

DECLARAÇÃO DE INTEGRIDADE

Eu, Inês Cabral Ferreira, estudante do Mestrado Integrado em Medicina Dentária do Instituto Universitário de Ciências da Saúde, declaro ter atuado com absoluta integridade na elaboração deste Relatório de Estágio intitulado: “Damage of resin composite and amalgam surfaces after exposure to bleaching agents”.

Confirmo que em todo o trabalho conducente à sua elaboração não recorri a qualquer forma de falsificação de resultados ou à prática de plágio (ato pelo qual um indivíduo, mesmo por omissão, assume a autoria do trabalho intelectual pertencente a outrem, na sua totalidade ou em partes dele).

Mais declaro que todas as frases que retirei de trabalhos anteriores pertencentes a outros autores foram referenciadas ou redigidas com novas palavras, tendo neste caso colocado a citação da fonte bibliográfica.

Relatório apresentado no Instituto Universitário de Ciências da Saúde

Orientador: Júlio César Matias de Souza

DECLARAÇÃO

Eu, Júlio César Matias de Souza com a categoria profissional de Professor Convidado do Instituto Universitário de Ciências da Saúde, tendo assumido o papel de Orientador do Relatório Final de Estágio intitulado, “Damage of resin composite and amalgam surfaces after exposure to bleaching agents” da Aluna do Mestrado Integrado em Medicina Dentária, Inês Cabral Ferreira, declaro que sou de parecer favorável para que o Relatório Final de Estágio possa ser presente ao Júri para Admissão a provas conducentes para obtenção do Grau de Mestre.

Gandra, 15 de maio de 2020

O orientador,

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Aos meus pais, por me terem proporcionado estes anos na universidade apoiando-me e acreditando sempre em mim.

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ESTRUTURA DO RELATÓRIO FINAL DE CURSO

O presente relatório de final de curso está dividido em 2 Capítulos. O primeiro Capítulo foi dedicado à preparação de uma revisão sistemática integrativa sobre o efeito de substâncias branqueadoras na alteração da superfície de resinas compostas e amalgama. Este trabalho de revisão foi escrito em língua Inglesa e na estrutura padrão para publicação em revista internacional indexada (*International Scientific Indexing- ISI*). A problemática deste trabalho está relacionada a diferentes protocolos e substâncias usadas (peróxido de hidrogénio e carbamida) para o tratamento branqueador que podem alterar a superfície de materiais restauradores compósitos e metálicos.

O segundo Capítulo corresponde ao estágio que faz parte do Mestrado Integrado em Medicina Dentária. Este é constituído por três componentes: Estágio de Clínica Geral Dentária, Estágio Hospitalar e Estágio de Saúde Oral Comunitária.

CHAPTER I: "Damage of resin composite and amalgam surfaces after exposure to bleaching agents"

RESUMO

O objetivo deste estudo foi realizar uma revisão sistemática integrativa sobre os danos nas superfícies de resinas compostas e amalgamas após exposição a agentes branqueadores compostos de peróxido de carbamida e de hidrogénio. Foi realizada uma pesquisa eletrônica na PUBMED usando os seguintes termos de busca: "Amalgam" OR "Resin composite" AND "Bleaching treatment" AND "Corrosion" OR "Erosion", "Roughness" OR "AFM" OR "Profilometry" OR "SEM".

A busca identificou 127 artigos, dos quais 32 foram considerados relevantes para este estudo. Os estudos avaliaram os danos das superfícies a partir de análises da rugosidade por profilometria e microscopia de força atômica (AFM) enquanto os aspetos morfológicos foram inspecionados por microscopia eletrônica de varrimento (SEM) e AFM. Os resultados revelaram um aumento significativo da rugosidade do amalgama em escala micrométrica após contacto com os agentes branqueadores. Já, a rugosidade das resinas compostas foi alterada em menor escala e dependeu do teor de matriz orgânica dos materiais testados e tempo de exposição aos agentes branqueadores. Alterações morfológicas das superfícies de amalgama foram evidenciadas por SEM e AFM. Como consequência das alterações morfológicas, foram iões de Hg, Ag, Cu detetados após contato do amalgama com agentes branqueadores que podem apresentar toxicidade local e sistêmica. Os produtos da degradação da matriz orgânica das resinas compostas são à base de monómeros metacrilatos que também podem apresentar caráter tóxico para as células e tecidos circundantes.

Os estudos prévios apresentaram evidências da degradação de superfícies de amalgama e resina composta após contacto com agentes branqueadores. A degradação é mais severa para amalgama e a consequente libertação de iões pode danos aos pacientes como respostas biológicas adversas locais e sistêmicas.

Damage of resin composite and amalgam surfaces after exposure to bleaching agents

Palavras-chave: “Amalgama”, “Resina composta”, “Tratamento branqueador”, “Corrosão”, “Erosão”, “Rugosidade”, “AFM”, “Profilometria”, “SEM”.

ABSTRACT

The aim of this study was to perform an integrative systematic review on the damage of resin composite and amalgam surfaces after exposure to bleaching agents composed of hydrogen or urea (carbamide) peroxide. An electronic search on PUBMED was carried out using the following selected terms: "Amalgam" OR "Resin composite" AND "Bleaching treatment" AND "Corrosion" OR "Erosion", "Roughness" OR "AFM" OR "Profilometry" OR "SEM".

The search identified 127 articles, of which 32 were considered relevant to this study. The results revealed a significant increase in roughness values of the amalgam within a micro-scale damage after contact with the bleaching agents. The roughness of the resin-matrix composites was altered at a lesser extent that was dependent on their organic matrix content and time of exposure to the bleaching agents. As a consequence of the morphological changes, a release of Hg, Ag, Cu ions was measured after contact of the amalgam with bleaching agents that can promote local and systemic toxicity. The degradation products of the organic matrix of the resin composites consisted in methacrylate monomers which can also be toxic to the surrounding cells and tissues.

The findings showed evidences of the degradation of amalgam and resin-matrix composite surfaces after contact with bleaching agents. Degradation was severe for amalgam and the consequent release of ions can induce local and systemic adverse biological response to the patients.

Keywords: "Amalgam", "Resin composite", "Bleaching treatment", "Corrosion", "Erosion", "Roughness", "AFM", "Profilometry", "SEM".

1. INTRODUCTION

In the last twenty years, the use of amalgam has declined for dental restoration, but amalgam is still used in some countries. Recently, amalgam has been forbidden due to the release of metal ions such as copper (Cu), silver (Ag) and mercury (Hg) (1,2). The release of metal ions occurs since the amalgam handling until surface polishing or removal for placement of alternative materials. In the oral cavity, the acidic environment also speeds up the corrosion of amalgam and release of metal ions. Additionally, the main reason in the decrease of number of amalgam restoration was the improvement of resin-matrix composites regarding the physical properties. However, the polymeric organic matrix of resin composite restorations are also susceptible to damage concerning acidic substances in the oral cavity or therapeutic substances such as found in bleaching agents (3–6).

Bleaching treatment of teeth can be divided into at-home (7–9) and in-office (7,10,11) procedures. The main bleaching agents that are used are hydrogen peroxide (10,12,13) and urea peroxide, also known as carbamide peroxide (7,14,15). The concentration of bleaching agent varies depending on the type of bleaching that will be performed. For instance, at-home bleaching uses lower concentrations while the concentration of bleaching agents are higher at in-office bleaching treatment (14). The presence of bleaching agents in the oral cavity also induces a chemical reaction with restorative materials such as amalgam and resin-matrix composites. Amalgam is an alloy mainly composed of Cu, Ag, Hg, tin (Sn) (16,17). Metallic elements are reactive to chemical solutions regarding the pH and electrochemistry of the compounds. In this case, amalgam surfaces can be considerably damaged in contact with hydrogen or urea peroxide leading to the release of metal ions to the surrounding tissues. On teeth restored with amalgam, greenish tooth-amalgam interfaces have been clinically noted due to the active oxidation and corrosion during long-term whitening with 10% urea peroxide (18). Such active oxidation indicates chemical reactivity of the amalgam in contact with bleaching compounds. Additionally, the release of metal ions and debris can be intensified in

Damage of resin composite and amalgam surfaces after exposure to bleaching agents clinical procedures such as teeth cleaning with abrasive pastes, surface polishing, and amalgam removal without a proper clinical isolation and suction procedures (19,20).

Resin-matrix composites are materials for replacement of amalgam restorations depending on the coronal reconstruction scale. The organic matrix is composed of a combination methacrylate-based materials such as Bis-GMA, UDMA, TEGDMA and Bis-EMA (9,13,15,21–23) while the inorganic fillers comprise micro- and nanoparticles of zirconium silicate, amorphous silica, barium silicate, ytterbium fluoride, or boron-aluminum silicates (8–10,13–15,21–25). The organic matrix can be altered by a hydrolytic phenomenon that is dependent on the polymerization degree, chemical composition, and environment conditions (e.g. pH, temperature, loading). In this way, the resin-matrix composites also are susceptible to surface damage leading to release of degradation products from the methacrylate matrix. The gradual dissolution of the organic matrix results in water absorption (hydrolysis) with complete or partial detachment of the fillers (26–28). Also, surface alterations are reported on resin-matrix composites as a result of the deleterious impact of oxidizing bleaching agents (8–10,13,15,21–25). That results in surface damage with increase in roughness and a decrease in physical properties (e.g. elastic modulus, strength and hardness) of the resin-matrix composites (29,30). Rough surfaces are retentive micro-regions for accumulation of reactive substances such as bleaching agents and acidic fluids (31).

The aim of this study was to perform a systematic review on the damage of resin-matrix composites and amalgam surfaces exposed to hydrogen and urea peroxide. It was hypothesized that metallic materials such as amalgam are more vulnerable to surface alterations when compared to resin composites after contacting bleaching agents.

2. SEARCH STRATEGY

A literature search was performed on the MEDLINE/PUBMED database using the following search terms: “Amalgam” OR “Resin composite” AND “bleaching treatment” “Corrosion” OR “Erosion” OR “Roughness” OR “AFM” OR “Profilometry” OR “SEM”. Also, a manual search of the reference lists in the selected articles was carried out. The inclusion criteria involved articles published in the English language from January 1997 up to January 2019, reporting surface alterations and roughness measurement on amalgam or resin composites after contact with the bleaching gels. Two of the authors (JCMS, ICF) independently evaluated the titles and abstracts of potentially relevant articles. Selected articles were individually read and analyzed concerning the purpose of this study. The following variables were collected for this review: author names, journal, publication year, restorative materials, bleaching agents, roughness measurement, and microscopic analysis.

3. RESULTS

The literature search identified a total of 127 articles on the MEDLINE/PUBMED database, as shown in Figure 1 (see annex). A number 51 duplicate articles were removed. After reading the titles and the abstracts of the articles, 44 were excluded because they did not meet the inclusion criteria. The remaining 32 potentially relevant studies were then evaluated (Fig. 1).

Findings on the chemical composition of the restorative materials and bleaching agents are given in Table 1. Also, the main outcomes considering the roughness measurement and ions release were retrieved from relevant studies as shown in Table 1.

Out of the 32 selected studies, 8 (28.6%) studies investigated damage on amalgam surfaces, 15 (53.6%) articles reported damage on resin composites, while only one (3.6%) compared damage on both resin composite and amalgam. The roughness evaluated by atomic force microscopy (AFM) was only reported in 3 articles on resin composites (10.7%), not being reported in articles on amalgam. Ion release was measured in 2 articles (7.1%) on amalgam while 3 articles (10.7%) reported the measurement of amalgam volume loss. Regarding roughness measurement, surface irregularities were evaluated by profilometry analyses and reported in 8 studies (28.6%) on resin composites and only one on amalgam. Regarding the bleaching agents, 5 studies evaluated the effect of hydrogen hydroxide (17.9%), 13 studies (46.4%) reported carbamide peroxide effects while only one study evaluated the effect of both bleaching agents.

In fact, several types of bleaching agents, amalgam, and resin composite materials were assessed in the selected articles. The resin composite restorative materials were composed of combined dimethacrylate-base matrix reinforced by approximately 60-87% wt inorganic particles ranging from 0.1 to 10 μm . The dimethacrylate matrix of the resin composites was almost always composed of Bis-GMA, UDMA BISEMA, and TEGDMA (8–10,13,15,21–25,32,33). The amalgam restorative materials assessed were mainly composed of 45-69.3% Ag, 11.8-31% Sn, and 13-28.2 % Cu (7,12,14,24,34,35). Hydrogen peroxide ranging between 6.5-40% and carbamide peroxide at 10-35% were used for the surface modifications assays of resin

Damage of resin composite and amalgam surfaces after exposure to bleaching agents composite and amalgam. The exposure time for the restorative materials to the bleaching agents ranged from 80 min up to 21 days, as seen in Table 1.

The roughness of amalgam significantly increased after contacting all bleaching conditions as seen in Table 1. Surface amalgam modifications were clearly noticeable after contact with the bleaching agents (12).

Considering the ion release measurement, the increase in the bleaching agent concentration led to an increase in the Hg, Ag, and Cu ion release from amalgam surfaces (34,35). However, a study could not find a relationship between the bleaching agent content and ion release rate (14).

However, the surface alteration did not occur for all the test resin composites (Table 1). The findings from the previous studies revealed that the organic matrix of resin composite was modified after contact with the bleaching agent solutions (8). Also, there was a slightly increase in roughness after immersion of some resin-matrix composite in bleaching agent solutions.

However, such opinion was not consensual, and there were studies that reported no statistically significant changes in roughness on resin-matrix composites (13) and therefore those changes did not have any clinical relevance on surface finishing conditions (25). It was also reported that the hardness depends on the material (22), and that polishing after bleaching should not be performed, since it is not able to reverse the damage (21). In fact, changes in resin composite roughness after bleaching are dependent on the exposure time to the bleaching agent and the chemical composition of the resin-matrix composite (9).

4. DISCUSSION

Data from the selected articles revealed that amalgam surfaces were significantly damaged after exposure to bleaching agents since metallic materials have a high chemical reactivity to therapeutic solutions. In fact, the findings evaluated by ion release analysis, roughness measurement, and microscopy (7,12,14,24,31,34,35) corroborated the hypothesis of the present work. Regarding resin composites, the surface damage caused by bleaching agents is not so significant and therefore some previous studies did not report any changes on resin-matrix composite surfaces. The relationship between bleaching agent and surface alteration of amalgam or resin-matrix composites are discussed as follow.

4.1. Bleaching agents

Most usual compounds in bleaching treatment are composed of urea peroxide (carbamide peroxide) or hydrogen peroxide (14,23,35). The protocols of application for bleaching agents are related to the type of application regarding in-office or at-home bleaching treatment, as seen in Figure 2 (10,11,36). Regarding in-office bleaching treatment, the content of the bleaching agents composed of urea peroxide varies from 15 up to 35% while the content of hydrogen peroxide is at a range from 20 up to 40% (7,10,23). On at-home bleaching treatment, lower concentrations are recommended for the patients and therefore the content of the bleaching agents composed of urea peroxide ranges from 16 up to 20% while the content of hydrogen peroxide varies from 6.5 up to 10 (8,9,22).

The application protocols also depend on the type and concentration of the bleaching compounds. In this way, the studies try to mimic the in-office or at-home bleaching treatment as illustrated in Figure 2. For urea peroxide treatment over a period of 14 days, the application protocols were the following: 1 application per day for 1h (14); 3 applications of 30min per day with a 3-day interval between sessions (14); 8 cycles of 8h at intervals of non-treatment for 16h (25); 1 application of 6h per day (7,24); 1 application of 30 minutes per week (7). On

Damage of resin composite and amalgam surfaces after exposure to bleaching agents hydrogen peroxide treatment, the application protocols deal with 2 applications of 30min (13) and 2 applications of 15min (21) over a period of 14 days. Most of the studies chose a base time for 14 days as a standard exposure testing time (8,9,12,13,15,21,22,24). In the case of articles that did not considered 14 days, the closest value of the 2 weeks or the only available value was considered (7,23,34,35). In the selected studies, the temperature of the bleaching treatment was maintained at 37 °C to mimic the temperature of the oral cavity (7,8,12,15,22–24,34). However, some studies were performed at room temperature (9,10,13,14,21,25,35).

4.2. Amalgam versus resin composite: the surface damage

Amalgam is an alloy composed of mercury (Ag) and other different metals, such as tin (Sn), silver (Ag), or copper (Cu) and therefore it has been used by dentists for more than 100 years (16,17). Nowadays, amalgam is still used in public or private practice in a few countries due to economic situations. Since 2019, the use of dental amalgam that is not dispensed in the system of capsules has been forbidden throughout the European Union (1,2). Therefore, the use of amalgam restoration has been forbidden in the following clinical cases: children with primary dentition or underage of 15 years; pregnant women and women on breastfeeding. However, adult patients often claim failures of old amalgam restorations and replacement by resin composite materials (19,20). Thus, many patients reveal amalgam restoration which are on aging process in contact with oral therapeutic substances including bleaching agents.

On teeth surfaces restored with amalgam, greenish tooth-amalgam interfaces have been clinically noted due to the active oxidation during long-term whitening with 10% urea peroxide (18). Such active oxidation indicates the chemical reactivity of the amalgam to the bleaching compounds. Some clinical procedures recommend the polishing of the amalgam restoration before starting a bleaching therapy should to reduce the corrosion potential of the amalgam (31). However, the polishing of amalgam also promotes a high release of metallic ions to the oral cavity and surrounding tissues. On *in vitro* studies, a significant damage of the amalgam surfaces in contact with bleaching agents has been reported in several studies from

Damage of resin composite and amalgam surfaces after exposure to bleaching agents measurements by optical profilometry or scanning electron microscopy (12,35), as shown in Table 1.

On the other hand, the resin composites are hybrid materials composed of an organic matrix and inorganic fillers. The polymer-matrix composites have a lower surface energy when compared to the metallic materials such as amalgam. That results in lower chemical reactivity to several oral or therapeutic substances including bleaching agents. However, surface alterations are also reported as a result of the deleterious impact of oxidizing bleaching agents on the polymeric matrix of resin-based materials, as seen in Table 1 (8–10,13,15,21–25). In addition, the negative influences of oxidizing agents in the resin matrix lead to the water absorption from resin-based restorative materials with complete or partial detachment of the fillers (26–28). That results in surface damage with increase in roughness and a decrease in strength and hardness of the resin-matrix composites (29,30). Rough surfaces are retentive micro-regions for accumulation of reactive substances such as bleaching agents and acidic fluids (31). The careful polishing of restorative materials can decrease the roughness leading to a clearance effect in the oral cavity. Even though several studies have not reported any surface damage on resin composites by optical profilometry and SEM analyses (2,3), a sensitive technique namely atomic force microscopy (AFM) has detected increase in nano-roughness and morphological changes on nano-hybrid after contact with bleaching agents (8,10,22).

4.3. Loosening of restorative material and release of debris

The loss of material and release of debris such as metallic ions are the major consequences of surface damage of amalgam restoration, as illustrated in Figure 2. The release of Hg, Ag, Cu, Sn ions from amalgam restorations after contact with bleaching agents has been reported by previous studies (7,12,14). The release of ions has been measured by the following techniques: optical profilometer, ICP-MS (inductively coupled plasma mass spectrometry), SEM (scanning electron microscopy), AFM (atomic force microscopy), and energy dispersive spectrometric (EDS) microanalysis, (7–10,12–15,21–25,34,35). A high release of Cu ions has been measured in the studies that indicates the corrosion of the amalgam and toxic risks to

Damage of resin composite and amalgam surfaces after exposure to bleaching agents the patients (7,14,24,34). However, a few studies reported that release of Cu ions was almost non-existent (12,35). A previous study reported a decrease in the release of Cu ions when the surfaces were finished by polishing tools prior to the immersion in bleaching agent solutions (37). Although some studies claim that the ion release level was not considered high enough to cause a health hazard (15), others studies reported that the long-term bleaching treatment can increase the risks of toxicity to the patients (12). The release of mercury higher when comparing to the release of the remaining ions (34,35). It should be noted that this release of metal ions is dependent on the chemical composition of the amalgam as well as the type, content, and clinical guidelines of the bleaching agent (38).

On the damage of resin composites, the organic matrix composed of methacrylates is more susceptible on the degradation in acidic environment. The slight increase in roughness of the resin composites corroborate the effect of the bleaching agents on the surface damage. The progressive damage of the organic matrix can promote the instability of the inorganic fillers and ejection of particles on mastication loading (3). The corrosion measurements should associate the effect of wear by abrasion to determine the overall degradation of resin-matrix composites on sliding wear during mastication. Regarding the toxicity of degradation products, the release of methacrylate products such as bisphenol-A (BPA) has been studied in literature (3–6). BPA has revealed local and systemic toxicity in several situations although it depends on the content of the toxic product. The release of BPA from resin composites is high within the first hour and that decreases over time (39). The exposed area of the resin-matrix composites to bleaching agent determine the release of BPA and therefore the contact of the restoration with the oral mucosa margins might induce inflammatory reactions. However, there is a lack of data on the local toxicity of methacrylate-based products released from resin-matrix composite restorations. Further studies should evaluate the release of methacrylate-based products to clarify the toxicological potential and the pathological consequences for the patients.

5. CONCLUSIONS

The present review study evaluated the side effects of the bleaching agents comprising hydrogen or urea peroxide on the surface damage of amalgam and resin-matrix composites considering findings from previous original research articles. Within the limitations of the *in vitro* and *in vivo* studies, the following concluding remarks can be drawn:

- The surface damage caused by the bleaching agents was significantly higher on amalgam surfaces when compared to resin-matrix composites surfaces. Considering amalgam is a metallic material, the chemical reactivity of the surface is high in contact with corrosive substances such as hydrogen peroxide and urea (carbamide) peroxide;
- In contact with the bleaching agents, amalgam restorations release ions such as copper, silver, and mercury. The release of metal ions can be toxic for the human cells and tissues depending on the content and chemical composition of the ions. It is known that mercury can also cause mutagenic reactions;
- The corrosion damage and release of ions promoted by the bleaching agents alter the roughness of the restorations. Rough surfaces can become retentive micro-regions for accumulation of bacteria and acidic substance that can intensify the degradation of the surfaces;
- Considering the resin-matrix composites, the polymeric methacrylate-based matrix is susceptible to the chemical interaction with bleaching agents. That promotes the release of products (monomers) such as bisphenol A which is a toxic product to cells and tissues. However, the local or systemic adverse effects depend on the content of methacrylate products;
- Future studies should evaluate the correlation between the type and proportion of organic matrix of resin composite and release of products when in contact with bleaching agents. *In vitro* degradation studies should mimic the aggressive conditions in the oral cavity. For instance, simultaneous wear and corrosion testing of different

Damage of resin composite and amalgam surfaces after exposure to bleaching agents materials also can provide the magnitude of degradation of restorative surfaces once the studies only evaluate the chemical adverse effect.

The insight of the dangers of the restorations is fundamental to perform a correct treatment to each patient looking for a treatment. We must be aware to these microscopic alterations in order to provide the best treatment possible to patients, before proceeding with a bleaching treatment.

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7. ANNEX

Anexo 1

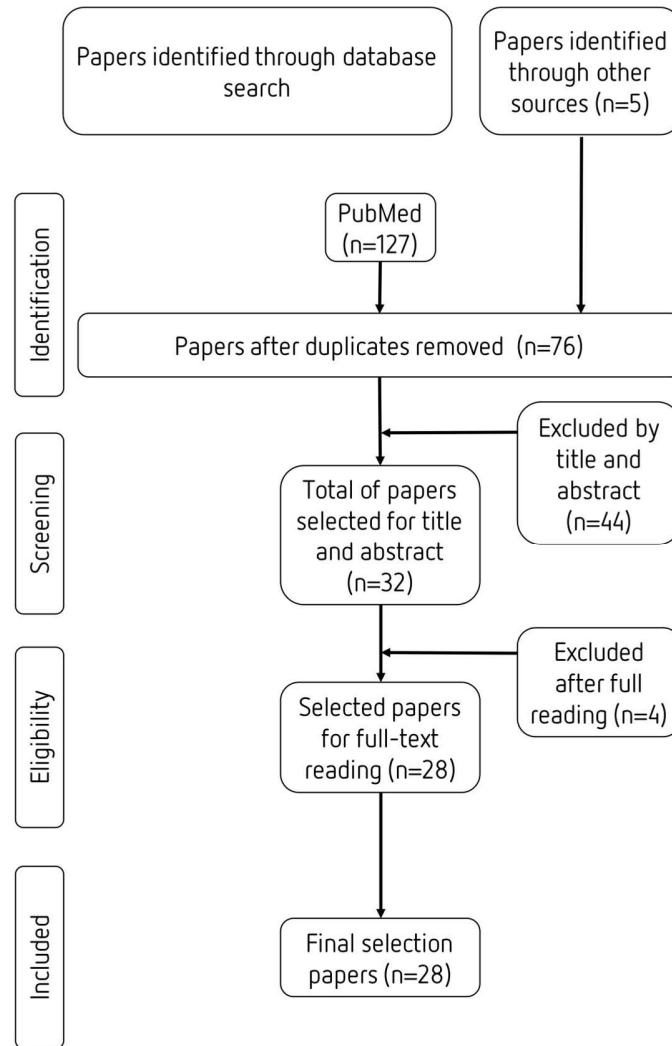


Figure 1. Search strategy used in this study.

Damage of resin composite and amalgam surfaces after exposure to bleaching agents

Anexo 2

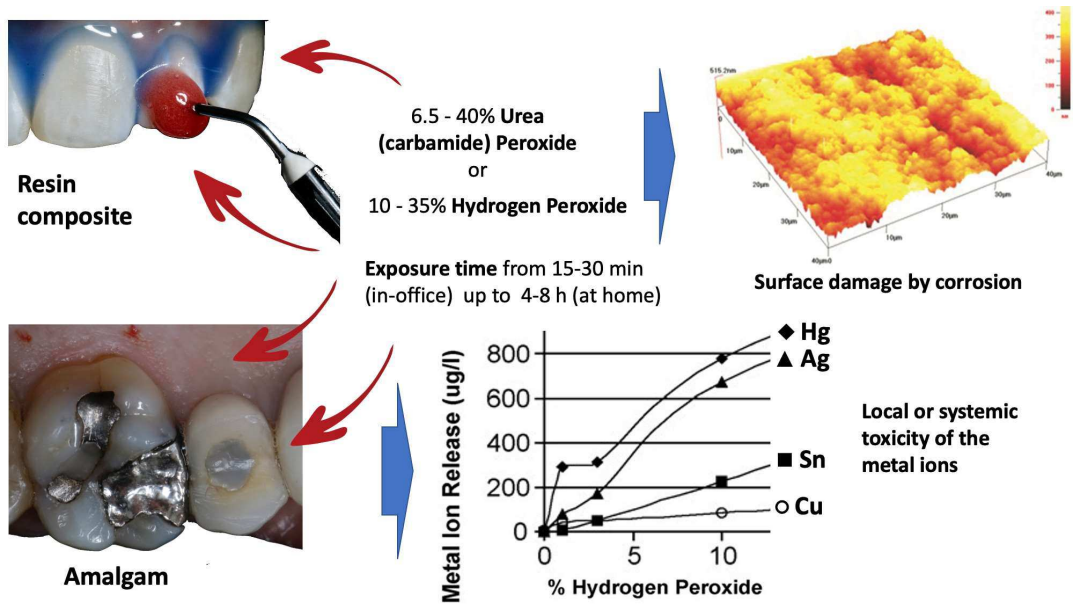


Figure 2. Schematic drawing.

Anexo 3

Table 1. Data on restorative materials and surface damage related to the bleaching agents: mean values of roughness and ions release.

Authors (Year)	Restorative Material Type	Chemical Composition: %	Bleaching procedure	Bleaching Agent Chemical Composition	Rz Roughness (nm)	Profilometry (µm)	Material Loss Mean values of ions release (µg/L)
Yu, <i>et al</i> (2018) (3)	Resin composite	Organic matrix: Bis-GMA, UDMA, Inorganic fillers: zirconia, silica, strontium glass, silanized amorphous silica, 100 nm, 0.1-1 µm	40% at 37°C for 80 min	Hydrogen peroxide	N/A	Baseline: 0.2-0.29 After bleaching: 0.28-0.34	N/A
Al-Salehi, <i>et al</i> (2007) (41)	Amalgam	59 Ag, 28Sn, 13Cu	10% at 37°C for 24 h	Hydrogen peroxide	N/A	N/A	Baseline: 2.7 Hg, 0.02 Ag, 9.16Cu After bleaching: 782 Hg, 670 Ag, 82.6 Cu
Gurgan, <i>et al</i> (2007) (14)	Amalgam	45 Ag, 31 Sn, 24 Cu 69.3 Ag, 11.8 Sn, 17.9 Cu	(A) 16% for 1h per day over a period of 14 days (B) 30% for 30 min, 3 times daily within a 3day interval	Carbamide peroxide	N/A	N/A	Baseline: (A)21.6 Hg, 0.46 Ag, 37.4 Cu (B)14.5 Hg, 1 Ag, 21.1 Cu After bleaching: (A) 121 Hg, 2.4 Ag, 20.2 Cu (B) 243 Hg, 0.26 Ag, 46 Cu

Damage of resin composite and amalgam surfaces after exposure to bleaching agents

Author (Year)	Material	Exposure Conditions	Bleaching Agent	Baseline (A)	After Bleaching (B)	Baseline (%)	After Bleaching (%)
Gouveia, <i>et al</i> (2016) (8)	Resin composite	16% at 37°C for 4h during 14 days	Organic matrix: Bis-GMA, UDMA, TEGDMA, Bis-EMA 78.5% (wt) fillers: Nanoclusters (0.6 and 1.4µm); zirconia (5-20nm) and silica (20nm) nanoparticle	Carbamide peroxide + Carbopol or (B)	Baseline: (A)0.01- (B)0.012 After bleaching: (A)0.284- (B)0.109	N/A	N/A
Al-Salehi, <i>et al</i> (2006) (43)	Amalgam	10% for 24 h	41.8 Ag, 29.3 Sn, 28.2 Cu	Carbamide peroxide	Baseline: 1.74 After bleaching: 2.23	Baseline (µg/cm ²): 0.58 Hg, 0.22 Ag, 0.5 Cu	After bleaching (µg/cm ²): 1.18 Hg, 0.3 Ag, 0.52 Cu
Rotstein, <i>et al</i> (1997) (12)	Amalgam	10% at 37°C for 14 days	600 mg AgCuSn alloy, 536 mg mercury	(A) Carbamide peroxide and (B) Hydrogen peroxide	N/A	Baseline (%): 33.92Hg, 19.29Ag, 13.19Cu	After bleaching (%): (A)37.64- (B)35.88Hg, (A)23.16- (B)22.25Ag, (A)11.51-

Markovic, <i>et al</i> (2014) (25)	Resin composite	Organic matrix: Bis-GMA, TEGDMA-Bis- GMA, UDMA, TEGDMA	16% for 8 cycles of 8 h with non- treatment intervals of 16 h	Carbamide peroxide	N/A	Baseline: 42.69–28.51 After bleaching: 43.98– 30.92	N/A	(B)13.23Cu, (A)39.05– (B)39.10Hg, (A)25.11– (B)25.44Ag, (A)12.07– (B)12.56Cu	N/A
		Inorganic fillers: barium- aluminium- fluoride-glass, silicone dioxide 58.7 wt%-glass ceramics 71.4wt%							
Oskoe, <i>et al</i> (2010) (7)	Amalgam	600mg Cu alloy, 540mg mercury	15% at 37 °C for (A)6 h a day over a period of 3 weeks (B)35% at 37 °C for 30 min per week over a period of 3 weeks	Carbamide peroxide	N/A	N/A	Baseline: 36.11 After bleaching: (A)42.32– (B)41.69	N/A	

Zavanelli, <i>et al</i> (2011) (24)	(i) Resin composite or (ii) Amalgam	(i) Organic matrix: urethane modified BisGMA Inorganic fillers: barium glass, silica microparticle (ii) 56%Ag, 27.9%Sn, 15.4%Cu, 0.2%Zn, 47.9%Hg	(A) 10% or (B) 15% at 37°C, 6 h per day over a period of 21 days	Carbamide peroxide	N/A	Baseline: (A) (i)0.22- (ii)0.15 or (B) (i)0.18- (ii)0.15 After bleaching: (A)(i)0.27- 0.24 or (B)(i)0.22- 0.72	N/A	N/A	N/A
Varanda, <i>et al</i> (2013) (10)	Composite resin	Organic matrix: Bis-GMA, UDMA, TEGDMA, Bis-EMA Inorganic Fillers: barium fluoroborosilicate glass, zirconia, silica	(A)20% for 50min or (B)35% for 15min in 3 times	Hydrogen peroxide	Baseline:(A)49.05-27.07 or (B)23.41-36.78 After bleaching: (A)47.54-29.11 or (B)29.11-36.99	N/A	N/A	N/A	N/A
Zuryati A-G, <i>et al</i> (2013) (54)	Composite resin	Organic matrix: BisGMA, Bis-EMA, UDMA, TEGDMA 78.5% (wt) inorganic fillers: zirconia, silica (5-20nm)	(A)10% or (B)20% at 37°C over a period of 14 days	Carbamide peroxide	Baseline: 83.73 After bleaching: (A)77.95 or (B)63.83	N/A	N/A	N/A	N/A

Gurbuz, <i>et al</i> (2013) (13)	Composite resin	Organic matrix: Bis-GMA, TEGDMA Inorganic fillers: Ba-Al-B-Si glass, silicon dioxide, silicon oxide	6.5% for 30 min, 2 times a day over period of 21 days	Hydrogen peroxide	N/A	Baseline: 1.4-0.8 After bleaching: 2.0-0.9	N/A	N/A
A.P.K.F. Mendes, <i>et al</i> (2012) (21)	Composite resin	Organic matrix: urethane modified Bis- GMA, dimethacrylate TEGDMA or Bis- GMA, UDMA, TEGDMA, Bis- GMA-EMA Inorganic fillers: barium boron aluminum silicate glass, barium boron fluoro-aluminum silicate glass or silane-treated ceramic, silane- treated silica	(A)10% or (B)35% for 30 min (2x15min) over a period of 14 days	Hydrogen peroxide	N/A	Baseline: (A)0.232-0.2 or (B)0.232- 0.238 After bleaching: (A)0.216- 0.178 or (B)0.346- 0.294	N/A	N/A
Wang, <i>et al</i> (2011) (9)	Composite resin	Organic matrix: Bis-GMA, Bis- EMA, TEGMA	16% for 4 h daily during 4 weeks	Carbamide peroxide	N/A	Baseline: 0.15 or 0.13	N/A	N/A

Moraes, <i>et al</i> (2006) (15)	Composite resin	78.5% wt or Bis-GMA, TECMA, 87% (wt) inorganic fillers: Ba-Al-B-Si glass, silica (5-20nm, 0.6-1.4µm) (nanoclusters) or 20-50nm	(A)10% at 37°C for 3h daily during 14 days or (B)35% at 37°C for 30min/week for 14 days	Carbamide peroxide	N/A	Baseline: (A)0.07-0.05 or (B)0.07-0.04 After bleaching: (A)0.08-0.05 or (B)0.06-0.05	N/A	N/A	After bleaching: 0.18 or 0.14
		colloidal silica or (0.01-3.5µm, 60 vol%) zirconia silicate							

□

CHAPTER II – Relatório dos Estágios

1. INTRODUÇÃO

Os estágios realizados no plano curricular do 5º ano do Mestrado Integrado em Medicina Dentária fazem parte da componente prática do curso, onde os alunos têm a oportunidade de porem em prática tudo o que foi aprendido em anos anteriores. Estes estágios decorreram durante todo o ano letivo 2018/2019 são os seguintes:

1. Estágio em Clínica Geral Dentária (ECGD).
2. Estágio em Clínica Hospitalar (ECH).
3. Estágio em Saúde Oral Comunitária (ESOC).

O principal objetivo destes estágios, que são supervisionados e orientados por professores médicos dentistas, é a aplicação de todos os conhecimentos obtidos, preparando assim o aluno o seu futuro.

2. ESTÁGIO EM CLÍNICA GERAL DENTÁRIA

O Estágio em Clínica Geral Dentária decorreu na clínica universitária do Instituto Universitário de Ciências da Saúde, com a duração de 5 horas semanais e teve início a 13 de setembro de 2018 e término a 13 de junho de 2019. O estágio foi supervisionado pelo Mestre João Baptista e pela Professora Doutora Filomena Salazar.

<i>Ato Clínico</i>	<i>Operador</i>	<i>Assistente</i>	<i>Total</i>
<i>Restauração</i>	6	5	11
<i>Exodontia</i>	0	2	2
<i>Endodontia</i>	2	2	4
<i>Destartarização</i>	7	3	10
<i>Outros</i>	1	0	1
<i>Total</i>	16	12	28

Outros: Curetagem alveolar.

3. ESTÁGIO EM CLÍNICA HOSPITALAR

O estágio hospitalar foi realizado no Serviço de Estomatologia/Medicina Dentária do Centro Hospitalar de São João, Unidade de Valongo. Teve início a 14 de setembro de 2018 e terminou a 14 de junho de 2019. O estágio foi supervisionado inicialmente pela Doutora Ana Azevedo e posteriormente pelo Professor Doutor Luís Monteiro e pela Doutora Rita Cerqueira.

<i>Ato Clínico</i>	<i>Operador</i>	<i>Assistente</i>	<i>Total</i>
<i>Restauração</i>	16	15	31
<i>Exodontia</i>	11	15	26
<i>Endodontia</i>	3	2	5
<i>Destartarização</i>	8	15	23
<i>Outros</i>	2	0	2
<i>Total</i>	40	47	87

Outros: Curetagem alveolar e triagem.

4. ESTÁGIO EM SAÚDE ORAL COMUNITÁRIA

O estágio em saúde oral comunitária teve início a 8 de Outubro de 2018 e terminou a 3 de junho de 2019, supervisionado pelo Professor Doutor Paulo Rompante. O estágio dividiu-se em dois locais: Estabelecimento Prisional de Paços de Ferreira com o auxílio da Doutora Cristina Calheiros e Unidade Hospitalar de Santo Tirso com a supervisão do mestre José Pedro Novais.

<i>Ato Clínico</i>	<i>Operador</i>	<i>Assistente</i>	<i>Total</i>
<i>Restauração</i>	4	5	9
<i>Exodontia</i>	5	10	15
<i>Endodontia</i>	0	3	3
<i>Destartarização</i>	1	6	7
<i>Outros</i>	2	1	3
<i>Total</i>	12	25	37

Outros: Triagem, selante de fissura e curetagem alveolar.

Para além da componente prática também foram feitas 6 tarefas que ao longo do ano letivo que tinham como objetivo apelar à criatividade e solidariedade dos alunos. As tarefas encontram-se descritas na tabela abaixo.

Número da Tarefa	Nome da Tarefa	Objetivo
1ª Tarefa	Projeto de intervenção comunitária no estabelecimento prisional de Paços de Ferreira.	Facilitar a reinserção social. Reabilitar e promover a higiene oral.
2ª Tarefa	Implementar um Projeto de Intervenção Comunitária na área da Saúde Oral num Hospital da Misericórdia.	Proporcionar cuidados de saúde oral às pessoas mais carenciadas. Reabilitar e promover a higiene oral.
3ª Tarefa	Elaborar um projeto de intervenção comunitária de rua na área da Saúde Oral.	Incentivar a população a ter uma higiene oral mais cuidada. Promover a saúde oral de uma forma mais informal.
4ª Tarefa	Patologias sistémicas com repercussões na cavidade oral. Conhecer e saber como proceder.	Demonstrar ter conhecimento, reciclar ou adquirir o conhecimento sobre a temática.
5ª Tarefa	Patologia benigna dos tecidos moles em odontopediatria. Diagnóstico e terapêutica em ambulatório.	
6ª Tarefa	Patologia oral maligna em odontopediatria. Diagnóstico e o que saber para fazer terapêutica em ambulatório.	