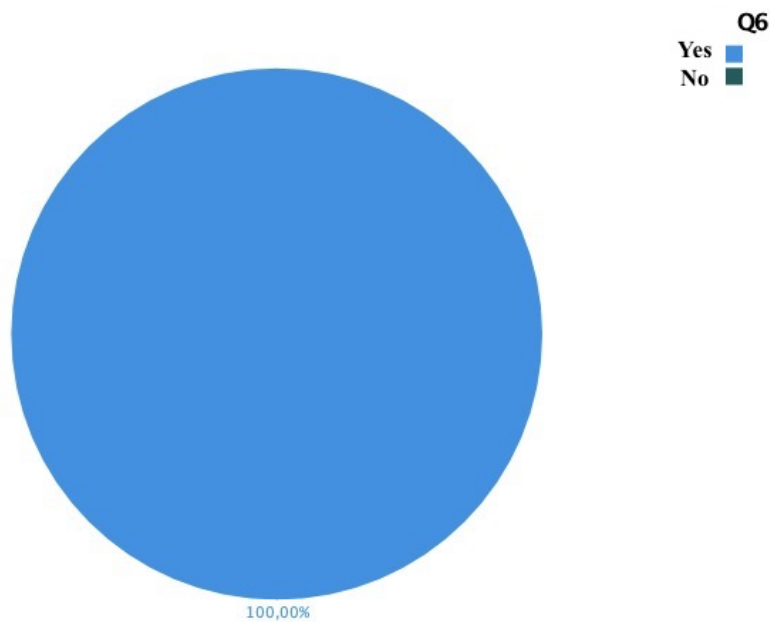
Figure 11. Result of the 14th item of the qualitative questionnaire (%).

On the two questions about the realization of dental full crown preparation on Frasaco mounted on Phantom, items 15 and 16, 100% of participants found that the completion is not more straightforward to achieve and more educational (figure 12), and 100% of participants see the achievement more complicated but more educational (Figure 13).



Q5 - The crown preparation on Frasaco mounted in Phantom is easier to achieve, but less pedagogical

Figure 12. Result of the 15th item of the qualitative questionnaire (%).



Q6 - The crown preparation on Frasaco mounted in Phantom is more difficult to achieve, but more pedagogical

Figure 13. Result of the 16th item of the qualitative questionnaire (%).

V- DISCUSSION

We carried out our study successfully by adapting a practical pre-post questionnaire. The first two questions of the questionnaire on extracurricular habits do not allow us to establish a causal link between difficulty and ease of execution. It would have been necessary to carry out another specific practical study by evaluating the final dental preparations referenced concerning each participant. In this way, assessing if there was no causal link would be possible. In the percentages obtained between the first question on extracurricular manual work, 65% do not practice or practice very rarely, and in the second question, 65% occasionally, frequently, or very frequently use rotary-type machines. There needs to be more consistency in these two outcomes. Today, we can use new technological tools such as virtual reality using new generation instruments that record all information throughout the process. The Egas Moniz University Institute (IUEM) is also equipped with a room composed of a virtual simulator that would allow us to obtain more information that could then be used in relation to these first two questions.

For 90% of the participants, realized the dental preparation for a total crown on the posterior tooth directly on Frasco in direct vision is «easier to perform but less educational». However, 100% judge this same achievement on Frasco mounted on Phantom in indirect vision as «more difficult but more educational», thus realizing a total dental crown is an act of precision that requires adequate and considerable prior training. The practices can be complementary: a first grip on Frasco in direct vision and then pass on Frasco mounted on Phantom in indirect vision. Indeed, the Phantom reproduces the human oral cavity by allowing it to be in conditions as close as possible to the clinical reality, which makes it an almost indispensable tool. Interestingly, the visibility ($P=0.263$) and the ease of instrumentation ($P=0.852$) do not meet any significant difference between the two supports. It is unanimous that the level of difficulty of execution ($P<0.001$) and the difficulty of access ($P<0.001$) are more critical in indirect vision with the Frasco mount on Phantom. Therefore, it would be necessary to carry out preclinical practical courses using Frasco in direct vision and indirect vision mount on Phantom so that the students are in conditions close to the clinical reality.

During the practice, we found in most participants that the ergonomic position when performing the complete crown preparation was one of the main difficulties. Each participant chooses a different position from the others (Figure 14). The participants did not encounter this difficulty in direct vision because they could manipulate the Frasco at their leisure without having to

place themselves in a particular position to be the most comfortable regarding the position of the tooth to prepare. On the other hand, the Frasaco mounted on Phantom does not allow as much freedom because it reproduces identical position and oral cavity in actual condition. The participants must then find an appropriate ergonomic position concerning the tooth that must be prepared. Very few articles are available on the subject and, when available, need to be updated. A practical ergonomics course for realizing dental preparation for a total crown on a posterior tooth can significantly benefit dental students.

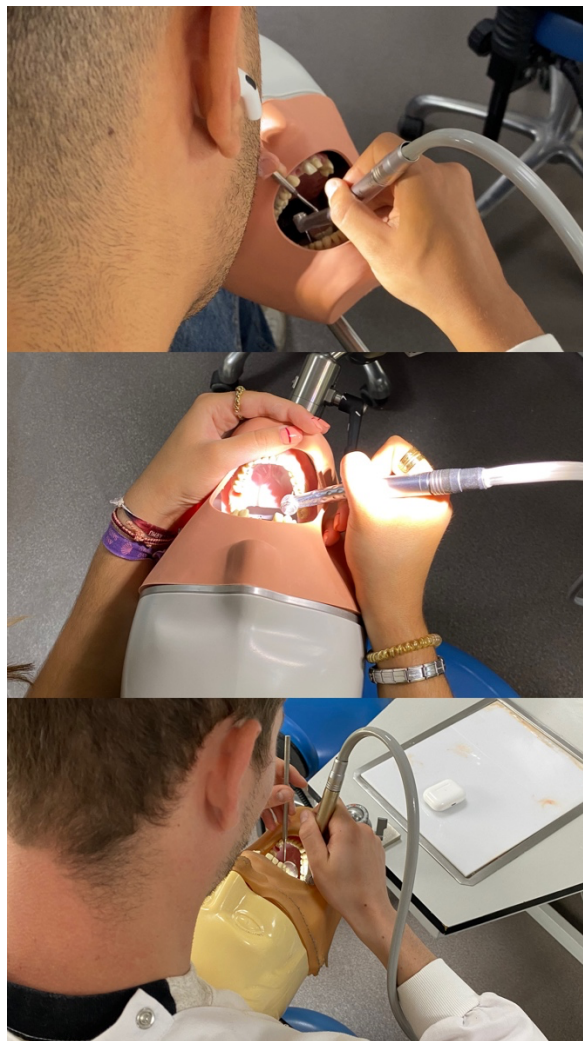


Figure 14. Participants position during full crown preparation on tooth n°46 mounted on Phantom.

All participants were unanimously satisfied to have been able to participate in our study, bearing a point of honor on having been able to practice on the two supports, namely Frasaco in direct vision and Frasaco in indirect vision, mounted on Phantom.

STRENGTHS AND LIMITATIONS

The forces of the investigation were found in the execution of work on both supports during the same practical class. It allowed participants to practice with two different techniques, namely direct vision and indirect vision, and we collected their immediate feelings, thanks to the pre-post practical questionnaire, limiting the margins of error.

The sample, with 20 students, represents a standard practical class during dental studies. It allows us to have a precise idea that the class group felt in similar working conditions and to meet the main objective of the investigation.

Regarding the limitations, some items could not provide us with more information about the ease or difficulty of execution in this study, namely item 1 and item 2.

VI- CONCLUSION

Full Dental crown preparations were the most difficult to perform when the Frasaco was mounted on the Phantoma, however, compared to the Frasaco with direct vision, students reported that the preparations performed in Phantoma were more pedagogical.

VII- REFERENCES

- Ahmed, W., Sein, H., Jackson, M.J., Rego, C., Hassan, I.U., & Subramani, K. (2018). Chapter 13 – Surface engineering of dental tools with diamond for enhanced life and performance. <https://doi.org/10.1016/B978-0-12-812291-4.00013-3>
- Aleisa, K.I., Al-Dwairi, Z.N., Alwazzan, K., Al-Moither, M., Al-Shammari, M.M., & Lynch, E. (2013). Convergence angles of clinical tooth preparations achieved by dental students at King Saud University, Saudi Arabia. *Journal of dental education*, 77 9, 1154-8. <https://doi.org/10.1002/j.0022-0337.2013.77.9.tb05587.x>
- Alhazmi, M., El-Mowafy, O., Zahran, M.H., Uctasli, S., Alkumru, H., & Nada, K. (2013). Angle of convergence of posterior crown preparations made by predoctoral dental students. *Journal of dental education*, 77 9, 1118-21. <https://doi.org/10.1002/j.0022-0337.2013.77.9.tb05582.x>
- Alhoumaidan, A., Mohan, M.P., & Doumani, M. (2019). The knowledge, attitude and practice of fixed prosthodontics: A survey among Qassim dental practitioners. *Journal of Family Medicine and Primary Care*, 8, 2882 - 2887. https://doi.org/10.4103/jfmpe.jfmpe_683_19
- Amine, M., Wahid, H.O., Fahi, S., Lehmuouddi, S., Hamza, M., & Elarabi, S. (2022). Assessment of Convergence Angle of Tooth Preparations for Complete Crowns Among Dental Students: Typodont vs Simulator. *International Journal of Dentistry*, 2022.
- Association for Dental Education in Europe. (2022). *Le diplômé européen en médecine bucco-dentaire : Un nouveau cadre de programme d'études de formation initiale*. <https://adee.org/sites/default/files/02%20Introduction.pdf>
- Atwood, D.A. (1969). Practice of prosthodontics: past, present, and future. *The Journal of prosthetic dentistry*, 21 4, 393-401. [https://doi.org/10.1016/0022-3913\(69\)90049-3](https://doi.org/10.1016/0022-3913(69)90049-3)
- Ayad, M.F. (2009). Effects of tooth preparation burs and luting cement types on the marginal fit of extracoronal restorations. *Journal of prosthodontics: official journal of the American College of Prosthodontists*, 18 2, 145-51. <https://doi.org/10.1111/j.1532-849X.2008.00398.x>
- Bairsto, R. (2021). Phantom head. *British Dental Journal*, 231, 152 - 152. <https://doi.org/10.1038/s41415-021-3346-8>

- Blair, F., Wassell, R.W., & Steele, J.G. (2002). Crowns and other extra-coronal restorations: Preparations for full veneer crowns. *British Dental Journal*, *192*, 561-571. <https://doi.org/10.1038/sj.bdj.4801428>
- Campos, F., Valandro, L.F., Feitosa, S., Kleverlaan, C.J., Feilzer, A.J., de Jager, N., & Bottino, M.A. (2017). Adhesive Cementation Promotes Higher Fatigue Resistance to Zirconia Crowns. *Operative dentistry*, *42* 2, 215-224. <https://doi.org/10.2341/16-002-L>
- Chan, D.C., Chan, B.W., & Chung, A.K. (2007). Mathematical modeling of molar tooth preparations for complete crowns. *Journal of dentistry*, *35* 11, 875-7. <https://doi.org/10.1016/J.JDENT.2007.08.002>
- Christensen, G.J. (2004). Defining oral rehabilitation. *Journal of the American Dental Association*, *135* 2, 215-7. <https://doi.org/10.14219/jada.archive.2004.0154>
- Curtis, D.A., Lind, S.L., Brear, S., & Finzen, F.C. (2007). The correlation of student performance in preclinical and clinical prosthodontic assessments. *Journal of dental education*, *71* 3, 365-72. <https://doi.org/10.1002/J.0022-0337.2007.71.3.TB04286.X>
- Daud, A., Matoug-Elwerfelli, M., Daas, H.I., Zahra, D., & Ali, K. (2023). Enhancing learning experiences in pre-clinical restorative dentistry: the impact of virtual reality haptic simulators. *BMC Medical Education*, *23*. <https://doi.org/10.1186/s12909-023-04904-y>
- Delaunay, L., Slim, K., Briquet, E., Joris, J., Boudemaghe, T., Léger, L., & Bizard, F. (2024). Diffusion de la réhabilitation améliorée après chirurgie en France. Étude nationale à grande échelle, à partir des données du PMSI. *Santé Publique*. <https://doi.org/10.3917/spub.pr2.0028>
- Diário da República. (2019). *Aviso n.º13403/2019, de 23 de agosto*. <https://diariodarepublica.pt/dr/detalhe/aviso/13403-2019-124171082>
- Durham, J., & Ohrbach, R. (2010). Oral rehabilitation, disability and dentistry. *Journal of oral rehabilitation*, *37*(6), 490–494. <https://doi.org/10.1111/j.1365-2842.2010.02078.x>
- Egas Moniz School of Health and Science. (2022). *We care to make a difference: becoming a civic university*. <https://www.egasmoniz.com.pt/en/about>
- Eichenberger, M., Biner, N., Amato, M., Lussi, A., & Perrin, P. (2018). Effect of Magnification on the Precision of Tooth Preparation in Dentistry. *Operative dentistry*, *43* 5, 501-507. <https://doi.org/10.2341/17-169-C>
- Emir, F., Ayyıldız, S., & Şahin, C. (2018). What is the changing frequency of diamond burs? *The Journal of Advanced Prosthodontics*, *10*, 93 - 100. <https://doi.org/10.4047/jap.2018.10.2.93>

- Field, J., Steele, J.G., & Wassell, R.W. (2018). Fundamentals of Tooth Preparation. *BDJ Clinician's Guides*. https://doi.org/10.1007/978-3-319-79093-0_20
- Fons-Font, A., Solá-Ruiz, M.F., Granell-Ruiz, M., Labaig-Rueda, C., & Martínez-González, A. (2006). Choice of ceramic for use in treatments with porcelain laminate veneers. *Medicina oral, patología oral y cirugía bucal*, 11 3, E297-302.
- Forrai, J., & Andrew I., S. (2023). History of the dental crown. *Kaleidoscope history*. <https://doi.org/10.17107/kh.2023.26.25>
- Franks, A.S. (1976). The concept of oral rehabilitation. *Journal of oral rehabilitation*, 3 1, 1-8. <https://doi.org/10.1111/j.1365-2842.1976.tb00924.x>
- Frasaco. (2018). *Toward the future with tradition*. <https://www.frasaco.de/en/company/>
- Fugill, M. (2013). Defining the purpose of phantom head. *European journal of dental education : official journal of the Association for Dental Education in Europe*, 17 1, e1-4 . <https://doi.org/10.1111/eje.12008>
- Furuta, Y., Shibiya, M., Kazama, Y., Iijima, H., Kakehashi, Y., & Igarashi, T. (1989). [The influence of the operating positions on the prepared abutment contour of full cast crowns. Unanatomical artificial teeth for fixed bridge]. *Nihon Hotetsu Shika Gakkai zasshi*, 33 2, 359-68. <https://doi.org/10.2186/jjps.33.359>
- Glick, M., Williams, D.M., Kleinman, D.V., Vujicic, M., Watt, R.G., & Weyant, R.J. (2017). A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. *Journal of public health dentistry*, 77 1, 3-5. <https://doi.org/10.1111/jphd.12213>
- Goldstein, R.E., & Patzer, G.L. (2018). Concepts of Dental Esthetics. *Ronald E. Goldstein's Esthetics in Dentistry*. <https://doi.org/10.1002/9781119272946.ch1>
- Goodacre, C.J., Campagni, W.V., & Aquilino, S.A. (2001). Tooth preparations for complete crowns: an art form based on scientific principles. *The Journal of prosthetic dentistry*, 85 4, 363-76. <https://doi.org/10.1067/mpr.2001.114685>
- Gupta, R.K., Nagpal, A., Sharda, V., Swain, S., & Bhadwal, M. (2016). Prosthodontic Rehabilitation - Past, Present and Future.
- Gureckis, K.M., Burgess, J.O., & Schwartz, R.S. (1991). Cutting effectiveness of diamond instruments subjected to cyclic sterilization methods. *The Journal of prosthetic dentistry*, 66 6, 721-6 . <https://doi.org/10.1016/0022-3913%2891%2990402-I>
- Habib, S.R. (2018). Rubric system for evaluation of crown preparation performed by dental students. *European Journal of Dental Education*, 22, e506–e513. <https://doi.org/10.1111/eje.12333>

- Hadjichristou, C., Kokoti, M., & Bakopoulou, A. (2024). Haptics in fixed prosthodontics and their role in dental education: A literature review. *Journal of dental education*, 10.1002/jdd.13533. Advance online publication. <https://doi.org/10.1002/jdd.13533>
- Hadjichristou, C., Symeonidis, D., & Dimitriadou, E. (2024). Haptics Vs Typodonts for Crown Preparation in Undergraduate Dental Student Education. *The European journal of prosthodontics and restorative dentistry*, 32(2), 175–182. https://doi.org/10.1922/EJPRD_2647Hadjichristou08
- Hall V F. *History of King's College Hospital Dental School*. London: King's College Hospital Medical School London, 1973.
- Han, S., Yi, Y., Revilla-León, M., Yılmaz, B., & Yoon, H. (2023). Feasibility of software-based assessment for automated evaluation of tooth preparation for dental crown by using a computational geometric algorithm. *Scientific Reports*, 13. <https://doi.org/10.1038/s41598-023-39089-3>
- Haralur, S.B., & Al-Malki, A.E. (2014). Student perception about efficacy of preclinical fixed prosthodontic training to facilitate smooth transition to clinical context. *Journal of Education and Health Promotion*, 3. <https://doi.org/10.4103/2277-9531.134898>
- Hariri, I., & El Yamani, A. (2023). The Impact of Computer-aided Design/Computer-aided Manufacturing Technology on Improving the Esthetics of Our Patients: A Case Report. *CODS - Journal of Dentistry*. <https://doi.org/10.5005/jp-journals-10063-0136>
- Hawthan, M., Chrcanovic, B.R., & Larsson, C. (2022). Retrospective clinical study of tooth-supported single crowns: A multifactor analysis. *European Journal of Oral Sciences*, 130. <https://doi.org/10.1111/eos.12871>
- Henkel, G.L. (2007). A comparison of fixed prostheses generated from conventional vs digitally scanned dental impressions. *Compendium of continuing education in dentistry*, 28 8, 422-4, 426-8, 430-1.
- Hey, J., Schweyen, R., Kupfer, P., & Beuer, F. (2017). Influence of preparation design on the quality of tooth preparation in preclinical dental education. *Journal of dental sciences*, 12(1), 27–32. <https://doi.org/10.1016/j.jds.2016.05.002>
- Hill, G. L., & Hampel, A. T. (1987). A typodont used exclusively for practical examinations. *Journal of dental education*, 51(9), 553–554. <https://doi.org/10.1002/j.0022-0337.1987.51.9.tb02140.x>
- Höhne, C., Schwarzbauer, R., & Schmitter, M. (2020). Introduction of a new teaching concept for crown preparation with 3D printed teeth. *European journal of dental education* :

- official journal of the Association for Dental Education in Europe.*
<https://doi.org/10.1111/eje.12532>
- International Health Conference. (2002). Constitution of the World Health Organization. 1946. *Bulletin of the World Health Organization*, 80(12), 983–984.
- Ishizuka, T. (1984). The influence of the home operating positions on the prepared abutment contour of full cast crowns - With special reference to the maxillary right first molar. *Nihon Hotetsu Shika Gakkai Zasshi*, 28, 284-301.
<https://doi.org/10.2186/jjps.28.284>
- Ishizuka, T., Koizumi, M., Nameta, Y., Tsue, A., Moriya, Y., Oshima, S., Kochi, T., Kakehashi, Y., & Igarashi, T. (1983). The Influence of the Dentist Positions for the Prepared Abutment Tooth Contour. <https://doi.org/10.2186/jjps.27.1182>
- Janus, C.E., Unger, J.W., & Best, A.M. (2006). Survival analysis of complete veneer crowns vs. multisurface restorations: a dental school patient population. *Journal of dental education*, 70 10, 1098-104. <https://doi.org/10.1002/J.0022-0337.2006.70.10.TB04183.X>
- Jm, H. (1991). Modern concepts in crown preparation. *The New York state dental journal*, 57, 32.
- Jonsson, A., & Svingby, G. (2007). The use of scoring rubrics: Reliability, validity, and educational consequences. *Educational Research Review*, 2, 130-144.
<https://doi.org/10.1016/J.EDUREV.2007.05.002>
- Khalaf, K., El-Kishawi, M., Mustafa, S., & Al Kawas, S. (2020). Effectiveness of technology-enhanced teaching and assessment methods of undergraduate preclinical dental skills: a systematic review of randomized controlled clinical trials. *BMC Medical Education*, 20. <https://doi.org/10.1186/s12909-020-02211-4>
- Koizumi, M., Kakehashi, Y., Ishizuka, T., Nameta, Y., Tsue, A., Oshima, S., Kochi, T., Choi, D., Shoji, Y., Nakazawa, K., & Igarashi, T. (1983). The influence of the Dentist Position for the Prepared Abutment Tooth Contour : Part V. Mandibular Right First Molar. *Nihon Hotetsu Shika Gakkai Zasshi*, 27, 616-623.
<https://doi.org/10.2186/jjps.27.616>
- Kui, A.I., Manziuc, M.M., Petruțiu, A., Buduru, S., Labuneț, A., Negucioiu, M., & Chisnoiu, A. (2023). Translucent Zirconia in Fixed Prosthodontics—An Integrative Overview. *Biomedicines*, 11. <https://doi.org/10.3390/biomedicines11123116>
- Lee, B., Kim, J., Shin, S., Kim, J., Park, J., Kim, K., Kim, S., & Shim, J. (2021). Dental students' perceptions on a simulated practice using patient-based customized typodonts

- during the transition from preclinical to clinical education. *European journal of dental education : official journal of the Association for Dental Education in Europe*.
<https://doi.org/10.1111/eje.12672>
- Lee, M., Lee, S.A., Jeong, M., & Oh, H. (2020). Quality of virtual reality and its impacts on behavioral intention. *International Journal of Hospitality Management*, 90, 102595.
<https://doi.org/10.1016/J.IJHM.2020.102595>
- Lele, D.G., & Sikdar, D.M. (2021). From Real to Virtual-Technology Assisted Instruction in Preclinical Dental Education.
- Li, Y., Ye, H., Ye, F., Liu, Y., Lv, L., Zhang, P., Zhang, X., & Zhou, Y. (2020). The Current Situation and Future Prospects of Simulators in Dental Education. *Journal of Medical Internet Research*, 23. <https://doi.org/10.2196/preprints.23635>
- Liu P. R. (2005). A panorama of dental CAD/CAM restorative systems. *Compendium of continuing education in dentistry (Jamesburg, N.J. : 1995)*, 26(7), 507–527.
- Liu, L., Zhou, R., Yuan, S., Sun, Z., Lu, X., Li, J., Chu, F., Walmsley, A.D., Yan, B., & Wang, L. (2019). Simulation training for ceramic crown preparation in the dental setting using a virtual educational system. *European journal of dental education : official journal of the Association for Dental Education in Europe*.
<https://doi.org/10.1111/eje.12485>
- Liu, X., Liu, M., Yang, Y., Fan, C., & Tan, J. (2019). Step-by-step teaching method improves the learner achievement in dental skill training. *European journal of dental education : official journal of the Association for Dental Education in Europe*.
<https://doi.org/10.1111/eje.12435>
- Lucie Dalibert, Jérôme Goffette. (2020). Qu'est-ce qu'une prothèse ? Concepts et usages. Corps et prothèses. *Presses Universitaires de Grenoble*. <https://shs.hal.science/halshs-02475011>
- Makhija, S.K., Lawson, N.C., Gilbert, G.H., Litaker, M.S., McClelland, J., Louis, D.R., Gordan, V.V., Pihlstrom, D.J., Meyerowitz, C., Mungia, R., & McCracken, M.S. (2016). Dentist material selection for single-unit crowns: Findings from the National Dental Practice-Based Research Network. *Journal of dentistry*, 55, 40-47.
<https://doi.org/10.1016/j.jdent.2016.09.010>
- Malau-Aduli, B.S., Roche, P., Adu, M.D., Jones, K., Alele, F.O., & Drovandi, A. (2020). Perceptions and processes influencing the transition of medical students from pre-clinical to clinical training. *BMC Medical Education*, 20.
<https://doi.org/10.1186/s12909-020-02186-2>

- Marghalani, T.Y. (2014). Convergence angles of metal ceramic crowns prepared by dental students. *The Journal of prosthetic dentistry*, *112* 5, 1250-6.
<https://doi.org/10.1016/j.prosdent.2014.03.024>
- McCracken, M.S., Louis, D.R., Litaker, M.S., Minyé, H.M., Mungia, R., Gordan, V.V., Marshall, D.G., & Gilbert, G.H. (2016). Treatment recommendations for single-unit crowns: Findings from The National Dental Practice-Based Research Network. *Journal of the American Dental Association*, *147* 11, 882-890.
<https://doi.org/10.1016/j.adaj.2016.06.012>
- McKinney, R., & Olmo, H. (2023). Developmental Disturbances of the Teeth, Anomalies of Shape and Size. In *StatPearls*. StatPearls Publishing
- McLean, J.W. (2001). Evolution of dental ceramics in the twentieth century. *The Journal of prosthetic dentistry*, *85* 1, 61-6. <https://doi.org/10.1067/mpr.2001.112545>
- Mesko, M.E., Sarkis-Onofre, R., Cenci, M.S., Opdam, N., Loomans, B.A., & Pereira-Cenci, T. (2016). Rehabilitation of severely worn teeth: A systematic review. *Journal of dentistry*, *48*, 9-15. <https://doi.org/10.1016/j.jdent.2016.03.003>
- Moreira, A., Freitas, F., Nabais, J., & Caramês, J. (2018). Full Mouth Rehabilitation of a Patient with Bruxism using Implant and Tooth-supported Monolithic Zirconia with Feldspathic Veneers. *Journal of Clinical and Diagnostic Research*.
<https://doi.org/10.7860/JCDR%2F2018%2F37209.12127>
- Morimoto, S., Vieira, G.F., Agra, C.M., Sesma, N., & Gil, C. (2009). Fracture strength of teeth restored with ceramic inlays and overlays. *Brazilian dental journal*, *20* 2, 143-8.
<https://doi.org/10.1590/S0103-64402009000200010>
- Mulla, S.A., Munshi, F.S., Patil, A.H., Mali, S.D., Saoji, H.A., & Jaiswal, H.C. (2023). Attitude and Perception of Dental Students and Dentists toward Efficacy of Typodont Exercise Practiced as a Part of Preclinical Conservative Dentistry Curriculum for Routine Clinical Practice. *European Journal of General Dentistry*, *12*, 097 - 102.
<https://doi.org/10.1055/s-0043-1768649>
- Naseem, A., Ishaq, W., Aziz, S., Ahmed, S.A., & Ghafoor, A. (2022). Influence of Operator Experience on Clinically Achieved Convergence Angle of Tooth Preparations for Metal-Ceramic Crowns. *Pakistan Armed Forces Medical Journal*.
<https://doi.org/10.51253/pafmj.v72i5.5411>
- Nunez, D. W., Taleghani, M., Wathen, W. F., & Abdellatif, H. M. (2012). Typodont versus live patient: predicting dental students' clinical performance. *Journal of dental education*, *76*(4), 407–413. <http://dx.doi.org/10.1002/j.0022-0337.2012.76.4.tb05272.x>

- Ohm, E., & Silness, J. (1978). The convergence angle in teeth prepared for artificial crowns. *Journal of oral rehabilitation*, 5 4, 371-5. <https://doi.org/10.1111/j.1365-2842.1978.tb01256.x>
- Öwall, B., Carlsson, G. E., Kayser, A. (1998). Prothèse dentaire : principes et stratégies thérapeutiques. Italie: Masson.
- Pagani, C. (ed). (2017). Tooth Preparation: Science & Art. Quintessence Publishing Company.
- Perry, C., Steffel, V.L., & Aull, A.E. (1968). Principles, concepts, and practices in prosthodontics—1967. *Journal of Prosthetic Dentistry*, 19, 180-198. <https://doi.org/10.1016/0022-3913%2868%2990160-1>
- Perry, S., Bridges, S.M., & Burrow, M.F. (2015). A Review of the Use of Simulation in Dental Education. *Simulation in Healthcare: Journal of the Society for Simulation in Healthcare*, 10, 31–37. <https://doi.org/10.1097/sih.0000000000000059>
- Ramesh, G., Nayar, S., & Chandrakala, S. (2020). Principles of Tooth Preparation - Review Article. *Indian Journal of Forensic Medicine & Toxicology*. <https://doi.org/10.37506/ijfmt.v14i4.11715>
- Ramp, M.H., McCracken, M.S., & Mazer, R.B. (1998). Tooth structure loss apical to preparations for fixed partial dentures when using self-limiting burs. *The Journal of prosthetic dentistry*, 79 5, 491-4. [https://doi.org/10.1016/S0022-3913\(98\)70167-2](https://doi.org/10.1016/S0022-3913(98)70167-2)
- Saadé, J., El-Khatib, W., Chedid, N.R., Makzoumé, J.E., El-Halabi, M.T., & El-Hage, F. (2021). Effect of self-assessment in a removable prosthodontics preclinical course on skills and competence. *Journal of dental education*. <https://doi.org/10.1002/jdd.12821>
- Sathvika, K. (2020). Assessing and Comparing the Fracture Strength of Typodont Versus Natural Teeth. *Biochemical and Biophysical Research Communications*, 13, 426-431. <https://doi.org/10.21786/bbrc%2F13.7%2F71>
- Seet, R.H., Soo, P.R., Leong, K.J., Pang, J.J., Lee, F.K., & Tan, M.Y. (2020). Crown preparations by undergraduate dental students: A comparison of conventional versus digital assessment via an intraoral scanner. *Journal of dental education*. <https://doi.org/10.1002/jdd.12285>
- Shillingburg, Herbert T. (1987). Fundamentals of Tooth Preparations for Cast Metal and Porcelain Restorations. Quintessence Publishing Company.
- Siegel, S.C., & Fraunhofer, J.A. (1999). Dental cutting with diamond burs: heavy-handed or light-touch? *Journal of prosthodontics : official journal of the American College of Prosthodontists*, 8 1, 3-9 . <https://doi.org/10.1111/J.1532-849X.1999.TB00002.X>

- Siegel, S.C., & von Fraunhofer, J.A. (1999). Dental burs--what bur for which application? A survey of dental schools. *Journal of prosthodontics : official journal of the American College of Prosthodontists*, 8 4, 258-63 . <https://doi.org/10.1111/J.1532-849X.1999.TB00048.X>
- Spielman, A. (2009). The Boy with the Golden Tooth: A 1593 Case Report of the First Molded Gold Crown. *Journal of Dental Research*, 88, 11 - 8. <https://doi.org/10.1177/0022034508328196>
- Stappert, C.F., Ozden, U., Gerds, T.A., & Strub, J.R. (2005). Longevity and failure load of ceramic veneers with different preparation designs after exposure to masticatory simulation. *The Journal of prosthetic dentistry*, 94 2, 132-9. <https://doi.org/10.1016/j.prosdent.2005.05.023>
- Suganna, M., Kausher, H., Tarek Ahmed, S., Sultan Alharbi, H., Faraj Alsubaie, B., Ds, A., Haleem, S., & Meer Rownaq Ali, A.B. (2022). Contemporary Evidence of CAD-CAM in Dentistry: A Systematic Review. *Cureus*, 14. <https://doi.org/10.7759/cureus.31687>
- T.Shillingburg..., H. (1979). Fundamentals of fixed prosthodontics.
- Tavares, V. (1984). [History of fixed prosthodontics]. *Revista portuguesa de estomatologia e cirurgia maxilo-facial*, 25 4, 1103-18.
- Theng, K.Y., Andanastuti, M., Aboras, M., Yahaya, N.Z., & Ghazali, M.J. (2013). Properties and Survival Rate of all Ceramics Dental Crown: A Review. *Applied Mechanics and Materials*, 465-466, 857 - 861. <https://doi.org/10.4028/www.scientific.net/AMM.465-466.857>
- Tricio, J.A., Kleiman, S.E., Eiriksson, V.I., Vicuña, D.P., Cacciuttolo, F., Jorquera, G.A., Córdova, C., Gualda, J.I., Gutiérrez, M.F., Villalón, P.A., & Orsini, C.A. (2022). Students' and tutors' perceptions of a deliberate simulated practice using patient-specific virtual and three-dimensional printed teeth models: A pilot study. *Journal of dental education*. <https://doi.org/10.1002/jdd.12909>
- Vasileva, I., & Bonev, B. (2022). Communication in Dental Practice: Preclinical Training. *Diogenes*. <https://doi.org/10.54664/hesn7796>
- Veiga, N.J., Diniz, L.R., Pereira, C.E., Amaral, O., Coelho, I., & Pereira, J. (2017). Oral Health and Rehabilitation among the Institutionalized Elderly. *European Journal of Social & Behavioural Sciences*, 18, 2353-2360. <https://doi.org/10.15405/EJSBS.208>
- Velayo, B.C., Stark, P.C., Eisen, S.E., & Kugel, G. (2014). Using dental students' preclinical performance as an indicator of clinical success. *Journal of dental education*, 78 6, 823-8. <https://doi.org/10.1002/J.0022-0337.2014.78.6.TB05735.X>

Vinski, I. (1979). Two hundred and fifty years of rotary instruments in dentistry. *British Dental Journal*, 146, 217-223. <https://doi.org/10.1038/sj.bdj.4804234>

Vivek V Nair. (2020). Complete Oral Rehabilitation - An Overview. *The journal of Prosthetic and implant dentistry*. <https://www.researchgate.net/publication/342917058>

APPENDIX

Annex 1) Authorization from the Ethics Committee



Comissão de Ética EGAS MONIZ

Proc. Interno nº 1227

PT-185/22

Ex.mo Senhor
Jean-Baptiste

Monte de Caparica, 27 de abril de 2023.

Ex.mo Senhor,

Em resposta ao Pedido de Parecer que submeteu à apreciação da Comissão de Ética da Egas Moniz, com o tema denominado: "**Estudo comparativo sobre os preparos dentários para coroa revestimento total, realizado por estudantes do mestrado integrado em medicina dentaria**", foi aprovado.

A Presidente da Comissão de Ética da Egas Moniz


Professora Doutora Maria Fernanda de Mesquita

Annex 2) Informed consent



ESTUDO COMPARATIVO SOBRE OS PREPAROS DENTÁRIOS PARA COROA REVESTIMENTO TOTAL, REALIZADO POR ESTUDANTES DO MESTRADO INTEGRADO EM MEDICINA DENTÁRIA

CONSENTIMENTO INFORMADO

O presente estudo faz parte de um projeto de investigação a decorrer no **IUEM-Instituto Universitário Egas Moniz**. Este estudo tem por objetivo comparar o grau de dificuldade nas metodologias pedagógicas de aprendizagem sobre a realização por estudantes de um preparo dentário para coroa total sobre diferentes suportes.

O estudo é realizado por alunos do 5.º ano do Mestrado Integrado em Medicina Dentária, Jean-Baptiste Renouard nº 113 266 (113266@alunos.egasmoniz.edu.pt) sob a supervisão dos docentes da Unidade Curricular, a saber, Prof. Doutor Sérgio Félix (sfelix1050@gmail.com) e Prof. Doutor Francisco Martins (Francisco.ed.martins@gmail.com), que se encontram disponíveis para serem contactados a qualquer momento, caso pretenda esclarecer alguma dúvida.

A sua participação no estudo é muito valorizada, pois irá contribuir para o avanço dos conhecimentos neste domínio da ciência, nomeadamente no processo de aprendizagem e treino quando da realização de um preparo dentário para coroa total sobre um primeiro molar. A sua colaboração consistirá na realização de dois preparos dentários em frasco, um suportado manualmente e o outro suportado em Phantoma. Por fim ser-lhe-á solicitado que preencha um breve questionário, sendo que em nenhum momento se procederá à avaliação dos trabalhos. Mais informamos que não existem riscos expectáveis associados à participação no estudo.

A participação neste estudo é estritamente **voluntária**, pelo que pode escolher livremente participar ou não no mesmo. Se tiver escolhido participar, pode interromper a participação em qualquer momento, sem ter de prestar qualquer justificação para a sua decisão. Para além de voluntária, a participação é também **anónima** e **confidencial**. Os dados obtidos destinam-se apenas a tratamento estatístico e nenhuma resposta será analisada ou reportada individualmente.

Declaro ter compreendido os objetivos do trabalho a realizar e o âmbito da minha participação no estudo, conforme me foi proposto e explicado pelo investigador. Adicionalmente, foi-me dada a oportunidade de fazer todas as perguntas sobre o presente estudo, tendo, para todas elas, obtido respostas esclarecedoras, pelo que **aceito** nele participar.

_____ (local), ____/____/_____ (data)

Nome: _____

Numero de estudante: _____

Assinatura: _____

Annex 3) practical post-realization Questionnaire



ESTUDO COMPARATIVO SOBRE OS PREPAROS DENTÁRIOS PARA COROA REVESTIMENTO TOTAL, REALIZADO POR ESTUDANTES DO MESTRADO INTEGRADO EM MEDICINA DENTARIA

Agradecemos, desde já, a sua colaboração no presente estudo. Solicitamos-lhe adicionalmente que, quando terminar a realização dos preparos, preencha o questionário abaixo.

Para realizar o trabalho dispõe no máximo 2h30, preencha os seguintes campos.

Faz ou fez tarefas/atividades manuais (mecânicas, artesanais,

nunca raramente ocasionalmente regularmente diariamente

Utiliza ou utilizou máquinas do tipo rotativo (Brocas, esmeriladeiras, lixadeiras, etc.)?

nunca raramente ocasionalmente regularmente diariamente

Dente selecionado para fazer o preparo de coroa revestimento total

Dente (46)

Classifique através uma cruz num dos números de 0-10 sendo que 0 é menor resultado é 10 o melhor resultado.

Diretamente no Frasco

- Grau de dificuldade

1	2	3	4	5	6	7	8	9	10
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- Dificuldade de acesso

1	2	3	4	5	6	7	8	9	10
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- Visibilidade

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- Facilidade na instrumentação

1	2	3	4	5	6	7	8	9	10
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Tempo min que demorou									
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**ESTUDO COMPARATIVO SOBRE OS PREPAROS DENTÁRIOS PARA COROA REVESTIMENTO TOTAL,
REALIZADO POR ESTUDANTES DO MESTRADO INTEGRADO EM MEDICINA DENTARIA**

No Frasco instalado no Phantoma

Tempo min que demorou	
-----------------------	--

- Grau de dificuldade

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

- Dificuldade de acesso

1	2	3	4	5	6	7	8	9	10
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- Visibilidade

1	2	3	4	5	6	7	8	9	10
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- Facilidade na instrumentação

1	2	3	4	5	6	7	8	9	10
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Após a realização dos preparos considera:

O preparo em frasco não montado é mais fácil de realizar, mas menos pedagógico. SIM NÃO

O preparo em frasco não montado é mais difícil de realizar, mas mais pedagógico. SIM NÃO

O preparo Frasco montado em Phatoma é mais fácil de realizar, mas menos pedagógico. SIM NÃO

O preparo em frasco montado em Phantoma é mais difícil de realizar, mas mais pedagógico. SIM NÃO