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STUDENT'S ASSESSMENT IN THE DIAGNOSIS AND TREATMENT OF DEEP CARIOUS LESIONS

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STUDENT'S ASSESSMENT IN THE DIAGNOSIS AND TREATMENT OF DEEP CARIOUS LESIONS

Monografia de Investigação de Candidatura ao grau de Mestre em Medicina Dentária

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List of Abbreviations

VPT – Vital Pulp Therapy

TPV – Terapia Pulpar Vital

DCL – Deep Carious Lesion

AAE – American Association of Endodontists

ESE – European Society of Endodontology

MTA – Mineral Trioxide Aggregate

$Ca(OH)^2$ – Calcium Hydroxide

USA – United States of America

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Abstract

Introduction: Vital pulp therapy (VPT) is an important topic when it comes to deep carious lesions (DCL), as its practice concedes an effort to maintain teeth's pulps vital. There are several treatment options within VPT, however confusion exists when it comes to choosing which one is the most adequate for the situation at hand. Therefore, it is important to analyze student's assessment of this topic and gather the data necessary, for them to make an informed decision when they are confronted with a deep carious lesion during their clinical practice.

Objective: This thesis' aim is to analyze the assessment and treatment choices of 5th year master's degree students in Dental Medicine as well as specialization students (2019/2020) from the Faculty of Dental Medicine of the University of Porto, regarding deep carious lesions and verify whether there are differences between these two groups.

Methodology: 80 Dental Medicine students from FMDUP and 32 students from the specializations taught in the academic year of 2019/2020 in FMDUP were contacted, resulting in a total of 112 students. Of these, 50 master's degree students and 11 specialty students responded, resulting in a total sample of 61 students (54%). Participants were asked to answer a survey with multiple choice and short answer questions, based on questionnaires previously conducted in Brazil, United States of America and Europe.

Results: Non-selective caries removal was the preferred treatment option in teeth with reversible pulpitis, particularly in the clinical cases, as well as regarding an asymptomatic patient with a deep carious lesion. Most students (45,9%) considered that all cariogenic microorganisms must be removed in order to stop caries progression, however when asked if in the case of a deep carious lesion dental tissue close to the pulp must be preserved to avoid exposure, most students either agreed (37,7%) or did not have an opinion (32,8%). Good clinical results (82%), patients' oral health (85,2%) and patients age (68,9%) were the main factors influencing the treatment choice. Most students (96,7%) admit to using an excavator when close to the pulp, 78,7% of students admit to not using rubber dam during treatment and 65,6% claim to doing routine follow-ups on patients with this type of caries.

Conclusion: There is a need to clarify and incorporate the new diagnostic and therapeutic terminology for a better understanding among professionals. It is still necessary to carry out more controlled studies on clinical guidelines in order to provide successful conservative treatments.

Key Words: vital pulp therapy; deep carious lesions; pulp exposure; reversible pulpitis; endodontic therapy; questionnaire; treatment

Resumo

Introdução: A Terapia pulpar vital (TPV) é um tópico importante no que diz respeito a lesões de cárie profundas, já que concede uma oportunidade para manter a vitalidade da polpa dos dentes. Existem várias opções de tratamento dentro da TPV, contudo, persistem dúvidas no momento de escolher qual o mais apropriado para a situação em causa. Dessa forma, é importante analisar os conhecimentos dos estudantes, acerca deste assunto e reunir os dados necessários, para que os mesmos possam fazer uma decisão informada quando confrontados com uma lesão de cárie profunda na sua prática clínica.

Objetivo: Com este trabalho pretende-se analisar os conhecimentos e as escolhas de tratamento dos estudantes do 5º ano do Mestrado Integrado em Medicina Dentária e dos cursos de especialização (2019/2020) da Faculdade de Medicina Dentária da Universidade do Porto no que diz respeito a lesões de cárie profundas e verificar se existem diferenças entre os dois grupos.

Metodologia: Foram contactados 80 estudantes de Medicina Dentária da FMDUP e 32 estudantes das especialidades lecionadas no ano letivo 2019/2020 na FMDUP, resultando num total de 112 estudantes. Desses, 50 estudantes do 5º ano e 11 estudantes das especialidades responderam, resultando numa amostra total de 61 alunos (54%). Aos participantes foi solicitada a resolução de um questionário com perguntas de escolha múltipla e resposta curta, baseado em questionários previamente conduzidos no Brasil, Estados Unidos da América e na Europa.

Resultados: A remoção não seletiva de cárie foi a opção de tratamento preferencial em dentes com pulpite reversível, principalmente nos casos clínicos, bem como no caso clínico de uma paciente assintomática com uma lesão de cárie profunda. A maioria dos estudantes (45,9%) considerou que todos os microrganismos cariogénicos devem ser removidos para interromper a progressão da cárie; no entanto, quando perguntados se, no caso de uma lesão de cárie profunda, o tecido dentinário próximo à polpa deve ser preservado para evitar a exposição, a maioria dos estudantes concordou (37,7%) ou não tinha opinião formada (32,8%). Bons resultados clínicos (82%), saúde oral dos pacientes (85,2%) e idade dos pacientes (68,9%) foram os principais fatores que influenciaram a sua escolha de tratamento. A maioria dos estudantes (96,7%) admite usar escavador quando perto da polpa, 78,7% dos estudantes admitem não usar dique de borracha durante o tratamento dessas lesões de cárie profunda e 65,6% afirmam fazer acompanhamento de rotina em pacientes com esse tipo de cárie.

Conclusão: Existe uma necessidade de clarificar e incorporar a nova terminologia diagnóstica e terapêutica para um melhor entendimento entre profissionais. É necessário ainda efetuar mais estudos controlados sobre *guidelines* clínicas no sentido de conferir sucesso aos tratamentos conservadores.

Palavras-Chave: terapia pulpar vital; lesões de cárie profundas; exposição pulpar; pulpite reversível; terapia endodôntica; questionário; tratamento.

Introduction

Dental caries occurs when there is a disturbance in the balance between dental tissues and microbial deposits. (1) When these lesions are neglected in their early stages, they can develop into deep carious lesions. These are classified by their radiographic involvement of the inner 1/3 or 1/4 of the dentin. (2)

Treatment of deep carious lesions is an important part of Dental Medicine, and of the daily routine clinical practice.(3) Several studies have shown that therapeutic protocols and diagnostic criteria varies when it comes to this type of lesions. (2) Its treatment can range from a total excavation with possible endodontic therapy, to a less invasive procedure. (3) Thus, one of the variables refers to the depth that is reached in the removal of the decayed dentin.

Another possible variable factor can be the technique used, as either a selective or non-selective excavation can be carried out. Non-selective excavation consists in removing decayed dentin until hard dentin is reached. Consequently, it possesses an increased risk of pulp exposure. In turn, selective excavation consists of partial removal of carious tooth decay, leaving carious dentin in the cavity area closest to the pulp.

Therefore, what makes the treatment of deep carious lesions challenging and variable is the high risk of pulp exposure. (1) In vital teeth, it's in the interest of the Dentist and the patient to maintain the vitality of the pulp as it reduces the number of interventions and maintains the defensive and proprioceptive functions, characteristic of the pulp. In these cases, classically reported as having a poor prognosis (4), new biomaterials such as bioceramics, as well as new techniques and a better understanding of the repair mechanisms of the pulp have been improving the outcome of teeth with symptomatic exposures, namely through direct pulp capping. (5)

Vital Pulp Therapy has become an important topic when it comes to dealing with deep carious lesions because it encompasses several different treatment options, but with the same goal: maintaining the vitality of the pulp. These types of treatments have been mostly recommended for young patients because of their healing capacity (6). On the other hand deep carious lesions in permanent teeth have been traditionally managed with a complete removal of the carious tissue and, in the case of exposure of the pulp, a pulpectomy is performed rather than an approach that aims at the maintenance of its vitality.(7) However, no studies are found supporting the hypothesis that VPT should only be performed in young patients and therefore it should be considered in vital permanent teeth with exposed pulps, as an ultra-conservative treatment modality. (6)

Thanks to these different treatment options, it is necessary to define evidence-based guidelines to facilitate the implementation of the most correct therapeutic procedures to be performed, (3) as well as to provide students with the necessary tools to make informed decisions when it comes to deep carious lesions.

The number of studies on this topic based on an accredited questionnaire is limited and has never been directed to a sample of undergraduate and specialization dental students. Thus, it is important to first understand what students are learning and applying in their clinical practice, in order to determine what changes are to be applied. (3)

The aim of the present study was to investigate, through a questionnaire, the awareness and compliance of pre- and post-graduate students to the recent guidelines about the management of

deep caries and the exposed pulp, as well as diagnosis criteria. Additionally, we also aimed to explore whether differences could be found between the two groups of students analyzed when confronted with a clinical situation.

Materials and Methods

Following approval from the Ethical Committee of the Faculty of Dental Medicine of the University of Porto, as well as approval from the Unit of Data Protection of the University of Porto the present study was conducted respecting the following criteria:

-Participants

The participants chosen for the questionnaire were students of the Faculty of Dental Medicine of the University of Porto, in their 5th year of the integrated master's in Dental Medicine as well as post-graduate students of the academic year 2019/2020. A total of 112 students were contacted, of which 80 were undergraduate and 32 were specialization students. Of the undergraduate students, 50 answered, while 11 of the specialization students responded.

-Questionnaire

Participants were asked to answer a questionnaire with multiple choice and short open questions, based on questionnaires previously conducted in Brazil (1), United States of America (3) and Europe (2, 8, 9). The questionnaire was made available in Portuguese and English in order to meet the needs of international students. After several questions related to the demographic, educational and professional background of the participants, 3 clinical cases were presented along with questions, related to the diagnosis and treatment of deep carious lesions. In addition to general information about each clinical case, photographs of the lesions prior to treatment, periapical radiographs of each of the teeth being analyzed and photographs after opening the cavities of the teeth, were also provided. Participants were also asked about routine approaches to their clinical practice when they are faced with the need to treat a deep carious injury. The questionnaire can be found in full in Appendix 1, as well as the clinical overview of the clinical cases provided in Appendix 2.

-Statistical Analysis

A database was created for further analysis using Excel (Microsoft Corp., Redmond, WA, USA). The statistical analysis was obtained using the IBM ® SPSS ® Statistics version 26.0 software. Data description was carried out by frequency tables to provide an overview of the responses. A Chi-square test was used to analyze the differences between undergraduate and pos-graduate students regarding the proposed diagnosis and treatment for each clinical situation. The statistical significance level was set at $p<0.05$.

Results

The response rate was of 54%, which consists in a 62,5% response rate from the undergraduate students and a 34,4% rate from specialization students.

Among the 61 respondents to the survey, 16.4% were male and 83.6% were female. Fifty (82%) were master's degree students and eleven 11 (18%) post-graduate students. The mean age was 24.31±3.97. The distribution of the sample according to age and sex, for both groups, can be found on Figures 1 and 2.

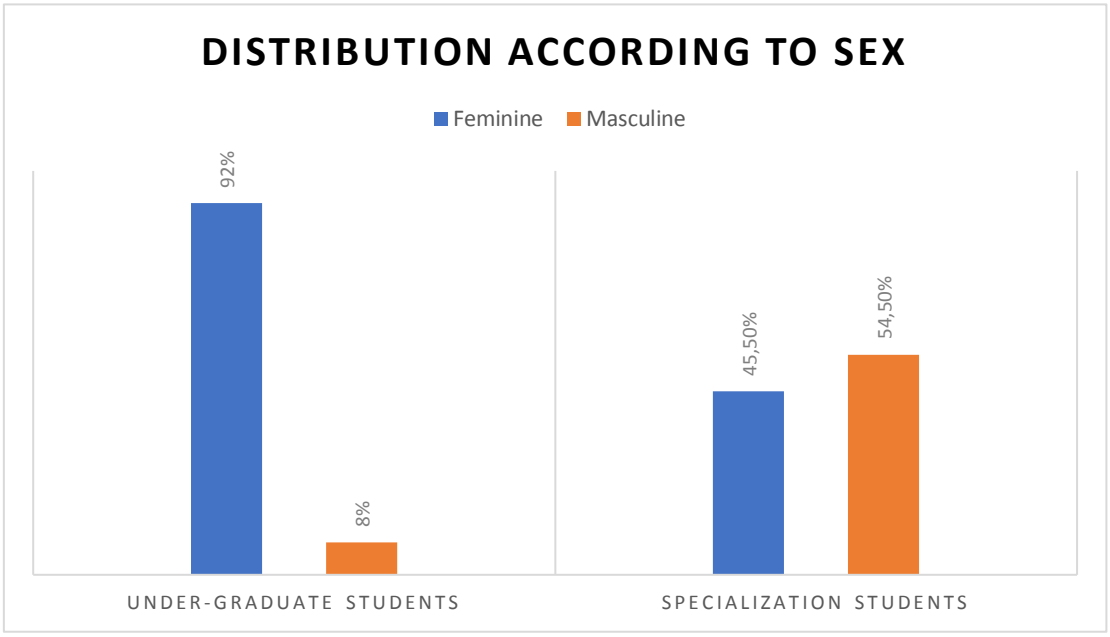


***Figure 1**- Distribution of both groups of students according to sex.*

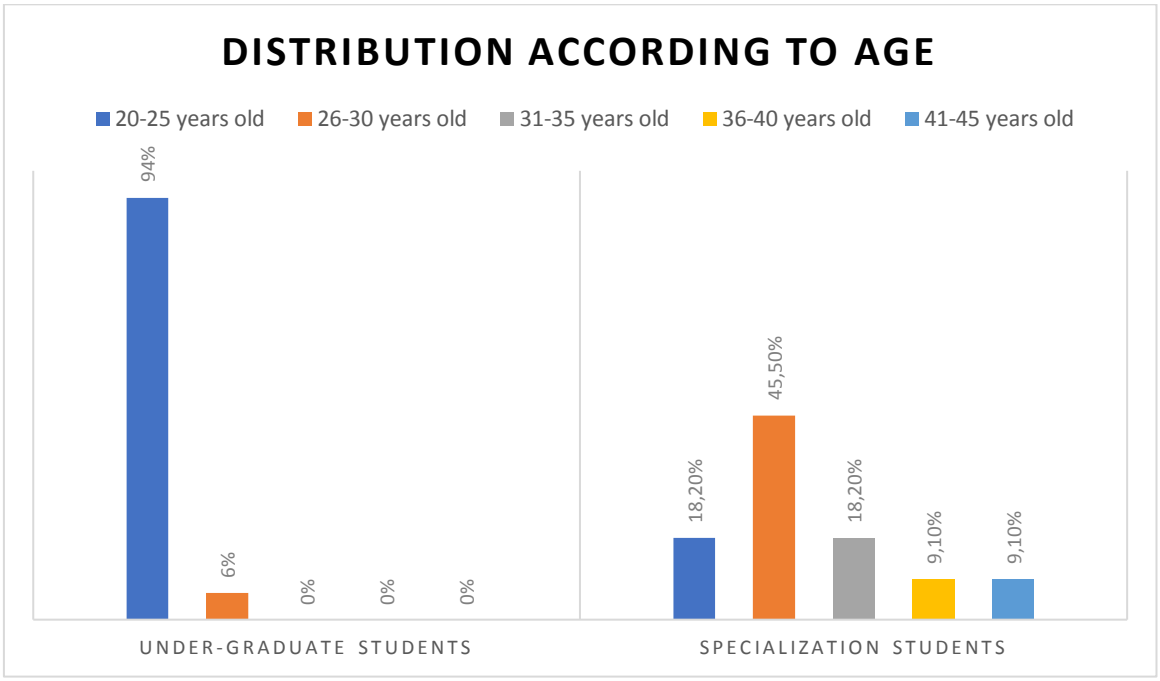


***Figure 2**- Distribution of both groups of students according to age.*

Regarding the constitution of the post-graduate sample, 2 students (18,2%), graduated in 2019, 6 students (54,5%) finished between 2012 and 2017 and 3 participants (27,3%) ended their studies before 2009, including. All of them are practicing clinicians in a private practice.

When it comes to the attendance of courses in the field of Cariology during the last five years, 56 students (91,8%), deny any participation, while 40 participants (65,6%) claim to have read an article related to minimum intervention in Cariology in the last five years. Within the two groups of students, 18,2% and 72,7% of post-graduates, and 6% and 64% of under-graduate students participated in a course and read an article related to cariology, respectively, in the last five years.

The responses to the three clinical cases presented, are described in Figures 3 and 4.

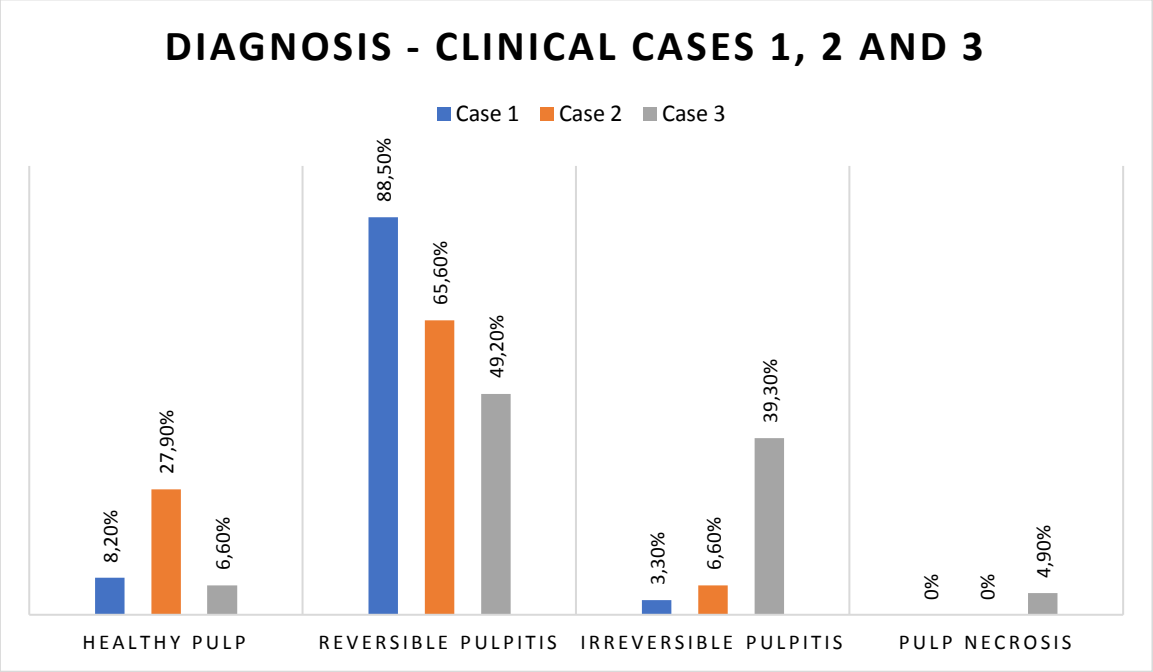


Figure 3 *- Proposed diagnosis by students for each clinical case.*

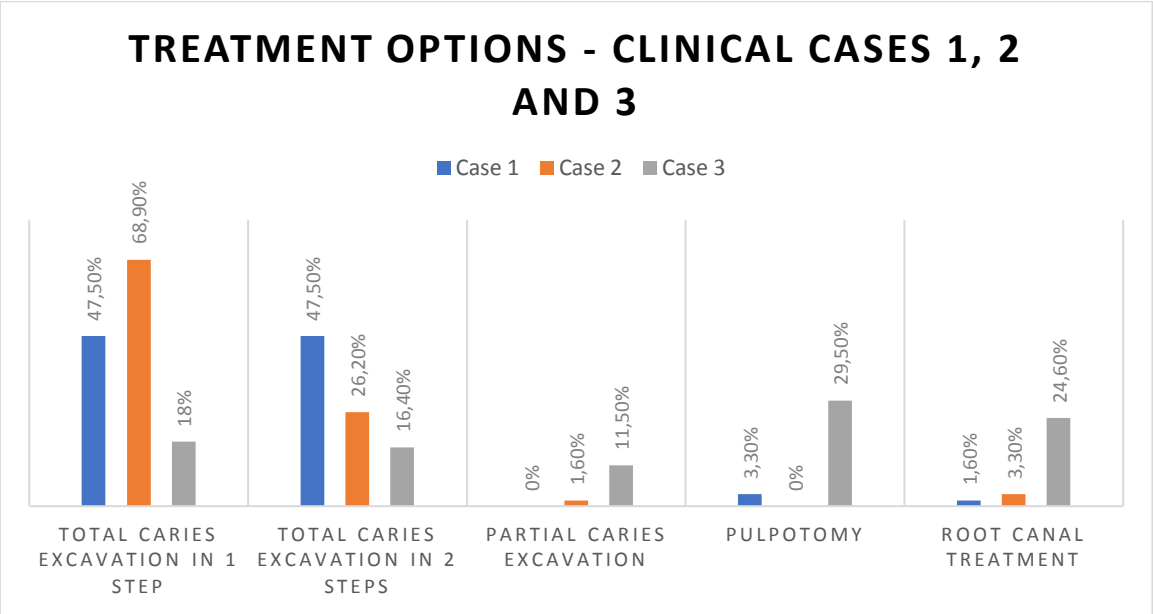


Figure 4 *-Proposed treatment options by students for each clinical case.*

Regarding Case 1, the most frequent answer for most likely diagnosis was reversible pulpitis (88,5%). When it comes to treatment option, students were mostly divided between non-selective caries removal (47,5%) and stepwise removal (47,5%). On Case 2, students mostly considered that the most likely diagnosis was a reversible pulpitis (65,6%), while 27,9% of students considered that the pulp was healthy. On the other hand, the main treatment option selected by students was non-selective caries removal (68,9%), while stepwise excavation comprised 26,2% of responses. Finally, Case 3 showed variant responses when it comes to most likely diagnosis, with 49,2% of students considering that the diagnosis was a reversible pulpitis, while 39,3% answered irreversible pulpitis. The responses to the most adequate treatment options were also varied, with 29,5% of students choosing Pulpotomy and 24,6% Root Canal Treatment. On the other hand, only 18% of students chose a non-selective removal, 16,4% a stepwise removal and 11,5% selective caries removal.

To the question exposing a female 20-year-old patient with an asymptomatic deep carious lesion, 49,2% of students chose a non-selective removal and, if there is a small pulp exposure, perform a direct pulp cap, while 42,6% of responses were: perform a caries removal in 2 steps; if there is a risk of pulpal exposure, leave some carious dentin close to the pulp and finish the caries removal weeks or months later. Students who chose this last option mostly considered that the second appointment should be performed after 2 weeks to 3 months (80,8%) and the majority of them chose a glass ionomer as a filling material between consultations (65,4%). Only 3,3% of students chose a partial excavation and, if there is risk of exposure, leave some carious dentin behind and restore definitively.

These results can be seen on Figure 5.

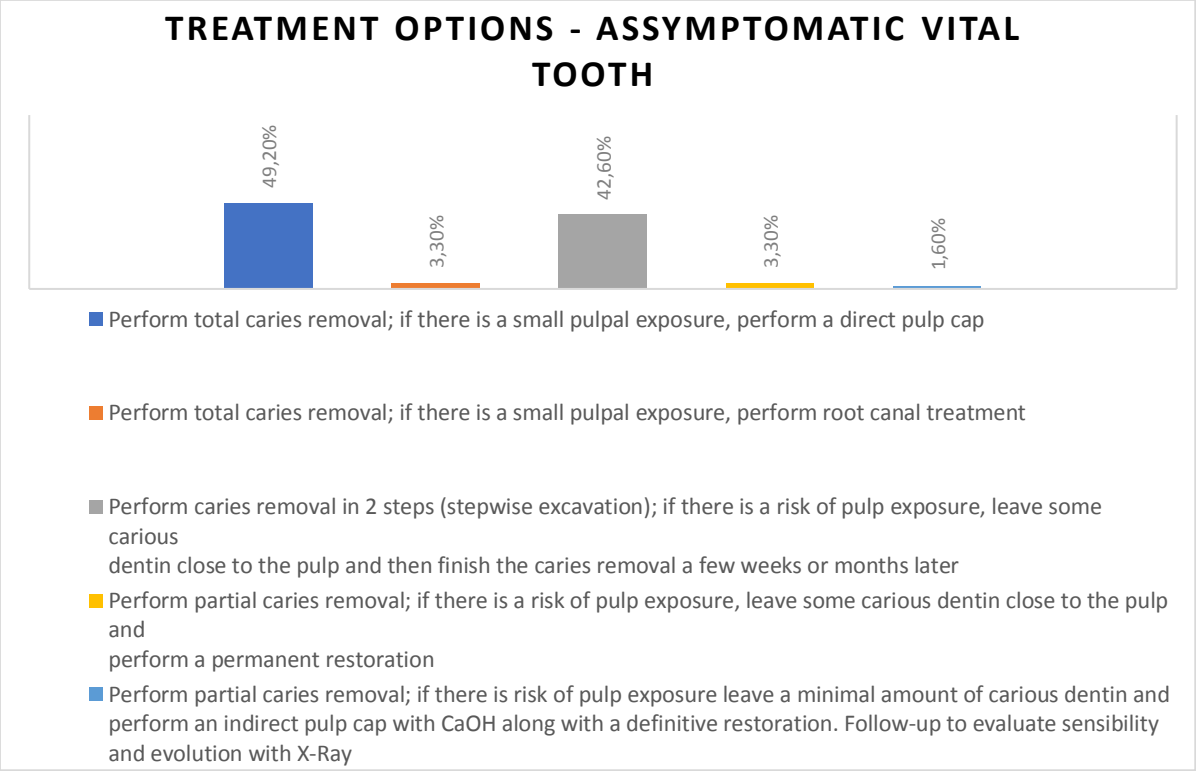


Figure 5 *- Treatment options selected by participants for the case of an asymptomatic vital tooth with a deep carious lesion.*

Regarding the factors that influence student's choices during treatment, 82% of students chose good clinical results, while the patient related factors primarily chosen were: patient's oral health (85,2%) and patient's age (68,9%).

In order to assess student's knowledge and the rationale for their treatment options, four assessments were presented, and participants were required to rate them on a scale from strongly disagree to strongly agree. The responses to these statements are represented on Table I.

Table I *- Students' degree of acceptance to different statements regarding the knowledge and attitudes on the management of deep carious lesions (n(%))*

Statement	Strongly Disagree	Disagree	No Opinion	Agree	Strongly Agree
A. Cariogenic microorganisms must be removed or the carious lesion will progress under a restoration	3 (4,9%)	12 (19,7%)	4 (6,6%)	28 (45,9%)	14 (23,0%)
B. A certain amount of microorganisms can be left under the restoration because the carious lesion will not progress if it is sealed	5 (8,2%)	25 (41,0%)	14 (23,0%)	15 (24,6%)	2 (3,3%)
C. The carious lesion must be removed completely because it presents a danger to the vitality of the pulp.	6 (9,8%)	23 (37,7%)	7 (11,5%)	20 (32,8%)	5 (8,2%)
D. In the case of a deep carious lesion, dental tissue close to pulp must be preserved to avoid any pulp exposure	2 (3,3%)	13 (21,3%)	20 (32,8%)	23 (37,7%)	3 (4,9%)

Answers for methods about routinely caries tissue removal approaches are shown in Table II.

Table II *- Routine approaches to removal of carious dentin when close to the pulp (n(%))*

Methods for carious dentine removal near the pulp	
Hand excavator	59 (96.7%)
Bur	2 (3.2%)
Other	0

Answers about treatment decisions and routine approaches in the management of DCLs are shown in Table III and IV.

Table III *- Treatment decisions in the management of deep carious lesions (DCLs)(n(%))*

Treatment decision	
Pulpal exposure during DCLs excavation in asymptomatic patient	
Direct pulp capping	39 (63.9%)
Pulpotomy	12 (19.7%)
Root canal treatment	10 (16.4%)
Pulpal exposure during DCLs excavation in symptomatic patient	
Direct pulp capping	13 (21.3%)
Pulpotomy	29 (47.5%)
Root canal treatment	19 (31.1%)
Liner or base materials used for different indications	
Materials used for direct pulp capping	
Calcium hydroxide	45 (73.8%)
MTA	16 (26.2%)
None	0
Materials used for indirect pulp capping	
Calcium hydroxide	46 (75.4%)
MTA	12 (19,7%)
None	3 (4,9%)

Table IV *- Routine approaches in the management of DCLs (n(%))*

Routine approaches	Yes	No
Use of rubber dam	13 (21,3%)	48 (78,7%)
Follow-up after treatment	40 (65,6%)	21 (34,4%)

When it comes to the clinical cases presented, only two showed significant statistical differences between the undergraduate and the specialization students, namely when asked about an asymptomatic vital tooth with a deep carious lesion (Question 13) and about the approach on a symptomatic patient with a pulp exposure (Question 21). The responses to these clinical cases, according to each group of students can be found on Figures 6 and 7.

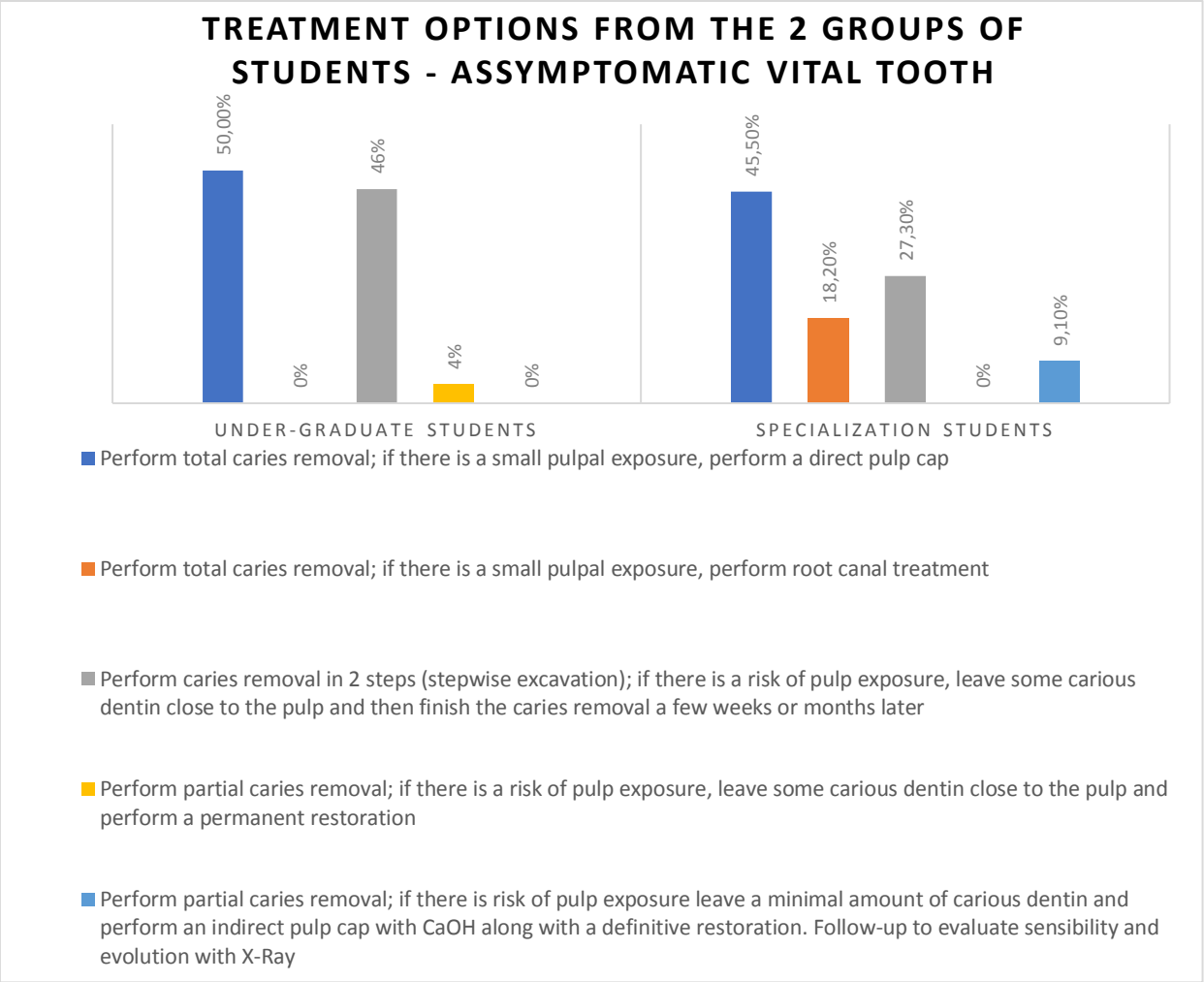


Figure 6 *- Treatment options selected by the two groups of students regarding an asymptomatic vital tooth with a DCL.*

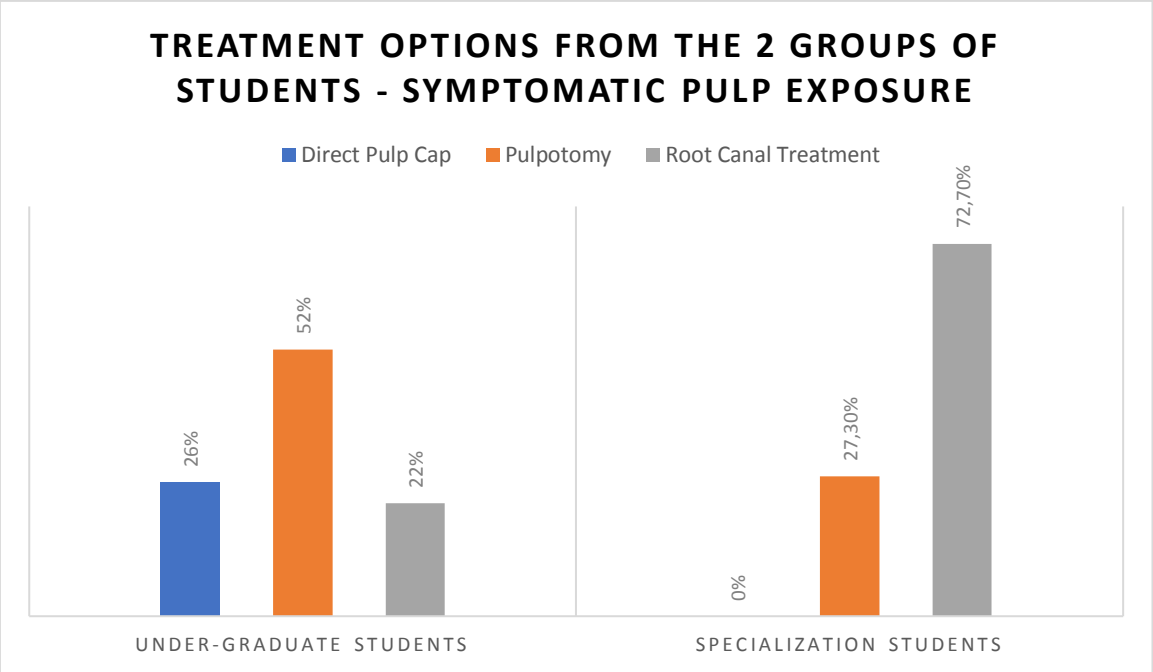


***Figure 7**- Treatment options selected by both groups of students regarding a symptomatic patient with a pulp exposure.*

Discussion

Since the diagnosis and treatment of these types of caries is controversial, it is important, before analyzing the results, to have a general idea on the current terminology and recommendations on the diagnosis and treatment of deep carious lesions, as well as opposing stances on these guidelines.

When it comes to diagnosis, there have been different approaches throughout time so, consensus hasn´t existed regarding this important stage towards the treatment of deep carious lesions. Therefore, the European Society of Endodontology (ESE) has concluded that a multi-factor diagnosis should be conducted. In other words, clinicians should rely both on radiographic evidence, namely the depth of the carious lesion, as well as symptomatology, sensitivity test results and other clinical aspects such as pain history, color of dentin and sleep disturbance.(7)

Currently, the classification of reversible and irreversible pulpitis is still accepted and supported by important agencies in the field of Endodontics, such as the American Association of Endodontics (AAE) and the ESE. According to these entities a reversible pulpitis is characterized by an absence of symptoms or short-lasting and low-intensity pain, whereas an irreversible pulpitis is usually characterized by spontaneous, sharp pain that doesn´t automatically disappear with the removal of the stimulus. However, the most recent guidelines point out the importance of clinical judgement when it comes to this nomenclature, since it has been assessed that the irreversible pulpitis diagnosis may also be associated to symptomless patients and may not represent the state of the pulpal complex in its totality. (6, 7) This notion has been supported by histopathological and histobacteriological findings, which show that apical tissues are usually bacteria-free zones in teeth with a deep carious lesion. (6)

Besides that, the tools beforementioned have their limitations, namely in their capacity to determine where is the stopping point of the inflammation within the pulp, as well as in their ability to measure the repair and healing capacity of the tooth, despite the damage that the pulp has already suffered. (10)

Once the diagnosis is established, it is necessary to begin treatment. There are many types of carious-tissue removal techniques, however the widely accepted consensus, in face of a reversible pulpitis, is to perform either a selective carious-tissue removal or a stepwise excavation. The first one consists in the removal of caries until there is a layer of either firm or soft tissue in the bottom of the cavity followed by the permanent restoration of the tooth, while the last resides in the removal of carious tissue until soft dentin is reached, enabling the placement of a biomaterial which will be left in the tooth for 6-12 months. Once this period is reached, the cavity is accessed once again, and a second removal of carious tissue is performed until firm dentin is reached. (7, 11) It is important to point out that, when performing these techniques, the clinician must take into account that a dentin layer with less than 1mm is just as permeable to bacteria as a pulp exposure. (11)

Both these techniques should be performed alongside a non-selective removal in the periphery of the cavity, leaving carious dentin only in the deepest part of the cavity, closest to the pulp. This facilitates the bonding of the material used for the definitive restoration, which in turn hinders bacterial access to the cavity. (7)

Therefore, by performing these techniques, the intention is to reduce the risk of pulpal exposure (12-14), which is considered a negative prognostic factor in the tooth's vitality (4, 15), since it induces damage to primary odontoblasts. Even though in the case of the destruction of a primary odontoblast, odontoblast-like cells like neo-odontoblasts are able to differentiate into mineralized-secreting cells and form a mineralized layer of dentin, it is considered easier on the reparative dentinogenesis process to avoid the destruction of this primary odontoblast. The only way that is possible, is by avoiding the exposure of the pulp and, therefore, by performing a selective carious removal technique. (11)

It is here that an opposing train of thoughts rises in some authors, such as Domenico Ricucci et al. (6) These authors consider that the pulp is not capable of healing if bacteria is left in the surgical wound and, therefore, VPT's goal should be the elimination of all bacteria in order to block the inflammation development inherent to any wound healing process in the human body.

Like it was previously mentioned, a selective or stepwise excavation sits in the principle that a layer of carious dentin may be left on the prepared cavity and the restoration of the tooth blocks the nutrients supply to the bacteria. However, some studies show that anaerobic bacteria(16), that do not rely on sugars for their survival (6), are found in the deepest areas of carious dentin and can survive for up to 5 months after the cavities are permanently restored (17). Therefore, they may survive a conservative excavation procedure and, consequently, become a potential inflammation focus that may lead to a relapse of the carious lesion, as well as to the production of metabolic products that are associated to pain.(18)

Besides that, these authors also challenge the idea that a pulp exposure is a negative prognostic. In fact, they consider that, in order for a treatment plan to be rightfully established, the deepest part of the dentin must be observed and analyzed, even if that implies a pulp exposure. Therefore, a non-selective removal of the carious lesion should be performed, which consists in the complete removal of carious tissue, until hard and sound dentin is reached.(7) According to certain characteristics that may or may not be detected during this analysis, a more accurate diagnosis can be established, as well as a more appropriate treatment plan.

According to these authors, (6) one of the mistakes performed during VPT procedures is the automatic assumption that once an exposure is made, a direct pulp cap should be performed. This falls, once again, in the lack of observation of the tissues, since the appearance of the exposure and its surrounding tissues has been neglected and ignored as a parameter for indication of VPT. Thus, when a pulp exposure occurs, the clinician should switch to a non-selective removal of the carious dentin, according to the consensus (7), if they were following the general guidelines; or continue with this type of caries removal if they were following the more invasive guidelines, which the latter support. If there is sound dentin around the exposure with no displaced dentin chips and a red homogeneous bleeding with no signs of yellowish fluids or dark areas indicative of necrosis, that is controlled in 2-5 minutes or less using chlorohexidine (0,2-2%) or sodium hypochlorite (0,5-5%) followed with the application of a sterile cotton pellet, a direct pulp cap can be performed. Nevertheless, it is important to point out that a direct pulp cap is not a simple procedure and requires, not only an aseptic technique with rubber dam and magnification to ensure that all carious dentin is removed and that the pulpal tissues are sound, but also experience from the operator in order to make a conscious decision on whether or not the direct pulp cap is the appropriate treatment to be undergone. (6)

If those conditions are not met and a dark or pale avascular pulp tissue along with soft dentin is detected, it may be more beneficial to perform a partial pulpotomy. Nonetheless, if the tooth shows signs of an irreversible pulpitis, a full pulpotomy or a pulpectomy are the indicated treatments when pulp is exposed. The pulpotomy should be performed when only the pulp chamber is pathological and the bleeding can be controlled within 2-5 minutes, while the pulpectomy should only be chosen when bleeding cannot be stopped.

A strict protocol of tooth disinfection, rubber dam placement and use of sterile instruments, is recommended by all authors, being emphasized that if a pulp exposure is performed without these cautions in place, a pulpectomy automatically becomes the chosen treatment. (5, 6, 11)

Besides that, the use of magnification is also pointed out by both points of view, as an important component for success, since these procedures are considered very demanding.(6, 11)

One final recommendation that can be found in both approaches to deep carious lesions is the use of an excavator when the deepest part of the dentin is reached. (6, 11)

Regarding biomaterials, one should be used to enhance and stimulate the healing of the tissues, as they promote the release of growth factors by dentin. (11) If there is no exposure a glass ionomer or a hydraulic calcium silicate cement may be used in the deepest part of the cavity. If there is pulp exposure, a hydraulic calcium silicate cement is considered the most adequate material, namely mineral trioxide aggregate (MTA) which has shown a better performance when compared to calcium hydroxide ($Ca(OH)^2$). (7, 19)

One other factor important in the prognosis of VPT is how the exposure occurred. A traumatic exposure is more likely to be successful than an exposure by a carious process(7, 20), probably because of the presence of infected dentin and bacteria in deep carious lesions. (20)

Several studies have shown that success is possible when a non-selective removal and a consequent direct pulp cap are performed along with the appropriate guidelines, namely rubber dam placement and magnification.(6, 21, 22) This success is independent from parameters such as age of the patient, pulp bleeding perseverance and affected surfaces of the tooth.(21) It shows, however the importance of following the implemented protocol as well as how the operator's experience, as well as the use of hydraulic calcium silicate cements such as MTA, may explain the high success rates of recent studies, compared to previous studies that show the failure of classical cases of direct pulp cap.(4, 13, 14) Therefore, it is important to note whether the current guidelines are being influenced by these studies, since the failure of the direct pulp cap procedure is mentioned multiple times as a justification on why the exposure of the pulp should be avoided. Thus, the studies that represent that failure, may not be representative of the potential on a correctly performed non-selective removal and direct pulp cap.

In various countries, studies based on an accredited survey have been conducted and one of the conclusions that is mentioned several times is the fact that younger professionals are most likely to adopt a more conservative approach to these types of caries. (1, 8) Therefore, this present study aims to verify whether that conclusion applies to students in Portugal and if they are applying the recommendations from the ESE on their clinical practice.

When confronted with the first and second clinical cases, consisting of a deep carious lesion that responds to a cold stimulus that ceases once the same is removed, most students considered that both teeth had a reversible pulpitis. However, for the same diagnosis, treatment options varied

between a non-selective and a stepwise removal. Nonetheless, the non-selective removal was still the most selected option, particularly in Case 2. These results are corroborated with other studies conducted in Spain (2), Brazil (1) and United States of America (3), where the same trend towards a non-selective removal was detected.

On the other hand, in Case 3 where an extremely deep carious lesion is presented and, therefore, where one can expect an exposure to occur, students answers to the treatment option were varied with only 18% of students choosing a non-selective removal. The main answer was pulpotomy with 29,5% of answers and 24,6% of students chose to perform a root canal treatment, which, in light of the current guidelines, is considered an overtreatment of this type of caries. In Brazil, most participants still chose non-selective removal (53,7%), although a slight increase in conservative treatments was detected. In Spain non-selective removal was also the most selected treatment option, however 26,8% of responses were root canal treatment, while very few chose pulpotomy (2%). In the study ran in the USA, an overwhelming number of endodontists chose root canal treatment, general dentists were very closely divided between a non-selective approach and root canal treatment and the majority of pediatric dentists either chose a selective removal or root canal treatment. Therefore, contrary to the present study, pulpotomy had very low results in these studies.

In the case regarding an asymptomatic female patient with a deep carious lesion (Question 13), similar results were observed with 49,2% of students choosing to perform a non-selective removal followed by a direct pulp cap, in the case of a small pulp exposure. On the other hand, a significant number of students (42,6%) considered a stepwise excavation while only 4,9% chose a partial removal. A very similar sample distribution was found in the surveys conducted in Germany (8) and particularly in Spain. (2) Regarding this question, a significant statistical difference was found between the under-graduate and the specialization students. The latter ones had less homogeneous answers, dividing themselves between direct pulp cap, stepwise excavation and, with a response rate of 18,2%, root canal treatment. It is also interesting to point out that, no undergraduate students considered performing RCT in the case of a pulp exposure.

In general, when taking into consideration all of the cases presented, students from both groups seem to be more inclined towards a non-selective removal.

It is therefore interesting to point out that, when asked on whether cariogenic microorganisms must be removed to stop the progression of the lesion, most of the students either agreed (45,9%) or strongly agreed (23%), which is in line with their main treatment choice. However, when asked if the carious lesion must be removed completely because it presents a danger to the vitality of the pulp only 37,7% of students disagreed while 11,5% did not have an opinion. Finally, regarding on whether dental tissue close to pulp must be preserved to avoid any pulp exposure, most students agreed with 37,7% of responses, 32,8% did not have an opinion and only 24,6% either disagreed or strongly disagreed. This seems indicative of some contradiction and confusion within students' ideas on deep carious lesions.

Concerning the question on students' approach towards a symptomatic exposure, contrary to what would be expected, given the previous responses, almost half chose to perform a pulpotomy (47,5%) whilst the rest were divided between root canal treatment (31,1%) and direct pulp capping (21,3%). Well, given that most students (78,7%) do not routinely use rubber dam when treating these types of caries, it is to be expected a low success rate for these treatments. It is also interesting

to note that the only difference between this question and the same but without symptoms, is the higher prevalence of direct pulp capping (63,9%).

Once again, a significantly statistical difference was found between the two groups of students when questioned on their approach to a symptomatic exposure. Following the less conservative trend, previously detected on question 13, specialization students tend, once again, to go for more conventional treatments, with 72,7% of them choosing RCT, while only 22% of undergraduates opted for this treatment. One could probably speculate that the clinical experience made them more cautious against VPT.

In regard to materials used for direct and indirect pulp cap, calcium hydroxide was the main choice with a response rate of 73,8% and 75,4%, respectively. Therefore, hydraulic calcium silicate cements don't seem to be widely spread in its use within both group of students, consisting of only 26,2% of responses for direct pulp capping and 19,7% for indirect pulp capping.

Finally, when it came to factors influencing treatment choice, students mainly chose good clinical results (82%), while patient's oral health (85,2%) and age (68,9%) were the main patient-related factors selected, similarly to the results from other studies. (1-3)

In conclusion, students are not applying the consensus recommendations and seem to be confused on when and how to apply the different types of vital pulp therapy procedures available. Therefore, there is a risk that overtreatment may still be occurring.

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Appendix 1

Questionnaire

Thank you very much for taking the time to respond to this the survey about diagnostic and treatment strategies when you encounter a patient with deep carious lesion. This survey is completely anonymous and only takes about 6-8 minutes of your time. Fill in the selected circle or mark it with an X and respond to the short questions asked.

Study Explanation

Title

"Student's assessment in the diagnosis and treatment of deep carious lesions"

Goals

The goal of this inquiry is to analyze the knowledge and treatment choices of 5th year Master Degree Dental Medicine students, as well as of the Specialization students, both from FMDUP.

Methods

Participants: 5th year Master Degree Dental Medicine students and Specialization students from FMDUP.

Instruments: Elaboration of a questionnaire to be available online.

Procedure: The participation in this study will be voluntary, being the questionnaire focused on the evaluation of student's knowledge on diagnosis and treatment of deep carious lesions.

Benefits

The participation in the current study does not have any benefits associated to it.

Risks/Discomforts

The current study does not present any risk or discomfort besides the time spent in the filling of the form, being that the anonymity of the participants in the gathering and treatment of the data, is guaranteed.

Ethical Features

In order for this study to come to fruition, an opinion will be requested to the Ethical Committee of FMDUP.

Considering the bioethical rules in the current legislation, a total confidentiality will be assured during the collecting, treatment and storing of the data. Participants have the right to willingly decide whether to accept or reject the participation in this study, knowing that they may leave the same, at any time, without any penalizations or having to uptake any expenses for the participation in this study.

If you want to cooperate with this study, please proceed with its filling.

1. Are you male or female?
Male __
Female __

2. How old are you?
____

3. Have you finished your graduate degree in Dentistry? If your answer was yes, in which year did you conclude your studies? If your answer was no, which year are you on?
Yes ___
No ___
What year did you conclude your studies in Dentistry? ___
What year in your Dentistry degree are you on? ___

4. Have you studied Dentistry in another University or College? If so, please specify.
Yes __
No __
Specify _____

5. Do you have any additional degree/s? If so, please specify.
Yes__
No__
Specify_____

6. In which of the following settings do you work? (Select all that apply)
Private practice __
Public Health Dentistry __
Salaried activity, specify below __
Academic, specify department below __
Other, specify below __
I do not have a clinical practice as a dentist __
Specify _____

7. How many years have you been practicing Dentistry?
Specify ___
I do not have clinical practice as a Dentist __

8. During the past 5 years have you attended any continuing education courses in the field of Cariology?
Yes__
No__

9. During the past 5 years have you read any articles about Minimum Intervention (e.g., caries removal) in Cariology?
Yes__
No __

10. **a.** Based on Case 1, what is the most likely diagnosis?
Healthy pulp __
Reversible pulpitis __
Irreversible pulpitis __
Pulp necrosis __

b. Based on Case 1, what would be your indicated treatment:
Total caries excavation in 1 step __
Total caries excavation in 2 steps __
Partial caries excavation __
Pulpotomy__
Root canal treatment __

11. **a.** Based on Case 2, what is the most likely diagnosis?
Healthy pulp __
Reversible pulpitis __
Irreversible pulpitis __
Pulp Necrosis __

b. Based on Case 2, what would be your indicated treatment:
Total caries excavation in 1 step __
Total caries excavation in 2 steps __
Partial caries excavation __
Pulpotomy __
Root canal treatment __

12. **a.** Based on Case 3, what is the most likely diagnosis?
Healthy pulp __
Reversible pulpitis __
Irreversible pulpitis __
Pulp necrosis __

b. Based on Case 3, what would be your indicated treatment?
Total caries excavation in 1 step __
Total caries excavation in 2 steps __
Partial caries excavation __
Pulpotomy __
Root canal treatment __

13. With reference to an asymptomatic vital tooth with a deep carious lesion on a 20-year-old female patient how would you proceed?
Perform total caries removal; if there is a small pulpal exposure, perform a direct pulp cap __
Perform total caries removal; if there is a small pulpal exposure, perform root canal treatment __
Perform caries removal in 2 steps (stepwise excavation); if there is a risk of pulp exposure, leave some carious dentin close to the pulp and then finish the caries removal a few weeks or months later __
Perform partial caries removal; if there is a risk of pulp exposure, leave some carious dentin close to the pulp and perform a permanent restoration __
Other, specify __

If your answer to question 13 is "Perform caries removal in 2 steps (stepwise excavation); if there is a risk of pulp exposure, leave some carious dentin close to the pulp and then finish the caries removal a few weeks or months later"

a. Then what time frame would you choose? Select one below:
2 weeks to 3 months __
After 3 to 6 months __
More than 6 months __

b. Then what filling material would you use between 2 appointments? Select one below:
Cavit __
Glass Inomer __
Amalgam filling __
Composite __
IRM __

14. What are the main reasons for choosing a particular treatment option for your patients with deep caries lesions? (Select all that apply)
Ease of use, familiarity with the technique __
Good clinical results __
Proven efficacy __
Recommended by colleague __
Recommended by clinical research __
Recommended in text books __
Profitability __
Other, please specify __

15. What are the main factors upon which you base your treatment choice? (Select all that apply)
Patient's general health __
Patient's age __
Patient's oral health __
Patient's attitude and preferences __
Type of tooth (Anterior, Premolar, Molar) __
Further restoration needs of the tooth __
Duration of the total treatment __
Other, please specify __

16. How do you rate the following statements?

	Strongly Disagree	Disagree	No opinion	Agree	Strongly Agree
A. Cariogenic microorganisms must be removed or the carious lesion will progress under a restoration					
B. A certain amount of microorganisms can be left under the restoration because the carious lesion will not progress if it is sealed					
C. The carious lesion must be removed completely because it presents a danger to the vitality of the pulp.					
D. In the case of a deep carious lesion, dental tissue close to pulp must be preserved to avoid any pulp exposure.					

17. How do you make sure you have made an adequate removal of carious dentin? Select all that apply.
Dentin's hardness __
Dentin's colour__
Dentin's moisture __
Using caries indicator __

18. How do you remove carious dentin when near the pulp?
Excavator __
Bur __
Other (specify) ____

19. Which material do you use in the following procedures:

a) Direct Pulp Capping
Calcium Hydroxide __
Calcium-Silicate based cements (MTA) __
None __

b) Indirect Pulp Capping
Calcium Hydroxide __
Calcium-Silicate based cements (MTA) __
None __

20. How do you proceed when a patient has no symptoms and pulp is exposed?
Direct Pulp Capping __
Pulpotomy __
Endodontic therapy __

21. How do you proceed when a patient has symptoms and pulp is exposed?
Direct Pulp Capping __
Pulpotomy __
Endodontic therapy __

22. Do you routinely use rubber dam, when treating deep carious lesions?
Yes __
No __

23. Do you have routine follow – ups after treatment of deep carious lesions?
Yes __
No __

Appendix 2

Overview of the information included for the 3 clinical cases provided

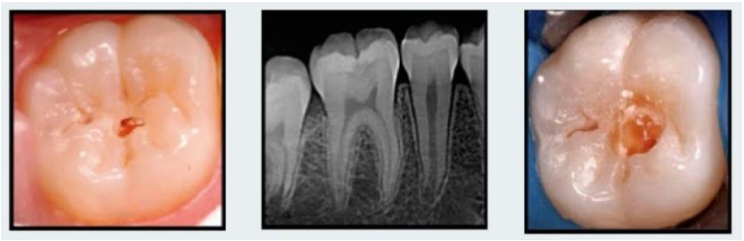
CASE 1



Occlusal view; Periapical radiography; View after opening the lesion

Age	25-year-old female student.
General History	No clinically significant medical history, no known allergies, oral contraception for 6 years.
Dental History	Extraction of the mandibular left first molar 3 years ago.
Oral Hygiene	Brushing teeth twice daily with fluoride toothpaste, no mouthwash, no dental floss.
Reason for Consultation	Sensitivity on maxillary right molar (pain while chewing and sensitivity to cold).
Clinical and Radiographic Examination	Deep carious lesion reaching the inner one-half of dentin. Soft, yellowing carious tissue in the center of the lesion, caries dentin moist and yellowish. Positive thermal test of pulpal sensitivity (painful response to stimuli was not prolonged after the test), negative vertical percussion test. No apical image on the periapical radiograph.

CASE 2



Occlusal view; Periapical radiography; View after opening the lesion

Age	11-year-old female student.
General History	No clinically significant medical history, no known allergies.
Dental History	The patient lived with her mother and her 5 older brothers and sisters, who benefitted from insurance; the patient had never been to the dentist before.
Oral Hygiene	Brushing teeth twice daily with fluoride toothpaste, no mouthwash, no dental floss.
Reason for Consultation	Examination in relation to a little sensitivity to cold on the mandibular right first molar.
Clinical and Radiographic Examination	Deep carious lesion reaching the inner one-half of dentin with opaque sides, which suggested an active lesion. Soft carious tissue in the center of the lesion, caries dentin moist and yellowish. Positive thermal test of pulpal sensitivity (painful response to stimuli was not prolonged after the test); negative vertical percussion test. No apical image on the periapical radiograph.

CASE 3



Occlusal view; Periapical radiography; View after opening the lesion

Age	14-year-old male high school student.
General History	No clinically significant medical history, no known allergies.
Dental History	Extraction of supernumerary tooth 1 year ago.
Oral Hygiene	Brushing teeth 4 times a day with fluoride toothpaste, no mouthwash, no dental floss.
Reason for Consultation	Pain while chewing and sensitivity to sugar on mandibular right first molar.
Clinical and Radiographic Examination	Deep carious lesion reaching the internal one-half of dentin. Soft caries tissue in the center of the lesion, caries dentin moist and dark brown. Positive thermal test of pulpal sensitivity (painful response to stimuli was not prolonged after the test); negative vertical percussion test. No apical image on the radiograph.

Appendix 3

Parecer do Orientador



Parecer do Orientador

Eu, Irene Graça Azevedo Pina Vaz, Professora Associada com Agregação da Faculdade de Medicina Dentária da Universidade do Porto (FMDUP), declaro que o Trabalho da Monografia desenvolvido pela estudante Rita Osório, do 5º ano do Curso de Mestrado Integrado em Medicina Dentária da FMDUP, subordinada ao tema "Student's assessment in the diagnosis and treatment of deep carious lesions", se encontra e está de acordo com as regras estipuladas pela FMDUP.

Mais informo que o referido trabalho foi por mim conferido e se encontra em condições de ser apresentado e defendido em provas públicas.

Porto, 20 de maio de 2020.

Irene Pina Vaz

(Irene Graça Azevedo Pina Vaz)

Declaração de Autoria de Trabalho



Declaração de Autoria de Trabalho

MONOGRAFIA DE INVESTIGAÇÃO/RELATÓRIO DE ATIVIDADE CLÍNICA

Declaro que o presente trabalho, no âmbito da Monografia de Investigação/Relatório de Atividade Clínica, integrado no Curso de Mestrado Integrado em Medicina Dentária da Faculdade de Medicina Dentária da Universidade do Porto, é da minha autoria e todas as fontes foram devidamente referenciadas.

Porto, 20 de maio de 2020.

Rita Osório

(Rita Osório)

Parecer Comissão Ética da Faculdade de Medicina Dentária da Universidade do Porto

U.PORTO
FACULDADE DE MEDICINA DENTÁRIA
UNIVERSIDADE DO PORTO

Exmª Senhora
Rita Osório de Moura e Silva
Faculdade de Medicina Dentária da U. Porto

000035 02 MAR 2020

Assunto: Parecer relativamente ao Projeto de Investigação nº 40/2019.
(Student's assessment in the diagnosis and treatment of deep carious lesions).

Informo V. Exa. que o projeto supracitado foi analisado na reunião da Comissão de Ética para a Saúde, da FMDUP, no dia 14 de fevereiro de 2020.

A Comissão de Ética é **favorável** à realização do projeto tal como apresentado.

O formulário definitivo de apresentação do trabalho, aprovado e carimbado pela Comissão de Ética para a Saúde, da FMDUP, acompanha a presente comunicação.

A Comissão de Ética recomenda a existência de um seguro de responsabilidade civil e relembra que a inexistência de seguro responsabiliza diretamente os investigadores.

Subject: Recommendation on the research project nº 40/2019.
(Student's assessment in the diagnosis and treatment of deep carious lesions).

I hereby inform that the aforementioned project was analyzed on the 14th day of february, 2020, by the Ethics Committee for Health of the Faculty of Dental Medicine,

The Ethics Committee is **favourable** to the project execution.

The final submission form approved and stamped by FMDUP's Ethics Committee for Health is attached.

The Ethics Committee recommends the existence of liability insurance and recalls that the absence of insurance directly holds researchers accountable.

Com os melhores cumprimentos,

A Presidente da Comissão de Ética para a Saúde, da FMDUP

Inês Alexandra Caldas

Prof. Doutora Inês Alexandra Costa Morais Caldas

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Parecer do Serviço de Proteção de Dados da Universidade do Porto – Vice-Reitor

U.PORTO	Reitoria da Universidade do Porto	DATA: 14/02/2020

Nome	Rita Osório de Moura e Silva
Nº Mecanográfico	201406089
Unidade Orgânica	Faculdade de Medicina Dentária da Universidade do Porto (FMDUP)
Título	"Student's assessment in the diagnosis and treatment of deep carious lesions"
Ticket Nº	2019121115000733

Sumário do Pedido

No âmbito da unidade curricular de "Monografia de Investigação ou Relatório de Atividade Clínica", integrada no plano de estudos do Mestrado Integrado em Medicina Dentária (MIMD) da FMDUP, pretende a requerente levar a cabo um estudo destinado a analisar os conhecimentos e as escolhas de tratamento, por parte de estudantes, no que diz respeito a lesões de cárie profundas. Os participantes no estudo serão recrutados de entre os estudantes inscritos neste ano letivo de 2019/2020, quer no 5º ano do MIMD, quer nos vários cursos de Especialização da FMDUP.

Os dados serão recolhidos através de um questionário online, implementado em português e em inglês, que os referidos estudantes serão convidados a preencher.

Para além das questões relacionadas com diagnóstico e terapêutica de cáries profundas, serão também solicitados os seguintes dados de cada participante: sexo; idade; se já terminou o MIMD, em que ano; se já estudou noutra Faculdade ou Universidade, em qual; se possui outro curso universitário, qual; se já trabalha como Médico Dentista, em que contexto e há quantos anos; e ainda se, nos últimos 5 anos, recebeu alguma formação específica em Cariologia ou leu algum artigo sobre Intervenção Minimalista. O objetivo será o de tentar correlacionar as respostas às questões de diagnóstico e terapêutica, com alguns destes dados, incluindo com o conhecimento clínico e com a experiência clínica dos participantes.

Síntese do parecer da Encarregada da Proteção de Dados

Analisada a documentação submetida pela requerente, somos do parecer que os riscos para os Direitos, Liberdades e Garantias dos potenciais participantes no estudo se revelam baixos, razão pela qual poderá ser realizado o tratamento de dados *supra*, uma vez cumpridas as diretivas enumeradas no parecer R-3/2020.

Decisão Reitoral

Uma vez analisado o pedido em questão e tendo em consideração o parecer da Encarregada da Proteção de Dados da Universidade do Porto, com a referência R-3/2020.

☒ Autorizo

☐ Não Autorizo

O Vice-Reitor

Assinado por : **FERNANDO MANUEL AUGUSTO DA SILVA**
Num. de Identificação Civil: BI078178290
Data: 2020.03.24 22:52:30 +0000

CARTÃO DE CIDADÃO

Fernando Manuel Augusto da Silva*

* Com delegação de competências do Reitor, Despacho n.º 1861/2020, publicado no *DR*, 2ª série, nº 27 de 7 de fevereiro.

Parecer do Serviço de Proteção de Dados da Universidade do Porto – Encarregada da Proteção de Dados da Universidade do Porto

U.PORTO	Unidade de Proteção de Dados	DATA:14/02/2020

PARECER R-3/2020

Nome	Rita Osório de Moura e Silva
N.º Mecanográfico	201406089
Unidade Orgânica	Faculdade de Medicina Dentária da Universidade do Porto (FMDUP)
Título	"Student's assessment in the diagnosis and treatment of deep carious lesions"
Ticket N.º	2019121115000733

Sumário do Pedido

No âmbito da unidade curricular de "Monografia de Investigação ou Relatório de Atividade Clínica", integrada no plano de estudos do Mestrado Integrado em Medicina Dentária (MIMD) da FMDUP, pretende a requerente levar a cabo um estudo destinado a analisar os conhecimentos e as escolhas de tratamento, por parte de estudantes, no que diz respeito a lesões de cárie profundas. Os participantes no estudo serão recrutados de entre os estudantes inscritos neste ano letivo de 2019/2020, quer no 5º ano do MIMD, quer nos vários cursos de Especialização da FMDUP.

Os dados serão recolhidos através de um questionário online, implementado em português e em inglês, que os referidos estudantes serão convidados a preencher.

Para além das questões relacionadas com diagnóstico e terapêutica de cáries profundas, serão também solicitados os seguintes dados de cada participante: sexo; idade; se já terminou o MIMD, em que ano; se já estudou noutra Faculdade ou Universidade, em qual; se possui outro curso universitário, qual; se já trabalha como Médico Dentista, em que contexto e há quantos anos; e ainda se, nos últimos 5 anos, recebeu alguma formação específica em Cariologia ou leu algum artigo sobre Intervenção Minimalista. O objetivo será o de tentar correlacionar as respostas às questões de diagnóstico e terapêutica, com alguns destes dados, incluindo com o conhecimento clínico e com a experiência clínica dos participantes.

Conclusões

Apesar de não ser solicitado qualquer identificador direto dos participantes, consideramos que, do cruzamento de todos os dados recolhidos, e tendo em conta que se trata de um universo de respondentes relativamente limitado e conhecido (conjunto de estudantes inscritos em 2019/2020, no 5º ano do MIMD ou num curso de especialização da FMDUP), poderá ser relativamente fácil chegar à identidade daqueles, pelo que concluímos estar perante um tratamento de dados pessoais.

Por outro lado, considerando que:

(1) Os dados serão fornecidos voluntariamente pelos estudantes que aceitarem participar no estudo, após terem acesso à descrição do mesmo, o que corresponde à prestação de um consentimento livre, informado, específico e explícito, traduzido no próprio ato de prosseguir com o preenchimento do questionário online;
(2) Tais dados serão utilizados apenas para o estudo acima referido, serão armazenados e trabalhados no computador do serviço de Endodontia da FMDUP, que é de acesso limitado, e serão eliminados assim que deixem de ser necessários (data estimada de eliminação – junho de 2020);
(3) O conjunto de dados fornecidos não inclui categorias especiais de dados, na aceção do artigo 9.º/1 do Regulamento Geral sobre a Proteção de Dados,

somos do parecer que os riscos para os direitos, liberdades e garantias dos potenciais participantes no estudo se revelam baixos, pelo que o tratamento de dados solicitado poderá ser realizado, contanto se observem as seguintes recomendações:

(1) Implementar o questionário na plataforma interna inqueritos.up.pt ou, pelo menos, através de uma conta institucional da Google For Education;

(2) Avaliar a possibilidade de supressão de alguns campos de resposta aberta (nomeadamente, qual a outra Faculdade ou Universidade em que estudou; qual o outro curso universitário que possui).

a Encarregada da Proteção de Dados
da Universidade do Porto

Susana Rodrigues Pereira

Doutora Susana Rodrigues Pereira

Cumprimento das diretivas da Universidade do Porto

U.PORTO
FACULDADE DE MEDICINA DENTÁRIA

INFORMAÇÃO

(Entrega do trabalho final de Monografia após cumprimento das diretivas emanadas pelo Serviço de Proteção de Dados da U.Porto)

Informo que, relativamente ao Trabalho de Monografia com o título: Student's assessment in the diagnosis and treatment of deep coronal lesions,

foram cumpridas todas as diretivas emanadas pelo Serviço de Proteção de Dados da U.Porto, encontrando-se em condições de ser apresentado em provas públicas.

17 / 05 / 2020

O(A) Estudante

(Nome em maiúsculas): RITA OSÓRIO DE MOURA E SILVA

(Assinatura): Rita Osório