DENTAL CERAMIC SYSTEM: A LITERATURE REVIEW

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ABSTRACT

Introduction: Aesthetic restorations in ceramics became part of the dentist's daily routine, due to their high demand in dental procedures. Their properties are very similar to natural teeth, such as translucency, fluorescence, coefficient of linear thermal expansion compatible with material / biological compatibility, and greater resistance to compression and abrasion. **Objective**: This work aimed to carry out a literature review of the types of dental ceramics, involving composition, advantages / disadvantages, and indications; in addition to emphasizing the main characteristics. **Data source:** The articles were collected from the online databases, national and international, Google Scholar, PubMed, SciELO and LILACS, considering the temporal period from 1996 to 2020, through the Boolean operators: AND, OR, and keywords: Ceramics; Tooth crown; Mouth Rehabilitation in the language of English and Portuguese. Then, after filtering, 35 articles were selected. **Data summary and Conclusion:** Numerous ceramic systems are available on the market, leading these professionals in the prosthetic area to constantly search for knowledge about their properties and indications so that they can find good results due to the selection of the best material for a given case combined with a skill of the professional.

Keywords: Ceramics; Tooth crown; Mouth Rehabilitation

RESUMO

Introdução: As restaurações estéticas em cerâmicas passaram a fazer parte no dia a dia do cirurgião dentista, e sua aplicabilidade se deu por apresentar várias propriedades muito semelhantes aos dentes naturais, dentre as quais se destacam: translucidez, fluorescência, coeficiente de expansão térmica linear compatível ao dente natural, compatibilidade biológica, e uma maior resistência à compressão e à abrasão. **Objetivo:** Realizar uma revisão na literatura visando mostrar os tipos de cerâmica odontológica, envolvendo composição, vantagem, desvantagem e indicações, além de enfatizar as principais características. **Fonte de dados:** Foram utilizados artigos de bases de dados, nacionais e internacionais, Google Acadêmico, PubMed, SciELO e LILACS, entre os anos de 1996 a 2020, através dos operadores booleanos: and e or, e dos descritores: Cerâmica; Coroa dentária; Reabilitação bucal. nos idiomas inglês e português. Foram selecionados 35 artigos. **Síntese dos dados e Conclusão:** Inúmeros sistemas cerâmicos estão disponíveis no mercado, levando esses profissionais da área reabilitadora a uma constante busca por conhecimento acerca das suas propriedades e indicações, para que encontre bons resultados devido à seleção do melhor material para determinado caso aliado à uma habilidade do profissional.

Descritores: Cerâmica; Coroa dentária; Reabilitação bucal

INTRODUCTION

Ceramics are increasingly being the option of choice in dental clinics, due to their clinical improvement. Aesthetic restorations in ceramics became part of the dentist's daily routine, due to their routine use. Its applicability was due to its several properties very similar to natural teeth, among which stand out: translucency, fluorescence, coefficient of linear thermal expansion compatible with natural teeth, biological compatibility, and greater resistance to compression and abrasion[1].

According to Peixoto & Akaki[2] (2008), the first materials to be manufactured by man were ceramics, having in their composition chemical components, minerals and a glassy matrix, being seen the material with features more similar to the aesthetics of natural teeth.

In 1774, in France, dental ceramics were used for the first time, replacing ivory, in artificial teeth for complete dentures. Over the years and together with scientific evolution, studies have been carried out to improve physical and mechanical properties in order to meet the needs that modern society imposed at the time[3].

Clinical studies demonstrate that there are good results in the use of ceramic restorations in the aesthetic area, due to biocompatibility, marginal adaptation and good relationship with periodontal tissues, which results in longevity for the treatment. In the development of dental ceramics, cementing agents were essential to obtain longevity and retain indirect restorations and nuclei in the oral cavity. For the performance of this step, it is necessary to treat the dental surfaces and the surface of the restorative material, in order to guarantee the clinical success of this rehabilitation procedure[4].

At the end of the 20th century, several systems were introduced to the market, with the purpose of providing the manufacture of metal-free ceramic restorations. Since then, several ceramic systems have been developed in order to improve the material's physical and mechanical characteristics[5].

Therefore, this work aims is to carry out a literature review in order to show the types of dental ceramics, involving composition, advantages, disadvantages and indications, in addition to emphasizing the main characteristics.

DESIGN

This is a review of the narrative literature on the comparative study of the ceramic systems used, for indirect dental restorations. Articles from online, national and

international databases, Google Scholar, PubMed, SciELO and LILACS were used. For a correct design and search for articles, keywords were inserted for the subject addressed: ceramics, dental crown, oral rehabilitation, using the Boolean markers "and" and "or" to search the databases. The search will be limited to articles published in Portuguese and English, published between 1980 and 2020. Then, after filtering, 35 articles were selected.

SYNTHESIS

3.1 COMPOSITIONS OF DENTAL CERAMICS

Dental ceramics are composed of inorganic structures, metallic and semi-metallic elements, such as: aluminum (Al), boron (B), calcium (Ca), cerium (Ce), lithium (Li), magnesium (Mg), phosphorus (P) , potassium (K), silicon (Si), sodium (Na), titanium (Ti) and zirconium (Zr), and when combined they result in two main phases: crystalline, opaque phase, with dispersed crystals and a glass phase of silicate, transparent. One phase will provide the material with resistance and the other translucency respectively[5,6,7].

The ceramics used in dentistry have silica (SiO_2) as its main compound, crystalline matter, which has a simple chemical formula and can exist in different ways[8].

In order to define the applications of ceramic materials in dental restorative processes, it is of great importance to know the composition of these ceramics. Because they are used in restorative procedures with greater feldspar and quartz content, providing an excellent aesthetic result[9].

3.2 CLASSIFICATION OF CERAMICS AS TO COMPOSITION

According to Raposo et al.[9] (2014), currently as dental ceramics can be divided in their composition as to the type in: ceramics conventional (feldspar) and reinforced ceramics where the materials can be: leucite, lithium disilicate, spinel, alumina and zirconia. As for the content, the ceramics are classified as vitreous ceramics: feldspar, leucite and lithium disilicate and crystalline/ polycrystalline ceramics: alumina, spinel and zirconia.

3.3 CONVENTIONAL CERAMICS: FELDSPATHIC

The feldspar ceramic is determined as a glass, having in its composition potassium feldspar ($K_2O.Al_2O_3.6SiO_2$) and small incorporations of quartz (SiO_2). At high temperatures, feldspar decomposes in a glassy phase with an amorphous structure and a crystalline phase consisting of leucite ($KAlSi_2O_6$ or $K_2O.Al_2O_3.4SiO_2$)[10].

Feldspar crowns were the pioneers to be made in high fusion and have been used for long dates. They presented excellent esthetic quality, however, their low resistance limited their indication only for anterior single crowns in situations of low occlusal stress[11]. According to Carvalho et al.[12] (2017), with these characteristics, an association of this ceramic system with metal came to solve the limitation of resistance in use in posterior teeth. Another possibility to

increase the resistance of this material would be a greater incorporation of crystalline matrix.

Feldspar ceramics have translucency and a linear thermal expansion coefficient similar to teeth. They are resistant to compression and to oral fluids that can degrade feldspar ceramic, and ultimately have no corrosive capacity, but have low resistance to traction and flexion[7].

As a disadvantage, feldspar, being a brittle material, has a limited ability to eliminate tensions, which are accumulated in the ends, angles and cracks of the restoration. Therefore, the stresses accumulate in the material itself and, if there are cracks, their propagation can occur, causing fracture. The main reason for the fracture of this material would be due to its inability to suppress the growth of cracks through deformation, being, therefore, indicated for the manufacture of metalloceramic crowns, stratified ceramics or veneers[9].

3.4 REINFORCED CERAMICS WITH ALUMINUM PARTICLES

Aluminized ceramics were developed to provide greater resistance to fracture when compared to conventional feldspar ceramics. With the addition of alumina, a loss in translucency was observed, due to the fact that the alumina crystals have a limited light transmission, as well as a low resistance to the use of high masticatory effort as fixed partial dentures, being more suitable for making nuclei. ceramic and limited to the anterior region[11].

Its composition is similar to that of feldspar porcelains, with a 40% increase in the glass phase with alumina (Al_2O_3), and its resistance is increased compared to conventional feldspathic ceramics. Alumina was responsible for decreasing the concentration of stresses inside the material, partially preventing the spread of cracks[8].

Alumina-reinforced ceramics with the objective of eliminating porosity, increasing strength, and limiting crack propagation were added lanthanum glass particles, improving compression stresses when a greater amount of force is applied to it. As an example is the InCeram® Alumina system, which has a degree of opacification due to its opaque copping and feldspar ceramic for aesthetic coverage, and this system can be used in the posterior and anterior regions, in the manufacture of single crowns and fixed partial dentures[6].

3.5 CERAMICS REINFORCED BY LITHIUM DISSILICATE

Lithium Disilicate is a ceramic system composed of crystals of lithium disilicate that are embedded and joined to the glass matrix (vitreous ceramic), in a proportion varying from 60 to 70% in volume of crystals for glass matrix. It is a material with resistance between 360MPa to 400MPa, a property that enables it to make extremely thin structures, thus preventing excessive wear on the dental structure[12,13]. According to Oliveira et al.[14] (2019), currently the protocols clinicians minimize or dispense with dental preparations, preserving enamel as a substrate to have greater bond strength at the tooth - cement - ceramic restoration interface, minimizing postoperative complications giving greater predictability and clinical success.

The Lithium Disilicate ceramic has a high flexural strength and, due to its translucency, it can be used to make monolithic restorations, completely anatomical and with integral contour[15]. According to Carvalho et al.[12] (2017), this ceramic system has a high aesthetic standard, due to its light refraction index similar to tooth enamel, without translucency interference, thus allowing the possibility of reproduction with the natural structure of the tooth.

The strength of the material together with the fracture toughness, the ceramics reinforced by lithium disilicate are indicated for making inlays, onlays, laminates, single crowns and fixed partial dentures of three elements. They can be used as infrastructure for unitary prostheses of up to three elements, later receiving coating with compatible feldspar porcelain[16].

3.6 ZIRCONIA REINFORCED CERAMICS

The addition of oxides was intended to further improve the strength of ceramics, where the incorporation of zirconia, resulted in a significant increase in flexural strength, giving one of the highest tenacity values among ceramic materials, however it led to a highly opaque. Its more precise indications were, therefore, limited to posterior regions, both for single crowns and for fixed prostheses[17,18].

Ceramics based on zirconia oxide with addition of yttrium were created to improve the quality of the prostheses and to replace the metallic alloys of the infrastructures with the addition of (Fe_2O_3) influenced the phase transformation, increased the hardness and the resistance to flexural fracture when its

concentration is between 0.02% and 0.17% of the total weight[19]. The addition of yttrium oxide to zirconia aims to decrease the propagation of cracks by controlling the volume expansion and stabilizing the zirconia in the tetragonal phase at high temperatures. This mechanism does not prevent the progression of a fracture, it just makes it more difficult to spread. With the increase in mechanical strength, this ceramic is more recommended for making abutments compared to alumina[20,21,22].

The clinical application of these ceramics are used mainly for the construction of infrastructures of total crowns and fixed prostheses of up to 3 elements in anterior and posterior teeth. For the restoration to be completed, the infrastructure must be covered with the appropriate porcelain. And although the zirconia structure is the one with the best mechanical property among dental ceramics, this material is the one with the greatest opacity, which can make it difficult to restore teeth that require high translucency, as in the anterior teeth[23].

3.7 CLASSIFICATION OF DENTAL CERAMICS AS TO SURFACE SENSITIVITY

A factor of great clinical relevance for ceramics is their classification as to the sensitivity of the ceramic surface and it can be divided into 2 groups: 1) acid-sensitive ceramics: the glassy matrix of the ceramic degrades in the presence of hydrofluoric acid and 2) acid-resistant ceramics: ceramics that are not affected by surface treatment because they have low or no silica content, consequently undergo little or no surface degradation in the presence of hydrofluoric acid[24].

Acid-sensitive ceramics correspond to ceramics with a large amount of silica (vitreous matrix) in their composition, such as feldspar and lithium disilicate ceramics; silica being the degraded substance when in contact with hydrofluoric acid in concentrations of 5 to 10%. As main characteristics, the high adhesiveness to resin cement and high translucency stand out, however, they present less mechanical resistance when compared to crystalline ceramics[25]. Ceramics based on feldspar, leucite and lithium disilicate, are classified as acid-sensitive, because when conditioned with hydrofluoride, there is a dissolution of the glassy surface components and the production of a more porous and rough surface, which facilitates the penetration of the cementing agent in micro entertainment[26].

However, acid-resistant ceramics have a high amount of oxides (crystalline phase) in their composition, such as aluminum oxide, zirconium oxide, and a low amount of silica. In this case, the acid conditioning of these ceramics is not efficient. Its advantages are: more mechanically resistant than glass ceramics, being indicated for wide fixed prostheses, including in the posterior region. They are less translucent, which allows to shade the color of darkened teeth or with metal retainers / pins, however, it has the disadvantage of being less resistant as regards the bonding of resin cement when compared to glass ceramics[25].

Hydrofluoric acid in concentrations of 5 to 10% in contact with acid-sensitive ceramics causes a dissolution of the vitreous matrix, depending on the time of exposure to acid, modifying the surface of the ceramic by means of micro retentions that favor the adhesion of the resin cement. Therefore, silane should be used as a bonding agent to promote a chemical bond between the ceramic and the resin cement and to increase the wettability of the cement in the micro-entertainment of the ceramic. This type of surface treatment followed by the application of the silane agent and resin cement promotes an excellent clinical performance of these indirect restorations[27]. In acid-sensitive ceramics, hydrofluoric acid is responsible for promoting surface dissolution and for selectively attacking the glass phase of these ceramics. When silane is used it will expose silica dioxide and produce changes that contribute to micromechanical retention and chemical bonding. When acid etching with silane is carried out, it promotes wettability to cement on the ceramic surface, changing its adhesive potential to resin[26].

The so-called acid-resistant ceramics require an alternative device to condition their surfaces, in order to promote better adhesion to resin cement and consequently with the dental substrate. In the literature, the two most frequently cited are: Aluminum oxide blasting (JAT) and silicate coating. In this method, the silica-modified aluminum oxide particles are blasted onto the ceramic surface. The impact of the particles generates a triboplasm and the consequent incorporation of silica on the surface[28]. This process not only creates superficial cracks, favoring micromechanical retention, but also covers the ceramic surface with silica, which facilitates silanization[28,29].

As for the adhesiveness characteristics, acid-sensitive ceramics are usually indicated for veneers, contact lenses, ceramic fragments, inlays, onlays and anterior crowns, as well as, they can be used in teeth that have filling cores associated with fiber pins. glass. Acid-resistant ceramics, on the other hand, have anterior and posterior unitary crowns and fixed anterior and posterior prostheses as their main indication due to their characteristics of high flexural strength[28].

The evolution of ceramic systems up to the present day is increasing comparing its aesthetic and functional needs in the ceramics used in rehabilitation, making available systems with greater resistance to traction and flexion, greater tenacity, translucency among other characteristics that indicate the use depending on the need clinic. It is important to highlight the part of the professional, scientific knowledge of the various materials available on the market, as well as recognizing their indications and limitations, to obtain durable restorations, and significantly increase their clinical life time[11].

The grow demand, regarding the aesthetic and harmonious standardization of dental elements, has led Dental Surgeons (CD) to seek restorative materials in their offices that express good mechanical and presentable shape, using in turn more and more the materials composed of ceramics[30].

Ceramics have been well indicated for indirect restorations, as they achieve excellent aesthetic results. In general, they present color, texture and high mechanical properties that justify their use in the rehabilitation of anterior teeth[31,32].

Many ceramics have a glassy structure and, they are reinforced with other materials such as alumina, leucite. However, when the ceramic is polycrystalline, the greater the resistance force and the greater the fracture toughness of the ceramic[11]. In order to expand the indication of these ceramics for making posterior single crowns and even fixed partial dentures, lithium disilicate and zirconia-reinforced lithium silicate were incorporated into the composition of these materials[33].

According to Raposo et al.[9] (2014), currently dental ceramics can be divided through their composition as: conventional ceramics (feldspar) and reinforced ceramics where the materials can be: leucite, lithium disilicate, spinel, alumina and zirconia. In this the ceramics are classified as vitreous ceramics: feldspar, leucite and lithium disilicate and crystalline / polycrystalline ceramics: alumina, spinel and zirconia. It is important that professionals to know about the chemical composition and clinical performance of current dental materials, thus allowing the choice of the most suitable restorative material for each individual case and, consequently, providing greater treatment longevity[34].

Acid-sensitive ceramics correspond to ceramics with a large amount of silica (vitreous matrix) in their composition, such as feldspar and lithium disilicate ceramics[25].

Among the sensitive acid ceramics, we can mention the feldspar, leukitic and lithium disilicate ceramics, being the lithium disilicate ceramics, a material with resistance between 360MPa to 400MPa, a property that enables it to make extremely fine structures, avoiding, thus, that excessive wear is made to the dental structure[12,13].

Based on the indications and aesthetics of each ceramic, the dentist must know about the cements and cementation techniques for each clinical situation, properly select the adhesive systems for resin cements, isolate the operative field, pay attention to the manufacturers' recommendations, in addition to observing the ideal thickness of the ceramic, use the substrate with the greatest possible elasticity module, observe the adhesion strength of the tooth-cement-ceramic interface and return the occlusal contacts. Ceramics need to be classified according to their composition, processing method, strength, melting temperature, translucency, clinical indications, cementation, surface sensitivity[30].

The strength of the material together with the fracture toughness, the lithium disilicate reinforced ceramics are indicated for making inlays, onlays, laminates, single crowns and fixed partial dentures of three elements. They can be used as infrastructure for unitary prostheses of up to three elements, later receiving coverings with compatible feldspar porcelain[16].

The crystalline / polycrystalline ceramics: alumina, spinel and zirconia, are acid-resistant ceramics in their composition with a high amount of oxides (crystalline phase), such as aluminum oxide, zirconium oxide, and a low amount of silica. In this case, the acid conditioning of these ceramics is not efficient. Its advantages: they are more mechanically resistant than glass ceramics, being indicated for wide fixed prostheses, including in the posterior region. As a disadvantage, they are less translucent, which allows to shade the color of darkened teeth or with metal retainers / pins, however, they are less resistant as to the union of resin cement when compared to glass ceramics[25].

The addition of yttrium oxide to zirconia aims to decrease the propagation of cracks by controlling volume expansion and stabilizing zirconia in the tetragonal phase at high temperatures[20,21,22].

Due to its high flexural strength, zirconium dioxide or yttrium-stabilized zirconia (Y-TZP) can be indicated for the manufacture of protocol prosthesis bars, extensive prosthetic rehabilitation infrastructure; however, the physical-mechanical requirements of the material as well as its technical principles must be respected, for example, when planning connectors of at least 4mm in thickness[20,21,22].

And although the zirconia structure is the one with the best mechanical property among dental ceramics, this material is the one with the greatest opacity, which can make it difficult to restore teeth that require high translucency, as in the anterior teeth[23].

Currently the market offers ceramic systems with excellent properties, making the aesthetic and functional needs are met. Thus, it is necessary to have the need for knowledge on the part of the professional when choosing which material to use according to the patient's clinical need, in order to obtain long-lasting and satisfactory results[30].

The selection of the types of techniques to be used in oral rehabilitation, as well as the association between them, depends on several factors, such as professional skill, the patient's desire, knowing the advantages and disadvantages of each technique, cost and degree of requirement aesthetics. It

is important that the professional knows the properties of different materials used in oral rehabilitation, in order to be able to safely indicate and execute them respecting the correct clinical principles[35].

CONCLUSION

There are many types of dental ceramics that are available on the market, making professionals in the field of rehabilitation dentistry need a constant search for knowledge about its properties and indications. Therefore, the good results are not exclusive to the type of material used, it depends on the type of ceramic used, case selection, adhesive protocols, laboratory steps and the preparation of the dental structure combined with the professional's skill.

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