VERIZONA PUBLISHER
Publishing Your Ideas

www.verizonaonlinepublishing.com
Vol: 1, Issue: 2

Journal of Dental Science and Therapy

Simplified Classification for Dental Ceramics

Gilbert Jorquera[1], Nicole Merino[1], Stephanie Walls[1], Eduardo Mahn[1]and Eduardo Fernández[2*]

[1]Universidad de los Andes
[2]AssociateProfessor, Restorative Dentistry Department, University of Chile, Santiago, Chile

***Corresponding author:** Eduardo Fernández, Associate Professor, Restorative Dentistry Department, University of Chile, Santiago, Chile; E mail: edofdez@yahoo.com

Article Type: Review, **Submission Date**: 5 August 2016, **Accepted Date:** 9 September 2016, **Published Date:** 30 September 2016.

Citation: Gilbert Jorquera, Nicole Merino, Stephanie Walls, Eduardo Mahn and Eduardo Fernández (2016) Simplified Classification for Dental Ceramics. J. Dent. Sci. Ther 1(2): 22-25.

Throughout history many types of ceramic materials have been developed in order to replace dental structures. At the beginning, porcelain fused to metal was the standard treatment, due to poor mechanical properties of pure ceramics. Over time, many improvements were achieved and metal-free restorations became a reality, for rehabilitation of anterior and posterior areas of the dental arch. Nowadays, due to the increasing expectations of our patients, as well as the importance of tooth preservation, metal-free restorations have become the standard treatment to replace teeth fragments such as inlays, onlays and veneersor full crown replacements as dental crowns, bridges and crowns on implants abutments. Nevertheless, how to choose the right ceramic material for each indication has become a real challenge for most of clinicians. The correct use of a classification based not only on mechanical and optical properties or microstructure, but in the way clinicians deal with the substrate will simplify our decision. This is the aim of the purposed classification, to facilitate the process of choosing the right ceramic material in our daily practice in order to fulfil patient's expectations.

Porcelain fused to metal (PFM) restorations have been used successfully for many years [1,2], nevertheless some drawbacks have raised over time. Allergic reactions [3], discolorations due to metallic ions [1] and a greyish [1] or darker gingiva due to the lack of light transmission [1,2] (Figure 1). These and other aspects have led the industry to develop metal-free ceramics characterised by their clearly superior optical properties, but in some cases inferior mechanical properties. If we enlist the mechanical features of ceramic materials, they roughly start at 60-70 Mpawith the feldspathic ceramics, fluorapatiteceramic have between 100-120 Mpa, 350-450 Mpathe lithium disilicate ceramics, approximately 350Mpa, In Ceram Spinell, 450 MpaIn Ceram Alumina, 650 MpaInCeram Zirconia and around 900-1100 Mpa the monolithic zirconium dioxide derivations [2,4]. These characteristics make each ceramic suitable for certain indications, whether we use the material alone or in combinations. When correctly indicated, ceramic materials present acceptable survival rates, biocompatibility in the oral environment [2] and they do not present galvanic corrosion [5]. These superior advantages are added to the obvious superiority in colour match and opacity match [1,2].

Figure 1: Staining and gingival margins visible metal ceramic restorations metal

Reviewing scientific literature in order to classify dental ceramics, a number of authors can be cited. A classification described by Giordano et al [4] sustains that dental ceramics can be divided according to their microstructure. In this order, Giordano et al [4] organized ceramics based on their glass content and their processing technique, such as powder/liquid, pressed or milled and finally based on their clinical application [4]. In addition, the author Narashimba et al [6], classified ceramics based on their microstructure, processing technique, composition and melting or baking temperature [6]. On the other hand, Kelly and Benettibased there classification on three groups; predominant glass content, followed by low glass content and finally absence of glass, considering the last two groups as structural ceramics [5].

However, the studies quoted above, refer to only three classification systems of a wide variety. Summarising, most of these can be grouped depending on, if the main focus is to facilitate the choice of the clinician based on practical factors, like optical properties and indications or the ceramic substrate treatment prior to cementation. Based on ceramics microstructure combined with their esthetic properties [4,6] four main groups can be distinguished; feldspathic ceramics, leucite or lithium reinforced, interpenetrating phase and polycristaline ceramics. On the other hand, ceramics can also be classified based on their processing technique such as the powder/liquid, pressed and milled [2,7].

The classification proposed in this review divides dental ceramics in two main groups; Glass ceramics and Oxide ceramics (Figure 2). Glass ceramics are characterized for being etchable, property of their glass phase. The protocol of pre-treatment prior to cementation of these ceramics includes the etching with hidrofluoric acid with a concentration between 4.5-10%oramoniumpolyfluoride (Monobond etch & prime®), silanization with one or two bottles or no silanization in case of the Monobond etch & prime® and an adhesive or directly resin cement (Figure 3). Due to the glass content these ceramics tend to be more translucent. The second group of ceramics are the oxide ceramics that are not etchable. They need to be sand-blasted and then primed with a phosphonic acid or MDP (Methacriloyloxydecyldihydrogen phosphate) containing primer (Figure 4). Then an adhesive or directly resin cement is applied depending on the type of cement. This division provides clinician orientation regarding the indication and way of cementation, with the glass ceramics being used for the more esthetic cases in the anterior region like thinner crowns, veneers, inlays, onlays and the oxide ceramics mainly used for crowns and bridges [8,9] (Figure 5 and 6).

Figure 2: Simplified classification

By nature, ceramic materials do not posses affinity with dental structures. It is for this reason why preparation of the ceramic surface as well as the tooth surface is needed prior to cementation. Adhesive cementation increases fracture resistance, measured by flexural strength [2]. This can be explained because the chemical and micromechanical bond between the ceramic surface and the tooth microstructure, permits this union to work as a unit [8]. Hydrofluoric acid or the recently introduced amoniumpolyfluoride creates an etching pattern by dissolving the superficial glass layer of mainly feldspathic ceramics, leucite or lithium disilicate reinforced ceramics. Accordingly, the smaller the glass phase, less effect of acid etching on the ceramic surface, being the case of InCeram ceramics, where Inceram Spinnelis etchable and InCeram Alumina has less interaction with the resin cement [8]. The acid creates pores, cleans the surface and increases the humectability, which allows the silane to infiltrate and create covalent bonding [8,9]. Silane is a coupling agent that allows two materials of different nature (organic cements with inorganic ceramics) to interact chemically by the creation of a silanol group, creating water as waste of the chemical reaction [2,7]. There is clear scientific evidence that proves the increase of bond strength between resin cements and ceramics with the use of silanes after the etching withhidrofluoric acid [7,8]. The second group of ceramics, the oxide ceramics, since they do not contain a glass phase, are not etchable and need a sandblasting procedure with aluminium oxide particlesof maximum 40 um at ideally no more than 1 bar of pressure. Then, as mentioned before, a phosphonic acid or MDP containing primer or bonding should be used prior to the cement placement [8].

It is also important not only to associate both ceramic groups to the cementation process, but also to the optical and mechanical properties that are desired for each case. The clinician should have enough knowledge about the differences between currently available ceramics in order to provide the patient with not only the best possible esthetic outcome, but also the best possible performance in terms of long survival rates [5]. The final esthetic outcome of an all-ceramic restoration depends on three main factors:

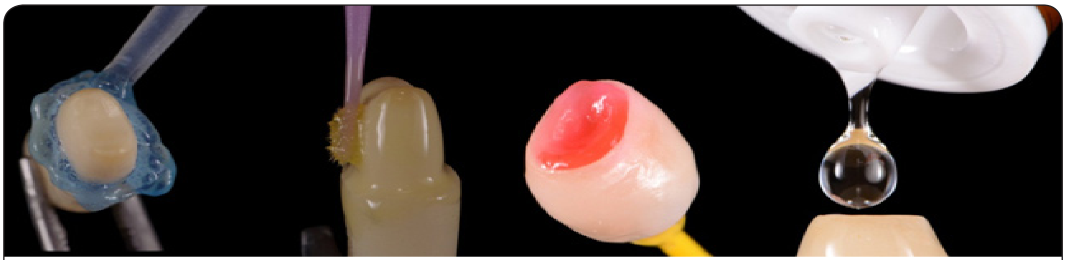

Figure 3: Management protocol for glass ceramics

Figure 4: Management protocol for oxide ceramics

Figure 5: Glass ceramic with lithium disilicate reinforced in a anterior case of high aesthetic requirement

Figure 6: Oxide ceramic for substructure in a posterior case of high mechanical requirement

1. The characteristics of the dental substrate: An important role depends on whether the substrate is a pure normal-colored dentin stump, a hybrid between severely discolored dentin and tooth colored composite or if a metal post and core is present.

2. The type, color and value of the cementation material: It is widely known that zinc phosphate cements and glass ionomer cements are very opaque. On the other hand resin cements offer a wide range of shades, opacity and chroma.

3. The type of ceramic: As mentioned before, there are ceramic materials that can be as opaque as metal and some that are extremely translucent. Combinations of them are also possible.

A review of the literature shows, that normally ceramic materials, from an optical point of view, are classified in semi-opaque and semi-translucent. Systems like InCeram Alumina, InCeram Zirconia or zirconium dioxide based ceramics are considered semi-opaque. They tend to have a rather higher flexural strength and have a partial light transmission [10]. Common feldspathic ceramics and systems like In Ceram Spinell, IPS Empress Esthetic or CAD® and IPS e.max Press or CAD® are classified as semi-translucent. They have inferior mechanical properties, but a clearly superior estheticpotential.Feldspathic ceramics or Fluorapatite ceramic (IPS e.max Ceram®) are the weakest, but present the highest esthetic potential. This is the reason why they are currently used only as a layering ceramic on top of a stronger core or for ceramic veneers. The second group is represented by the leucite reinforced ceramic mainly known as IPS Empress Esthetic® or IPS Empress CAD®. The addition of leucite to the feldspathic matrix makes the material less abrasive and increase its flexural strength avoiding the propagation of cracks [1]. This ceramic can be used alone for the fabrication of veneers, crowns, inlays and onlays. The minimum thickness recommended by the manufacturer needs to be strictly respected and adhesive cementation is mandatory. The last type in this group are the lithium silicate reinforced with zirconium oxide (Vita Suprinity® andCeltra® from Dentsply) and Lithium disilicate (IvoclarVivadent, IPS e.max Press®orIPSe.max CAD®). They present a high content of glass and very fine fillers. The interaction between the glass particles and the lithium raise the flexural strength up to 400 or 450 Mpa, three to four times more than the other glass ceramics [1]. It possess a low refractive index and the translucency can be managed at different degrees allowing this type of ceramic to be indicated for all kind of single unit restorations, even the most challenging estheticcases [4,6]. The second large group, the oxide ceramics or semi-opaque ceramics present a flexural strength of around 600 Mpa in the case of the aluminium oxide ceramics and 900-1100 Mpa in the case of the zirconium dioxide ceramics [1]. It is important to notice; that during theyears research referring aluminium oxide based ceramics has clearly diminished, with the logical consequence of the stagnation of innovation of products related to this type of ceramic. Big efforts are now pointed to the zirconium oxide ceramics with huge improvements in the optical properties as well as in their indications. Current characteristics allow this ceramic to be a reasonable solution for crowns, bridges and large superstructures on implants [4,6].

It is also important to mention that technological improvements have also affected dentistry. There is a clear trend towards digitalization. This means that less traditional impressions are taken and less ceramic is being pressed or layered compared to digital impressions, digital design and milling of ceramic blocks. Ceramic materials used for CAD-CAM systems can be classified the same way as traditional systems. In fact, most of the classical systems or pressed systems have their counterparts in the CAD-CAM world; this is the case for IPS e.max Press®that is the same material as IPS e.max CAD®. The CAD-CAMtechnology represents certain advantages over the traditional methods. The standardization of the process and the reproductability of the results are the main ones. But it also increases clinical performance, since the blocks are produced under standardized industrial conditions and then simply milled in the dental office or the laboratory. On the contrary, when ceramics are pressed or layered, the "human touch" can make the results very variable. The lack of standarization in the process is the main weakness. Digital dentistry is supposed to lower the cost and diminish clinical time spent [4,6]. One of the first materials used for CAD-CAM technology was the Vitablocks® known as Mark I and later Mark II, later the market developed systems like Procad® or IPS Empress CAD®. They were originally designed for the Cerec systems®. Their indications were inlays, onlays, crowns and veneers. All of these are still available as monochromatic or polychromatic blocks and can be used as monolithic restorations that need just to be polished or glazed and stained. When higher esthetic is required, they can also be layered [4,6]. Stronger materials, like Vita Suprinity®, Celtra®or IPS e.max CAD® from IvoclarVivadent, are stopped in their production process as a meta-silicate at roughly 160 Mpa of flexural strength in order to keep their resistance to the milling process low. Once the restorations are milled, a final crystallization process is needed in order to reach the final size of the crystals, increasing in consequence the mechanical properties and achievement of the final shade. The interruptionof the original crystallization process diminishes the final flexural strength in roughly 10%, which is clinically negligible [4].

The oxide ceramics or semi-opaque group, are milled in a pre-sintered stage. The already milled restorations need to be placed in a furnace for the sintering process that causes shrinkage of 20-25 % in volume [4,6].

In summary, the intention of creating 2 large groups of ceramic materials that have common characteristics in terms of microstructure, processing, cementation protocols, optical and mechanical properties is to simplify the indication of them and the clinical steps necessary for their placement. Systems like Mark II®, IPS Empress CAD® or IPS EmpressEsthetic®, Suprinity® or IPS e.max Press or CAD® belong all to the glass ceramic group, that present low to medium values of flexural strength, are etchable with hidrofluoric acid or amoniumpolifluoride, are silanized and are highly esthetic. The main indications are single units like crowns, veneers, inlays, onlays and table tops. Adhesive cementation is mandatory in all cases. All zirconium oxide derivations belong to the oxide ceramics, are semi-opaque, non etchable, should be sand-blasted and ideally primed with phosphonic acid or MPD containing primer or adhesive.

The classification remains as follows:

Group 1: Glass ceramics or semi-translucent ceramics. Etchables and used mainly for single units, anterior as well as posterior. Indications vary from fragments of tooth like partial veneers or table tops, edge ups,all type of veneers, inlays, onlays and full crowns.

Group 2: Oxide ceramics or semi-opaque ceramics. Non etchable, they should be sand-blasted. Main indications are crowns, bridges and implant suprastructures.

References

1. McLaren, ViG E. Crown considerations, preparations, and material selection for esthetic metal-ceramic restoration. Esthetic Technique; 2001.
2. Chu S, Ahmad I. A historical perspective of synthetic ceramic and traditional feldspathic porcelain. Pract Proced Aesthetic Dent PPAD. 2005; 17(9):593–8.
3. Rosenblum MA, Schulman A. A review of all-ceramic restorations. J Am Dent Assoc. 1997; 128(3):297–307.
4. Giordano R, McLaren EA. Ceramics overview: classification by microstructure and processing methods. Compend Contin Educ Dent. 2010; 31(9):682–4, 686, 688 passim.
5. Kelly JR. Dental ceramics: what is this stuff anyway? J Am Dent Assoc. 2008; 139 Suppl:4S – 7S.
6. Narasimha R. Ceramics in Dentistry, sintering of ceramics. New Emerging Techniques, Dr. Arunachalam Lakshmanan.
7. Heintze SD, Rousson V. Fracture rates of IPS Empress all-ceramic crowns--a systematic review. Int J Prosthodont. 2010; 23(2):129–33.
8. Ho GW, Matinlinna JP. Insights on Ceramics as Dental Materials. Part II: Chemical Surface Treatments. Silicon. 2011; 3(3):117–23.
9. McLaren EA. All-ceramic alternatives to conventional metal-ceramic restorations. Compend Contin Educ Dent 1998; 19(3):307–8, 310, 312 passim.
10. Raptis NV, Michalakis KX, Hirayama H. Optical behavior of current ceramic systems. Int J Periodontics Restorative Dent. 2006; 26(1):31–41.