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# Smile Makeover with Indirect Ceramic Restoration

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Departmentof Restorative and Aesthetic Dentistry in
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## Certification of the Supervisor

I certify that this project entitled **"Smile Makeover with Indirect Ceramic Restoration"** was prepared by the fifth-year student **Nadine Ra'id Ramzi** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dentistry.

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# Dedication

First of all, I thank "God" for providing me with willingness and strength to achieve this work.

I want to dedicate this work to my family especially my husband, my father and my mother, who supported and encouraged me.

To my friends who were there whenever needed.

To my supervisor for her guidance, patience and advises.

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# Introduction

Cosmetic dentistry has become one of the most aspects of dental practice importance and development over several years. Nowadays, the main reason for seeking the dental office is not to restore the dental tissues lost because of caries or trauma only, but also to achieve the desired color and form of teeth for social acceptance **(Miyazaki and Hotta, 2011).**

Ceramic veneer restorations have proven to be durable and aesthetic restorative procedure for treatment of teeth in the front area of the mouth. Ceramic veneers are more conservative than crowns, and maintain the biomechanics of an original tooth.

Restorative aesthetic dentistry should be practiced as conservatively as possible. The use of adhesive technologies makes it possible to preserve as much tooth structure as is feasible while satisfying the patient's restorative needs and aesthetic desires. With indirect restorations, clinicians should choose a material and technique that allows the most conservative treatment; satisfies the patient's aesthetic, structural, and biologic requirements; and has the mechanical requirements to provide clinical durability **(McLaren EA and Whiteman YY, 2010).**

Based on their strength, longevity, conservative nature, biocompatibility, and aesthetics, veneers have been considered one of the most viable treatment modalities. Aesthetic veneers in ceramic materials demonstrate excellent clinical performance and, as materials and techniques have evolved, veneers have become one of the most predictable, most aesthetic, and least invasive modalities of treatment **(Radz GM, 2011).** For this reason, both materials and techniques provide the dentist and patient an opportunity to enhance the patient's smile in a minimally invasive to virtually noninvasive way. Initially used to treat various kinds of tooth discoloration, porcelain laminate veneers have been increasingly replaced by more conservative therapeutic modalities, such as bleaching and enamel microabrasion **(Belser UC *et al*., 1997).** However this evolution has not led to a decrease in indications for veneers, as materials and techniques continue to be developed. Ceramic veneers are considered the ultimate option for a conservative aesthetic approach because they leave nearly all of the enamel intact before the veneer is placed **(Strassler HE, 2007).**

## Aim of Study

The aim of this project is to review the classification of ceramic materials, preparation of teeth for ceramic veneers and cementation.

# Review of literature

## 1.1 History

The Etruscans used dental crowns and bridges 2,500 years ago, but they fell out of use during the Middle Ages. Pierre Mouton reintroduced gold crowns in the 18$^{th}$ century, while accurate casting procedures for dental alloys were developed in the early 20$^{th}$ century. Metal that exhibits excellent mechanical properties for framework use, even for large dental prostheses, does not ensure a natural restoration appearance. Therefore, ceramics were rapidly employed as veneering materials, and the first esthetic crown, composed of porcelain fused on a platinum post, was patented in 1885 **(Shell JS and Nielsen JP, 1962).**

The first all-ceramic jacket crown was patented at the end of the 19$^{th}$ century **(Taylor J, 1923)**, and Mac Lean reintroduced it in the 1960s when he developed a jacket with an alumina core to replace metal. However, all ceramic restorations started to flood the market from the 1980s onward, with the introduction of the In-Ceram system (Vita Zahnfabrik) and glass-ceramics systems such as Dicor (Dentsply International), which were followed by the appearance of the Empress system (Ivoclar Vivadent) in the early 1990s.

Therefore, some all-ceramics are as old as some porcelain-fused-to-metal (PFM) systems, and already show a 40-year clinical background. The emergence of computer aided design/computer-assisted manufacture (CAD/CAM) processes has strongly influenced the development of dental ceramics since the 1990s, allowing the introduction of high-strength polycrystalline ceramics such as zirconia, progressively replacing hand craftsmanship with industrial production, promoting rapid manufacturing. The present trend is the substitution of the veneered restorations with monolithic restorations, which are simply tainted and glazed.

Today, dental ceramics represent a large variety of materials in terms of chemical composition, but also in terms of manufacturing processes. These systems possess specific properties and indications, and as there is no ideal material, the clinician should be able to choose the right one in each clinical situation. However, this choice is complicated by the number of products and the amount of information available on the market, as much by the rapid and constant evolution of materials. This chapter intends to give a comprehensive clinical overview and classification of dental ceramics, allowing an informed choice in order to promote clinical success.

## 1.2 Classification of all-ceramic materials

Dental ceramics can be classified in a number of different ways, including by their composition, processing method, fusing temperature, microstructure, translucency, fracture resistance, and abrasiveness.

### 1.2.1 Classification according to their chemical composition

Ceramics can be divided into three categories by composition: ceramics that are predominantly composed of glass, those made of particle-filled glass, and those consisting of polycrystalline.

- Glass ceramics: Glass-ceramic materials may be ideally suited for use as dental restorative materials. This class of materials consists of a glass matrix surrounding a second phase of individual crystals. Glass-ceramics generally have improved mechanical and physical properties, such as increased fracture resistance, improved thermal shock resistance, and erosion resistance. The exact properties depend upon the crystal size and density and the interaction between the crystals and matrix. The crystals help to slow crack propagation, and may even pin cracks by a combination of dispersion strengthening and compressive stress generated around each crystal as it grows **(Malament KA and Grossman DG, 1992).**

- Reinforced ceramics: In order to improve mechanical properties such as strength, thermal expansion and contraction, manufacturers have added particles to the basic composition of the glass-ceramics. These particles are generally crystalline, but may also be high-melting glass particles, which are stable at ceramic firing temperatures **(Kelly JR, 2004).** Greater amount of leucite was added to the feldspathic ceramic in order to increase its resistance. Approximately 55%wt of leucite crystals were added to a glass matrix, which brings advantages such as the absence of an opaque infrastructure, good translucency and the possibility of being used without special laboratory equipment, since the technique for manufacturing these ceramics is similar to that for feldspathic ceramics **(Kelly JR, 2004; Kelly JR, 2008; Kelly J and Benetti P, 2011).**

- Polycrystalline ceramics: These ceramics are exclusively produced by CAD/CAM technology and designed for the production of structures in polylytic restorations, without a glass matrix in their compositions. All of their atoms are condensed under regular arrangements, which makes exceedingly this class of material more resistant to the propagation of flaws than glass-ceramics or those containing a vitreous content in their composition. The crystalline arrangement lends these ceramic materials the highest strength, but they are generally less esthetic. Nonglass-containing polycrystalline ceramics comprise an aluminum oxide or zirconium oxide matrix **(Kelly JR, 2004; Kelly JR, 2008; Kelly J and Benetti P, 2011).**

### 1.2.2 Classification of all-ceramic materials according to the Processing Method

Ceramic restorations produced by different methods have different properties that affect clinical performance – strength, translucency/opacity and accuracy of fit. The methods of production include:

- Powder condensation: This is the traditional method of building ceramic. This condensation method incorporates building on a ceramic or metal core with a powder/liquid ceramic slurry with a brush or spatula by hand. The slurry is condensed by vibration to remove excess liquid, which rises to the surface and is blotted away by an absorbent tissue. It is important to remove any voids during the application, but this does not always occur. Depending on the skill of the technician, some voids may remain, decreasing the overall strength of the restoration. At certain steps in the fabrication, the ceramic buildup is vacuum fired at a selected temperature, which removes the moisture and further condenses the ceramic through a process called "sintering." During the sintering process, fusion occurs at the particles' points of contact, which results in densification by viscous flow when the ceramic or glass particles reach their firing temperature **(Powers JM and Sakaguichi RL, 2006).**

- Slip casting: This processing technique involves the creation of a porous core by slip casting, which is sintered and then infiltrated with a lanthanum-based glass, producing two interpenetrating continuous networks: a glassy phase and a crystalline infrastructure **(Denry I and Holloway JA,2010).** Restorations produced through this method tend to have fewer defects from processing and have greater strength than conventional feldspathic porcelain **(Powers JM and Sakaguichi RL, 2006).**

- Hot pressing: The hot-pressed ceramic fabrication technique was introduced in the late 1980s and allowed the dental technician to create the restoration in wax. Then, using the lost-wax technique, the technician was able to press a plasticized ceramic ingot into a heated investment mold. Ceramics containing high amounts of leucite glass or optimal pressable ceramics were initially used for this process **(Powers JM and Sakaguichi RL, 2006).** In 2006, lithium disilicate became the second generation of materials to use this method **(Helvey GA, 2010).**

- Computer-aided design/computer-aided manufacturing (CAD/CAM): CAD-CAM systems have recently been introduced to the dental profession. The processing begins with a smooth, rounded, well-tapered restoration. This preparation is sprayed and bonded to titanium dioxide contrast powder in the patient's mouth. An infrared camera records the powder and creates a 3-D optical impression on the computer. This image can be manipulated by the dentist to create ideal anatomy and contacts before processing. The shade of porcelain is selected by the dentist, and this shade selection is placed into the computer. The computer then tells the dentist what block of porcelain or composite is to be used. This block is then milled in-office according to the computer design **(Liu PR. A, 2005).** The ceramic material used for this system is either a glass-ceramic (Dicor MGC) or a feldspar-based ceramic (Vitabloc MKII). Dicor MGC is also a fluoromica glass-ceramic, but reportedly has a higher concentration of crystals and higher strength than the castable Dicor material **(Mormann et al, 1986; Shearer et al, 1993)**

## 1.3 Smile design

Given the importance of a smile and the complexity of its evaluation, a number of parameters such as facial, dentolabial, gingival as well as dental references are extremely important in identifying and recording all data needed to optimize the aesthetic appearance of the prosthetic rehabilitation **(Paris *et al.*, 2011).**

### 1.3.1 Facial Analysis

horizontal reference lines, vertical reference lines and facial proportions must be taken into consideration as a starting point in the aesthetic planning. Extraoral photos are used at the moment of the facial analysis and proper patient positioning is essential for carrying out the digital planning **(Fradeani M, 2004).**

Within these parameters, the main horizontal and vertical lines are:

1. the interpupillary horizontal line (passes through both pupils);
2. the horizontal line of the labial commissure (passes through the labial commissures);
3. the horizontal eyebrow line (passes through both eyebrows);
4. the vertical midline (center of the upper lip);

5. vertical lines of the nostrils (line tangent to the nasal alae);
6. the horizontal line of the incisal edge.

Horizontal reference lines are used to analyze the parallelism between the structures. The literature is unanimous on the importance of parallelism between horizontal lines of the face, such as the interpupillary, the eyebrow and the labial commissure lines **(Chiche GJ and Pinault A, 1994; Rodrigues CDT *et al*., 2009).** Often these references are used to guide the incisal plane, the occlusal plane and the gingival contour **(Fradeani M, 2004).**

### 1.3.2 Dentolabial Analysis

The correlation between lips, philtrum and central incisors is frequent and fundamental to establish the dominance of the centrals, which promotes a more pleasant aesthetics. As an example, bulky lips require longer and voluminous central incisors for proper display at rest **(Fradeani M, 2004).** This condition favors positioning correcting the teeth in situations of tiltings with ceramic veneer veneers in which the patient does not accept undergoing orthodontic treatment without interference of the facial aesthetic outcome. In contrast, thin and short lips require finer central incisors, which prevents their overdisplay at rest **(Fradeani M, 2004).** In this condition, it requires greater respect to morphology to be established, since the emergence profile to the three vestibular slopes, under the risk of changing the lip and facial aesthetics.

**Vig** & **Brundo** reported that maxillary incisors are more displayed on average in women (3.4 mm) when resting than in men (1.91 mm) and that in young patients they are more visible than in middle-aged patients (3.37 mm against 1.26 mm) **(Fradeani M, 2004).**

According to Gurel,**(Coachman *et al*., 2014)** a pleasant smile is achieved when the angles of the mouth (labial commissure line) are parallel to the interpupillary line and the incisal plane, with the tips of the canine gently touching the lower lip. This touch should be added to the the incisal curve coinciding with the lower lip.

According to Chang, **(Fields HW Jr *et al*., 2011)** and Cracel-Nogueira &Pinho, the average smile line is associated with more aesthetic smiles. Adding up these considerations, it is imperative that rehabilitative planning, especially surgical, to be based on this concept that the middle smile line is optimal and that is changeable over time. Thus, small distortions of high to middle smile lines will be compensated naturally and reach the optimal point through the years, which could, thereby promote less invasive therapies and quicker rehabilitation treatments.

During the smile, not only are the teeth should be considered, but also the illusion of depth or grading effect provided by the negative space created by the buccal corridor. Such terminology is defined by the available space in the buccal aspect of the smile of the posterior teeth until the buccal mucosa. This depth effect is emphasized by the vestibular-palatal position of the maxillary canines **(Gomes VL et al., 2006; Orce-Romero A et al., 2013; Rufenacht CR, 1990).**

### 1.3.3 Gingival Analysis

An aesthetically pleasing gingival contour occurs when the gingival zenith of the maxillary central incisor is symmetrical to the canine and ranges from 0.5 mm to 1.5 mm apical to the lateral incisor. In this conformation, the zeniths of the anterior superior teeth are characterized as the vertices of an imaginary triangle, which gives the balance of the gingival components. Lack of this harmony, verified by the absence of formation or inversion of this triangle, suggests the need for surgical correction of the tissue contour, in order to optimize the aesthetic result. The correct placement of the gingival margin will influence the tooth shape definitively.

In situations wherein the amount of gingival display is insufficient, it is more appropriate to use more triangular arches (more closed). On the other hand, when the amount of display is excessive gingival, parabolical smile arches are more preferred. Situations where such a gingival display is greater than 3 mm are known as gingival smile. Its etiology is related to different factors: (1) passive incomplete or altered eruption; (2) excess gingival growth; (3) maxillary anterior or complete vertical excess (hyper-maxilla); (4) insufficient length of crown; (5) short upper lip; and (6) hyperactivity of the upper lip **(Leong SCL and White PS, 2004).** Possible corrections for the gingival smile include periodontal surgery, orthodontic corrections, orthognathic surgery, and application of botulinum toxin and application of orthopedic cement. The definition for the type of treatment will depend on the variety of existing medical conditions **(Murthy BV, Ramani N, 2008)**, the generated clinical consequences, and above all upon the patient's compliance to the proposed treatment planning.

### 1.3.4 Dental Analysis

**1.3.4.1 Intratooth relationships:** In a harmonious dentition, the maxillary central incisors dominate in shape, size and position. The average length for maxillary central incisors has been measured at between 10 mm to 11 mm **(Chiche G, 1994).** The width to length esthetic relationship has been discussed to be 70% to 80% **(Magne *et al.*, 2003).** The optimal width to length ratio for the maxillary central zone was found to be a width of 75% to 85% of the length. It is extremely important to note that the esthetic perception of width-to-length ratios is significantly affected by the outline form and the reflective surface of the tooth. The lateral incisors are between 1 mm to a maximum of 2.5 mm shorter than the central. The canine is slightly shorter than the central between 0.5 to 1 mm **(Culp and McLaren, 2013).**

Premolars From the facial, premolars are roughly pentagon shaped (similar to canines) function with molars (a) to masticate food and (b) to maintain the vertical dimension of the face (between the nose and chin). First premolars (c) assist the canines in shearing or cutting food morsels, and all premolars (d) support the corners of the mouth and cheeks to keep them from sagging. This is more discernible in older people **(Scheid and Weiss, 2017).**

**1.3.4.2 Inter-tooth relationships:** When a person smiles and the teeth are displayed, there is an inter-tooth relationship that needs to be maintained for the composition to be considered esthetic. The maxillary central incisors should be relatively but not perfectly symmetrical. They should dominate but not overwhelm the smile **(Lombardi, 1973).**

Authors recommend using the golden proportion to define the optical width of the maxillary teeth as they go posteriorly **(McLaren and Cao, 2009).** Golden proportion: In dentistry it is a mathematical term concerning the proportions of the dentition. It is considered as the only mathematical tool for determining dominance and proportion in the arrangement of the maxillary teeth from the frontal view. Lombardi in 1973 was the first actually to apply this equation to dentistry.

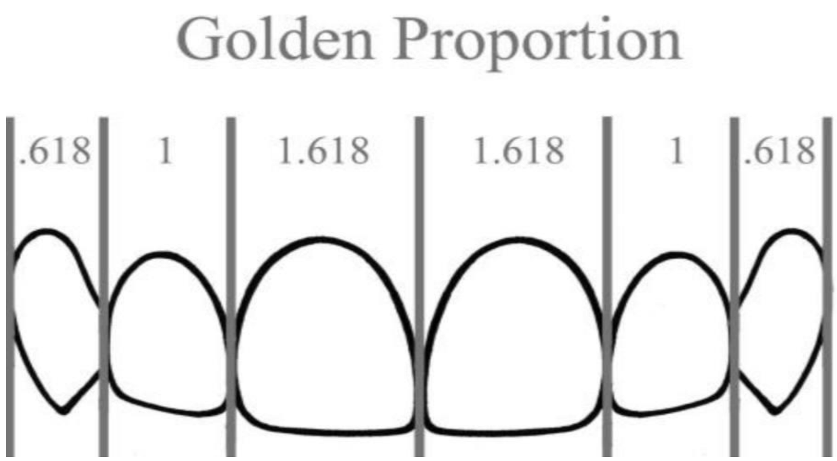


**Figure 1-1:** Diagram of Golden Proportion.

According to this, the ratio of the width from central to lateral to canine should follow 1.618:1:0.618, when viewed from the facial aspect. Even though it sounds reasonable, it is very difficult to apply this rule because in reality patients have different arch forms as well as different lip and facial proportions. Lombardi stated that the "strict application of Golden Proportion is too limiting for dentistry, owing to the differences in the shape of the dental arch" **(Bhuvaneswaran, 2010).**

## 1.4 Digital Smile Design

Digital Smile Design (DSD) is a method that allows us to digitally design the smile of our patients, by obtaining a simulation and pre-visualization of the therapeutic result. Patients are often found by the dentist and are immediately subjected to dental services or therapies, without the dentist himself having planned well or having shared the therapeutic project of a tailor-made smile for the patient with them. On the one hand, Digital Smile Design allows the patient to have awareness from the beginning of the therapeutic plan and for them be the first interpreter in the aesthetic and functional rehabilitation of their mouth, and on the other hand, it allows the specialist to tune in better to the expectations and needs of the patient, in order to pursue their shared goals.

DSD was used to create a diagnostic wax additive that shows the individual anatomical features of the teeth. After defining this process and getting the patients' approval, we conducted a test (mock-up) by placing wax directly over the patients' teeth without the need to erode the surfaces. In a mock-up, the patient can correct any of his/her dislikes **(Gurrea and Bruguera, 2014).**

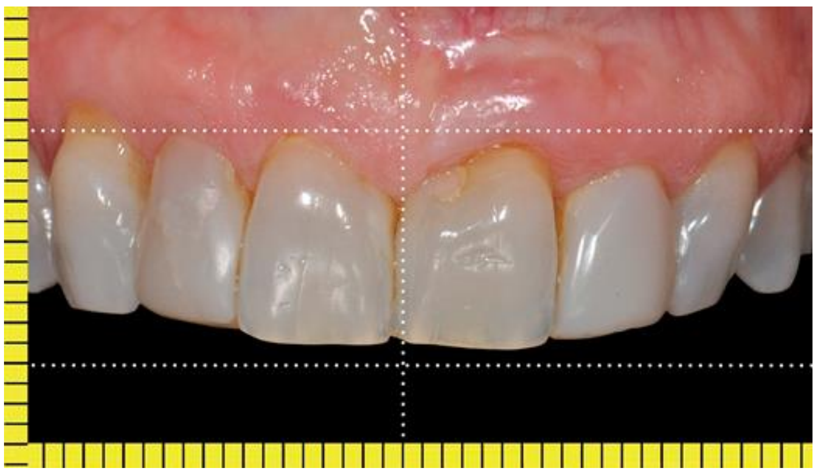

**Figure 1-2:** Digital Smile Design.

**Figure 1-3:** Diagnostic Wax-up.

Once the wax-up was completed, a silicone guide was made and put under 2 atm of pressure to increase detail reproduction. This silicone guide was partially filled with a bis-acryl resin material and placed in the patient's mouth. Before complete setting, a scalpel blade was used to define the correct gingival contour, respecting the manufacturer's recommendations **(Morita et al., 2016).**

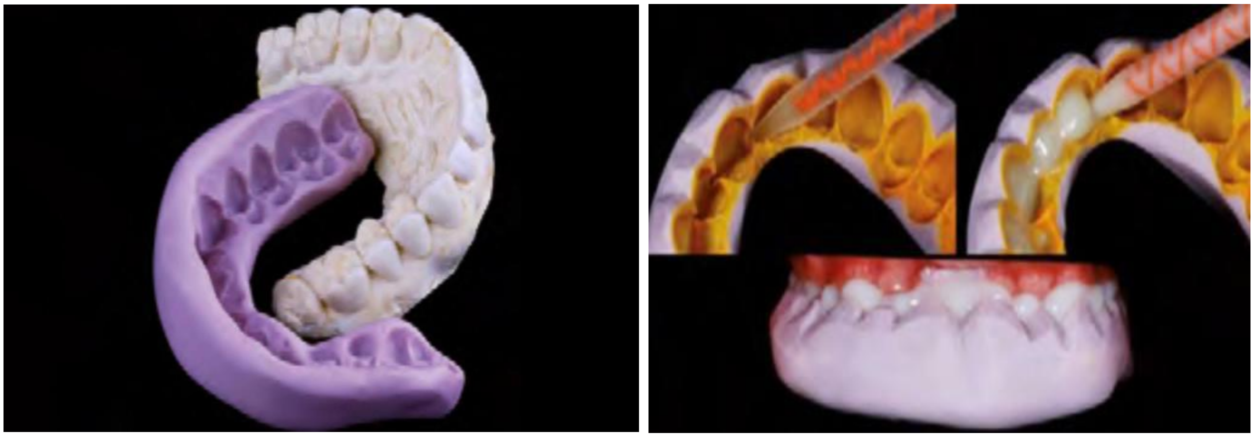

**Figure 1-4:** Indirect mock-up with bis-acrylic resin.

**Figure 1-5:** Final Mock-up.

## 1.5 Tooth Preparation

Preparations for ceramic veneers have undergone many changes and advances. The preparation shape can be influenced by tooth shape, location and orientation in the arch, tooth anatomy, occlusal function, mechanical forces, quantity and quality of the remaining tooth structure and anticipated final restorative dimension **(Gurel G, 2003; Hilgert LA *et al*., 2008; Terry DA, 2004)**. By using these clinical considerations, modifications in the preparation shapes may be varied and find a multitude of shapes, being guided by the pre-existing defect or depending on the anticipated dimension of the final restoration and the substrate shade.

### 1.5.1 Indications

- Color defects or abnormalities (Amelogenesis caused by hormones or tetracyclines)
- Abnormalities of shape (Microdontia)
- Abnormal structure or texture (Dysplasia, dytrophy, erosion, attrition)
- Malpositioning (Correction of minor malposition: rotated tooth, change of angulation)
- Diastemata
- Ceramic laminate veneer over ceramic crown (The ideal treatment in cases of partial fracture)
- Lingual laminate veneer (Useful for creating canine function or correcting anterior guidance)
- Lengthening (Lengthening will be in proportion to the volume of non-supported ceramics and occlusion) **(Garber, 1991).**

### 1.5.2 Contraindication

- Insufficient surface enamel (Laminate veneers are contraindicated if preparation does not provide for preserving at least 50% of enamel and if the margins are not located within the enamel)
- Pulpless teeth (In addition to being fragile, these teeth are liable to change color in time)
- Parafunction (Like bruxism and other ingrained habits)
- Unsuitable anatomical presentation
- Clinical crown too small (frequently found with the lower incisors, i.e. slender or outstandingly triangular teeth)
- Caries and fillings (Ideally, laminate veneers are intended for either healthy or slightly defective teeth. It is always preferable to replace defective fillings using glass ionomer or composites before placing veneers)
- Poor dental care and hygiene **(Garber, 1991).**

### 1.5.3 Consideratios in Preparation Design

Preparations for CVs should be based on the final smile design, with the shade and position of the margin of the restorations being taken into consideration. All efforts should be made to contain the preparation within enamel, as this provides the opportunity for a reliable and durable bond between restoration and remaining tooth tissue. Preparation into dentine should be avoided because of the less reliable bond to dentine, and the difference in elastic modulus and flexibility between dentine and porcelain. This puts the porcelain at risk of fracture when placed under tensile loading. In a 12-year study of 583 veneers, 7.2% or 42 veneers failed.

Those veneers bonded to dentine and teeth with preparation margins in dentine were approximately 10 times more likely to fail than those bonded to enamel **(Gurel G *et al*., 2013).**

### 1.5.3.1 Depth of the preparation

Control of reduction with silicone guides. The preparation design for ceramic veneers should allow for an optimal marginal adaptation of the definitive restoration and maximally resembling the ideal tooth morphology. Therefore, a diagnostic wax-up should be utilized as a reference for tooth reduction. Silicone guides, fabricated over the wax-up, provide simple and indispensable tools for control and in reduction of enamel **(Gurel G, 2003; Hilgert LA *et al*., 2008).** Two guides should be fabricated: a vertical guide (sectioned in the buccolingual direction) for reduction control in cervicoincisal direction; and a horizontal guide for the mesiodistal reduction control **(Baratieri LN *et al*., 2002; Baratieri LN and Guimarães J, 2008).**

**Figure 1-6:** PVS impression material for manufacturing the preparation guides.

- labial reduction

Preparation of the convex labial surface of incisors needs to be addressed in three planes: incisal, middle third and cervical. Preparation requires a minimum reduction of 0.3 mm (feldspathic porcelain) to 0.6 mm (leucite and lithium disilicate material). The enamel thickness at the gingival third is 0.3–0.5 mm.

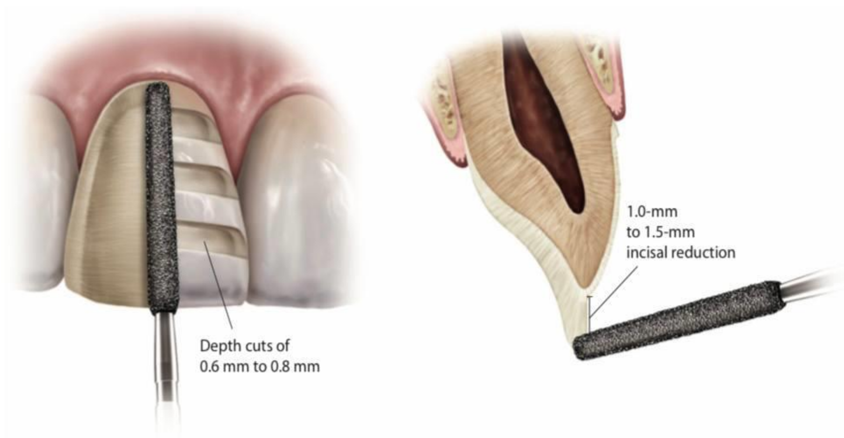


**Figure 1-7:** Porcelain veneer preparation requirements.

- proximal reduction

This may involve either stopping short of breaking the contact, or preparing through the contact area. If the contact area is to be maintained, the use of an elbow preparation, whereby the margins are extended proximally under the contact areas, may be used. This hides the margins as they extend inter-proximally. Breaking through the contact area may be required in cases with existing restorations, caries or crowding, and in cases where the dimensions of teeth are to be changed.

- Incisal reduction

There is little documented clinical evidence to support one specific incisal reduction design over another. According to Calamia, **(Calamia JR, 1988)** a tooth preparation that incorporates incisal overlap is preferable, as the veneer is stronger and provides a positive seat during cementation. This preparation design has the advantage of simple tooth preparation, and the esthetic characteristics are easier to achieve by the ceramist, as incisal translucency can be fully developed. This preparation also reduces stress concentration by distributing occlusal load over a wider surface area **(Highton R *et al.*, 1987).**

## 1.6 Gingival Displacement

Cervical termination of the preparation and the emergence profile are critical areas to be replicated in the working model for the manufacturing of ceramic veneers and contact lenses. In the case of gingival or intrassulcular termination, gingival displacement needs to be induced in order to allow for the access of the impression material into the sulcus. There are several methods of gingival displacement: • mechanical - displacement with impression copings or cords;

• chemo-mechanical - displacement with chemically-soaked cords;

• surgical; and

• ultrasonic. **(Pegoraro LF *et al.*, 1998; Pegoraro LF *et al.*, 2013)**

## 1.7 Impression Technique

A good impression is paramount in the successful provision of porcelain veneers. Due to the precise nature of the restorations the impression material used needs to be accurate and dimensionally stable. Elastomeric materials are considered to be the materials of choice. In the general practice setting, addition cured silicones are commonly used for indirect restorations **(Brunton *et al.*, 2005)** due to their superior dimensional stability, which means dies are accurate even if impressions are not poured straight away.

Three common methods for making impressions for fixed restorations are: single-viscosity (monophase technique), a simultaneous (dual-viscosity technique), and a putty-wash (sandwich technique) **(Wirz *et al.*, 1993)**.

In the monophase technique, since stock trays usually create less pressure upon insertion, the monophase technique is best suited for use with a customized tray or another tray with optimized fit and an impression material with excellent flow properties. With a custom tray and an automatically mixed polyether or VPS material extremely precise impressions can be achieved **(Wöstmann *et al.*, 2008)**. In the dual technique a putty or putty "soft" material is used as a tray material in combination with a light-bodied material. If the prepared tooth is syringed with the light-bodied material, the term one-step putty/wash technique is used as opposed to the sandwich technique where the light-bodied material is applied as a second layer "sandwich" on the putty tray material **(Wirz *et al.*, 1993).**

### 1.7.1 Digital Impression

Dental digital impression systems were initially envisioned by Duret in the 1970s for digital impression making directly in the patient's mouth or on a cast **(McLaren E, 2011).** Initial scanning relied on stripe scanning and video chips of crude design by today's standards. The resulting restorations had less than optimal adaptation and required substantial intraoral adjustment **(Tidehag P *et al*., 2014; Ng J *et al*., 2014).**

Digital impressions eliminate the possibility of dimensional change that is inherent in all conventional impression material. Voids, tears, pulls that are routinely experienced with elastomeric materials are no longer an issue with digital scans. In addition, the use of dental stones to create physical dental casts introduces additional inaccuracies due to expansion of stone and the possible movement or shifting of the individual dies when sectioned from the working cast. With digital scans, the number of steps is reduced and therefore the number of possible inaccuracies are reduced **(Ender A *et al*., 2016a).**

## 1.8 Shade Selection Methods

The color of a tooth is determined by a combination of intrinsic and extrinsic colorimetric effects. The intrinsic properties color are associated with the reflection and absorption of light; with the extrinsic properties related to coloring materials interacting with enamel, such as coffee, tea, tobacco **(Chu *et al*., 2004).** Factors such as enamel thickness, shape, surface texture, dominant color of dentin, double layer effect and light source may further complicate the visual perception of the various nuances of the whole tooth **(Joiner, 2004).**

### 1.8.1 Shade Guides

Although the subjectivity of the visual observation method is proven in several studies, to visually compare the natural tooth with artificial shade guide is still the primary means of shade selection used in Dentistry. The first shade guide, with 60 chromatic samples, was created by Clark in 1930. Since then, several studies have been performed to optimize its clinical application, but without significant changes. **(Paravina RD and Powers JM, 2004**). Currently, Vitapan Classical® (VC - Vita Zahnfabrik, Bad Säckingen, Germany) and 3D-Master Vita® (V3DM – Vita Zahnfabrik, Bad Säckingen, Germany)the most popular chromatic scales are considered. From a few differences presented by these scales, the difference in the arrangement of their chromatic samples stands out - in the first range it is performed in groups of hues, while in the second one, it takes place in groups of value **(Schmeling M *et al*., 2014).**

Formed in 1950, the VC shade guide has gained popularity to serve as the chromatic standard for ceramicsystemsfrom different manufacturers **(Brewer JD *et al*., 2004).** This shade guide has its chromatic tabs in four shades groups: A (brown), B (yellow), C (gray) and D (red).

### 1.8.2 Shade Taking Devices

Visual shade assessment is based on a subjective interpretation of colour and can vary at different times of the day. There is also variation from one clinician to another. The use of digital shade selection devices, developed to evaluate shades objectively, may eliminate human subjectivity, allowing a more reliable and reproducible shade assessment. The available devices include electronic colorimeters, spectrophotometers and digital image analysis instrumentation. When using such devices, it may, in certain cases, be prudent to check the selected shade using a conventional shade guide.

## 1.9 Provisional Restorations

The provision of temporary restorations is an integral element of the procedure for indirect, esthetic restorations. It is vital for periodontal and pulpal health while restorations are being constructed, and allows the clinician to demonstrate the proposed cosmetic improvements to the patient. Provisional restorations can be duplicated from a diagnostic wax-up, or constructed with a freehand chairside mock-up. This should incorporate the proposed changes that the patient, practitioner and ceramist have planned and agreed upon. These may include incisal lengthening, shade changes, and form and contour alterations. This step is essential in the planning process. It is much simpler and less costly to modify provisional restorations, according to the patient's expectations and requirements, than to remake completed restorations **(Wolfart M *et al*., 2007).**

delayed approach in the assessment of provisional restorations is recommended, so that patients are given ample opportunity to decide whether they are happy with the anticipated outcome. At the time of placing provisional restorations, the patient is often anaesthetized and cannot assess esthetics adequately. Time to allow patients to adjust to their new appearance, and to ask family and friends their opinion about their changed 'look', is invariably time well spent.

If the patient is happy with the provisional restorations, then the ceramist may construct the final restorations using the original wax-up as a blueprint. If the provisional restorations require modifications, they can be reduced or composite resin added to meet the needs of the patient. An impression of the modified provisional restorations will provide a template and serve as a communication tool for the ceramist regarding the required changes.

## 1.10 Try-in

Before any treatment of the teeth or the laminate veneers, the veneers must be tried-in with the utmost care, and without checking occlusal relationships. The objectives of this stage are to:

- survey the placing of the set of laminate veneers and the relationship between them and with the other (non-prepared) adjacent teeth;
- monitor the color;
- determine the color of the composite cement;
- check the fit of each laminate veneer.

The prepared tooth is first cleaned with a slurry of fine pumice and water. Some authors advocate a mixture of pumice and Mercryl, which is best applied using a rubber Prophymatic cup. This very practical instrument has an alternating movement which reduces any splashing or spillage, thus avoiding any harm to the gingivae. Contact areas should also be cleaned using very fine metal strips (e.g. Enhance Polishing Strips, Dentsply-DeTrey), moistened with Mercryl. The tooth is then well rinsed to eliminate any traces of pumice. It is not advisable to use a powder cleaner or brushes, since these two procedures can trigger bleeding, which is detrimental to bonding.

The veneers are tried in one at a time, taking care to moisten them to produce adhesion by surface tension, as with contact lenses. With a set of several laminate veneers, it is helpful to arrange them in strict order so as to avoid any chance of error. Try-in begins with the most posterior teeth. No pressure should ever be exerted at this stage. All adjustments will have to be made using either white silicone polishers (Komet) or red-banded diamond instruments combined with a water spray. Adjustment should be confined to adjusting a contact point or a minor undercut area **(Nixon RL, 1994).**

## 1.11 Cementation

The primary objective of cementation is to ensure a durable bond between the restoration and the remaining tooth tissues, and to create good marginal adaptation and seal. The cementation procedure is related to the composition and strength of the different materials. Glass-based ceramics (feldspathic and leucite and lithium disilicate-containing ceramics) need to be bonded with resin cements to obtain a clinically acceptable strength **(Wolfart M *et al.*, 2007).**

### 1.11.1 Resin Luting Agents

Resin luting agents are available in a wide range of formulations. These can be categorized on the basis of polymerization method (chemical-polymerization, light polymerization, or dual-polymerization), the presence of dentin-bonding mechanisms, and whether they incorporate the acid etchant. A chemically polymerized system is appropriate with metal restorations, whereas a light- or dual-polymerized system is appropriate with ceramics **(Della Bona A *et al*., 2002).**

### 1.11.2 Cementation Procedure for Ceramic Veneers

These restorations rely on resin bonding for retention and strength. The cementation steps are crucial for the restoration's success; careless handling of the resin luting agent may adversely affect their longevity.

Bonding is achieved with the following steps:

1. Etching the fitting surface of the ceramic with hydrofluoric acid

2. Applying a silane coupling agent to the ceramic material

3. Etching the enamel with phosphoric acid

4. Applying a resin-bonding agent to etched enamel and silane **(Della Bona A *et al*., 2002).**

5. Seating the restoration with a composite resin luting agent

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