

# Comparison of dental ceramic techniques



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Compariso  
n of Dental  
Ceramic  
Techniques

Convention  
al lost wax  
technique  
with heat  
press  
ceramic,  
CAD/CAM  
ceramic  
(lithium  
disilicate &  
monolithic  
Zirconia)

### Introduction:

Over the last 10 years, many technological advances have been introduced in the dental ceramic fields in both fabrication method and increase in availability of the materials. Those changes improve the ceramic restoration in strength, clinical performance, longevity and have simplified the work of the dental technician, which accelerated the growth of the proportion of all-ceramic restorative treatments (I. Denry & Holloway, 2010). Dental ceramic can be processed by various techniques, traditionally, it was fabricated by <https://assignbuster.com/comparison-of-dental-ceramic-techniques/>

powder and slurry technique or slip casting technique. However, those technique become less used in contemporary all ceramic industry.

Nowadays, conventional lost wax technique with a pressable ceramic ingot systems that uses staining technique or the layering technique with powder and liquid systems were often used, and also the CAD/CAM system using the lithium disilicate or the monolithic zirconia block become one of way to fabricate all ceramic restoration (Silva et al., 2017). This article reviews and discuss the dental ceramic and different fabrication methods of all ceramic restoration for last 10 years.

### Dental ceramic:

Dental ceramic materials are described as an inorganic and non-metallic materials made by man by heating the raw minerals at high temperatures (Powers & Sakaguchi, 2012), it is one of the most biocompatible and aesthetically pleasing dental restorations currently available to replaces the missing or damaged tooth with mimicking the appearance of patients' natural tooth structure accurately in terms of color, surface texture, and translucency of the enamel. Therefore, all ceramic restoration is identical to surrounding tooth and usually indistinguishable (Rosenstiel, Land, & Fujimoto, 2015). Other than all-ceramic restoration, there is also PFM systems available, which combines aesthetic properties of ceramics and the mechanical properties of metals together. Although, according to the Shenoy, metals ceramic restoration may contribute problems for some patients, for instance, metal allergies, gum staining and release of metallic ions into the gingival tissue and the fluid (Shenoy & Shenoy, 2010). With these drawbacks and also most importantly for the increasing aesthetics

demand of the patient, all ceramic restorations becoming a major part of contemporary dental practice, however, all ceramic restoration also has a drawback mostly due to their inability to withstand the masticatory forces within the oral cavity. Therefore, initially, dental ceramic was limited to use in the premolar and molar areas and generally used for low a stress situation like anterior region (Silva et al., 2017), although recent improvement of these materials and technology like CAD/CAM system has enabled all ceramic restoration as a posterior long life fixed partial prosthetic restoration.

#### Traditional method of fabricating all ceramic restoration:

Traditionally, technique called slip casting and conventional powder and slurry technique was commonly used in the laboratory (Gizowska, 2009).

#### Slip casting

Nowadays, slip-casting became very old technique in the ceramic industry. The slip is a low viscosity, homogenous mixture of the ceramic powder and water (Rosenstiel et al., 2015). Laboratory procedure of slip casting start with applying the slip onto a refractory die, which absorbs the moisture from the slip mixture and leads to the condensation of the slip on the die. Then the crown is fired at a high temperature, the refractory die will shrink more than the condensed slip, which allows an easy separation after the crown has fired (Mously, 2013). Another way is to fabricate the negative reproduction of the restoration and pour up the slip into the mould. The mould wall will also remove the water from slip and the framework of the restoration will removed from mould after the firing. The fired core is then glass infiltrated,

and glass powders are spread on the core, and fired glass powder become molten and flows into the pores on the crown by capillary action (I. L. Denry, 1996; Shen, 2013). The restoration processed by slip-casting tend to result in very weak and porous ceramic, and it must be infiltrated with glass, or it should be fully sintered before the application of the veneering porcelain (Silva et al., 2017). As this technique requires a complicated series of steps that provide a challenge to dental technician to achieving an accurate fit for the restorations and may result in weak material due to incomplete glass infiltration, (Griggs, 2007) therefore this technique is rarely used as contemporary ceramic fabrication method.

#### Conventional powder and slurry technique

Conventional powder and slurry technique are still used in contemporary all ceramic crown fabrication, this technique is considered to be the most traditional method (Li, Chow, & Matinlinna, 2014) and it involves building the crown restoration in layers on a die material to form the contours by applying porcelain powder using a wet brush. The moist porcelain powder particles are compacted by removing the excess moisture and fired under the vacuum (Silva et al., 2017). Those powders are available in various shades, translucencies, with characterizing stains and glazes. Ceramic crowns fabricated by this technique have greater translucency than crowns produced with the other techniques, therefore this technique are still used for aesthetic veneer layers on strong ceramic cores and frameworks (Mously, 2013). However, this technique can result in relatively low-strength restorations due to the large amount of residual porosity (Griggs, 2007), thus nowadays other improved techniques and materials that overcomes the

disadvantages inherent in that traditional method are more preferred to use in the laboratory.

#### Contemporary method of fabricating all ceramic restoration:

As mentioned earlier in this article, there is several contemporary processing techniques are available for fabricating all-ceramic restoration using advanced material like heat pressing lithium disilicate ingots and millable lithium disilicate block or the monolithic zirconia block with CAD/CAM system.

#### Lost wax technique with heat press ceramic:

Pressed ceramic restorations are fabricated using method similar to injection moulding. All pressable ceramics are supplied from their manufacturers in the form of ingots that consists of crystalline particles distributed throughout a glassy material (Giordano & McLaren, 2010). These pressable lithium disilicate ingots have similar microstructure to porcelain powder, however, it contains more crystalline material and less porosity content as the ingots are manufactured from non-porous glass with heat treatment that transforms the glass into the crystals, which produces a controlled and homogeneous material (Griggs, 2007).

The laboratory procedure starts with fabricating the mould of restoration by lost wax technique. Advantage the of press ceramic system is that the equipment needed to heat-press dental ceramics is relatively inexpensive and also dental technicians are already familiar with the lost wax technique as it commonly used to fabricate other dental prosthesis (Teja & Teja, 2015).

Also, the shrinkage arising in a conventional powder and slurry technique is reduced with this heat-press technique (Chander, Mutukumar, Sasikala, & Dhanasekar, 2015). Firstly, prepare the model by pinning, sectioning and margin ditching, apply the model hardener to protect the margin, spacer to produce cement gap and separator to avoid wax to stick on to the model, then dip the die into melted medium hard wax and build the anatomical wax pattern using the hard wax (Fathi, Al-Masoody, El-Ghezawi, & Johnson, 2016). Once the crown restoration is waxed up, moulding form are prepared by attaching sprue to the wax pattern. Then it is invested and waxes are burn out in the furnaces according to the manufacture's instruction (Stappert, Att, Gerds, & Strub, 2006). In contemporary method of fabricating all ceramic restoration, instead of conventional waxing up, scan the master model either by laboratory scanner or the intraoral scanner at the dental clinic. Then the restoration pattern is designed by CAD software and fabricated by milling machine. This method will save the time spent in the laboratory for the waxing up the crown, human errors will decrease, simplified the working process and will increase the production rates (Almustafa, 2019). After the wax pattern are burn out in the furnaces, the press ceramic ingot is then pressed into the mould by plunger in press furnace. The ceramic ingots are heated to a high temperature where they turn into a highly viscous liquid, to allow the material to slowly pressed and flow into a mould under the pressure (Mously, 2013; Stappert et al., 2006). Pressable ceramic can be used for inlays, onlays, veneers and single-unit crowns and the restoration can be cast to its final contours and to provide an aesthetic match, it will be stained to the desired shade of patient's tooth and glazed. Alternative to staining technique, a coping can be casted with press ceramic, then

porcelains are built to achieve the final shape and shade of the restoration (Ivoclar vivadent, 2017). Press ceramic restoration fabricated by layering technique will achieve better aesthetic compared to the staining technique.

### C AD/CAM all ceramic restoration:

Recently, the increasing use of high strength ceramic materials and variety of CAD/CAM systems accelerates its popularity and seem to be widely used today in most dental clinics and dental laboratories (Gopal, 2017).

The CAD/CAM system consists three main aspects, data acquisition, data processing and digital manufacturing. For the data acquisition, intra-oral which scans the patient's oral structure at chairside, or extra-oral scanners that scans the die model at laboratory are available to scan the data for designing process, data processing step will use the design software to processes the data and produces a data set to fabricate the prosthesis and these data sets transformed into the desired products by manufacturing machines (Park & Shim, 2019). This CAD/CAM system was introduced in dentistry by Dr. Francois Duret in the early 70's (Alifui-segbaya, 2019). The technology in ceramic industry was originally intended for fully sintered ceramic blocks with hard machining system, however, it has now been expanded to partially sintered ceramics which uses the soft machining system, that are later heat treated to ensure adequate sintering (I. Denry & Holloway, 2010). Fully sintered ceramics are available in non-porous blocks and they do not require any further sintering, but it is difficult to mill and requires more time during milling, and might introduces the surface cracks that weaken ceramics in the milling process (Ariel J. Raigrodski, 2004),



therefore partially sintered ceramic becoming more popular. Advantage of those partially sintered ceramics are its porous state of ceramic block, enabling the fast milling without bulk fracture which leads to substantial savings in time and tool wear than fully sintered blocks. On the other hands, partially sintered ceramics requires sintering treatment to eliminate the porosity. Therefore, computer software must compensate for the shrinkage that occurs during sintering to achieve the accuracy of fit (A. J. Raigrodski, 2005; Silva et al., 2017).

The CAD-CAM systems are already well established in the dental ceramic industry, although, they have drawback which related to the waste of material upon milling process as the leftovers from these material blocks are not reusable and wasted (Silva et al., 2017). However, even there is some drawback, CAD/CAM technologies are getting more common in contemporary all ceramic industry as it help to eliminate human errors that lead to inaccuracies or remakes as the digitally fabricated restorations have been shown greater accuracy when compared to those fabricated using conventional procedures (Ferencz, 2014) and it will also eliminate number of clinical and laboratory steps which leads to the fast and effective delivery of the dental prosthesis (T Miyazaki & Hotta, 2011). Another advance of milling technology is that it allows the use of materials like monolithic zirconia that cannot be used by conventional processing method, those controlled processing of ceramic material decreases the residual stresses, produces higher density with lower porosity and will improve the clinical performance (Shenoy & Shenoy, 2010).

Lithium disilicate

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Lithium disilicate is highly aesthetic and strength material that can be conventionally cemented. (Tysowsky, 2009). Lithium disilicate, for example, IPS™ e. max CAD, is highly resistant to the thermal shock due to the low thermal expansion rate. It can be processed using either heat press technique and CAD/CAM milling technique (Culp & McLaren, 2010). They are available in various shades as well as translucencies and are supplied in a pre-crystallised block which called blue state. This material can be use in fabricating inlays, onlays, veneers, anterior and posterior crowns, and also implant-supported crowns (Jain et al., 2018).

There are two basic fabrication methods when processing lithium disilicate with CAD/CAM milling machine. The first method is to mill the restoration to full contour, then staining, glaze and crystallise, it can be done by applying the stain and glaze after the crystallization step which allows the technician to see the final color of the crown before applying the stains and it can be easier for some technician to stains as it makes more straightforward to imagine the final looks of the crown (Shenoy & Shenoy, 2010). As contemporary lithium disilicate material has ability to offer a full contour restoration, which means fabricated from one high strength ceramic, it can eliminate the veneered ceramic and its bond interface, therefore, greater structural integrity can be achieved (Culp & McLaren, 2010; Tysowsky, 2009). The second method is to mill the restoration to full anatomical contour and before the crystallisation, the incisal edge is preserved by laboratory patty. Then the mamelons are created by cutting back incisal edge, and powder and liquid are layered until the appropriate incisal shape, suing the patty key as the guide to build back to the original contour. The

restoration is then crystallized in the furnace according to the manufacturer's instruction (Shenoy & Shenoy, 2010). This technique can provide in depth colour effect, however, veneering material tends to chip or fracture during function and quality of the strong interface bond between lithium disilicate and additional porcelain is highly depending on laboratory technician's experience (Culp & McLaren, 2010).

### Monolithic zirconia

There is an also growing demand for the zirconia prostheses as zirconia are able to withstand posterior occlusal loads. Therefore, zirconia crown can be alternative to metal crown with better aesthetic (Daou, 2014). Although zirconia cores are considered as reliable materials, these restorations are not problem free. Zirconia is harder than enamel, although, wear of opposing enamel appears to be less with monolithic zirconia than other dental ceramics, when the restoration are carefully polished otherwise a rough surface of zirconia will lead to increased wear of the opposing tooth (Esquivel-Upshaw et al., 2018) and the production of an all-ceramic crown using zirconia requires expensive equipment, such as 3D scanner, computer aided design software, and milling machining (Masuda, Kakimoto, Takahashi, & Komasa, 2016).

Zirconia ceramics can be fabricated by either of two method which mills a fully sintered solid block or partially sintered block using CAD/CAM procedures. For both methods, the die or the wax pattern is scanned and restoration are designed with computer software. In the first method, restoration with final dimensions can be milled directly from fully sintered

blocks using a milling machine. This system has the advantage of superior fit, because no shrinkage is involved in the process, but has the disadvantage of inferior machining associated with wear of the tool (T. Miyazaki, Nakamura, Matsumura, Ban, & Kobayashi, 2013; Silva et al., 2017). In the second method, frameworks with enlarged dimensions can be milled from partially-sintered block, again using milling machines, followed by post-sintering at high temperature to obtain a framework with final dimensions and sufficient strength (T. Miyazaki et al., 2013). This system has the advantage of easy machinability without wear on the tools and chipping of the material. Although, the dimensions of the frameworks must be adjusted to compensate for extensive sintering shrinkage during the post-sintering process, so that the final frameworks fit well (Shenoy & Shenoy, 2010).

### Conclusion:

There is various fabrication method of all ceramic restoration, recent improvements of material and advance in digital industry developed aesthetic ceramic restoration with superior biocompatible properties with strength, clinical performance, and longevity. Those improved restorative material and fabricating method can be considered as ideal replacement for natural tooth structures, however, they are relatively new and still lack the support of long term clinical experience and research. Therefore, as ceramics are playing an increasingly important role in restorative dentistry, research for the further improvements in fracture resistance, wear properties with aesthetics is to be expected.

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