

Choice of ceramic for use in treatments with porcelain laminate veneers

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ABSTRACT

Porcelain laminate veneers (PLVs) have been used for over two decades to treat esthetic and/or functional problems, particularly in the anterior sector (1-3). A range of dental ceramic materials are presently available on the market for these treatments, though with very different characteristics in terms of the composition, optic properties and manufacturing processes involved. As a result, selection of the material best suited for the management of each individual patient may prove complicated.

The present study proposes a simple system for selecting the most appropriate ceramic material, based on the two variables that most influence the esthetic outcome: the intrinsic characteristics of the substrate tooth, and the characteristics of the ceramic material in terms of resistance and optic properties.

Key words: *Dental ceramics, porcelain classification, porcelain laminate veneers, esthetic.*

RESUMEN

El tratamiento mediante Frentes Laminados de Porcelana (FLP) se utiliza desde hace más de dos décadas para el tratamiento de problemas estéticos y/o funcionales, particularmente en el grupo anterior de las arcadas dentarias (1,2,3). La actual oferta en el mercado de cerámicas dentales aptas para este tipo de tratamiento, pero muy distintas en cuanto a composición, características ópticas y sistema de elaboración, hace complicada la selección del material más adecuado a cada paciente en particular.

Proponemos un sistema sencillo de elección de la cerámica teniendo en cuenta las dos variables que más influirán en el resultado estético final: de un lado las características propias del diente (sustrato en el que nos apoyamos), y de otro las características propias del material cerámico en cuanto a resistencia y propiedades ópticas.

Palabras clave: *Cerámica dental, estética, clasificación porcelana, frentes laminados.*

INTRODUCTION

Porcelain laminate veneers (PLVs), also known as porcelain facets, Horn-type facets or ceramic facets, were first introduced in 1938 by Charles Pincus (4), who developed porcelain facets that temporarily adhered to the vestibular surface of the anterior teeth. The development of enamel adhesion techniques in the fifties, comprising the use of enamel etching by Buonocore and the introduction of bonding resins by Bowen (5), soon made it possible to apply such PLVs to teeth on a permanent basis. Finally, in 1983, Horn (6) proposed the use of porcelain facets to cover the vestibular surface of the anterior teeth as a definitive restoration technique.

Since then the indications of this procedure have continued to expand to the point where the use of PLVs is now common practice in dental clinics. In effect, evolution of the technique and materials used has led to gradual modifications in the indications of PLVs. Thus, while in the eighties the indications were limited to the restoration of slight alterations in tooth shape and/or color, the present broad range of indications of PLVs in the anterior sector to some degree reflects the reliability of such treatment (7-11):

- Correction of alterations in tooth shape or position
- Changes in morphology in patients with microdontia or tooth transposition
- Sealing of slight to moderate diastemas
- Fractures of the incisal third
- Extensive anterior dental restoration
- Abrasions of parafunctional origin
- Enamel alterations
- Alterations in tooth color
- Anterior guide rehabilitation
- Repair of crown or bridge fractures

However, this broad range of treatment possibilities gives rise to a problem, which the present studies attempt to resolve. In effect, when dealing with this great variety of clinical situations, not all ceramics behave as required. As an example, a material designed to resolve slight alterations in the color of an incisor will be of little help in the case of anterior guide restoration in a parafunctional patient.

In order to resolve the problem of which porcelain material to use in each concrete clinical case, we propose the methodology used in our Prosthodontics and Occlusion Teaching Unit (Valencia University Medical and Dental School, Valencia – Spain), based on the characteristics of the different ceramic materials and on the needs of the specific clinical problem involved.

A brief review is required of the classification of ceramic materials in order to define the best option for each concrete type of patient. Of the three possible ceramic classifications, based on sinterization temperature, composition and the manufacturing technique involved, we will focus exclusively on the composition of the material, since it offers all the information needed to resolve the problem of correct ceramic choice.

DENTAL CERAMICS CLASSIFICATION ACCORDING TO COMPOSITION

Dental ceramics comprise a large family of inorganic non-metal materials (12-15), and are commonly divided into two groups: silicate ceramics and oxide ceramics.

1.- SILICATE CERAMICS

The common characteristic of silicate ceramics is the presence of quartz, feldspate and kaolin – the basic component being silica dioxide. These are heterogeneous materials composed of crystals surrounded by a vitreous phase (16,17). Depending on the proportions of the different components and on the raw substance grain size, a broad spectrum of ceramic materials can be produced – including gres ceramics, porcelain and glass.

Based on their composition, silicate porcelains can be classified as feldspates or alumina porcelains.

1.1.- Feldspates

The predominant element in this case is silica oxide or quartz in a proportion of 46-66% versus 11-17% of alumina. The feldspate porcelains in turn are subclassified as follows:

- Conventional feldspate porcelains. These offer very good esthetic effects but the main problem is that they are fragile (low fracture resistance: 56.5 MPa). Examples include d-SING, Vintage, Luxor, Duceram, Flexoceram, Vivodent PE, IPS Classic, Empress esthetic.
- High resistance feldspate porcelains. In this case we have the following materials:

(a) Feldspate porcelain reinforced with leucite crystals. The chemical composition in this case comprises quartz (68%) and aluminum oxide (18%). As a result of the pressing process used to manufacture these materials, porosity is reduced and adequate and reproducible fit precision is achieved. The perfect distribution of the leucite crystals within the glass matrix, observable during the cooling phase and after pressing, contributes to increase resistance without significantly diminishing translucency. The resistance to flexion is 160-300 MPa (19,20). Examples of this type of porcelain include IPS-Empress I, Optec HSP, Mirage, Finesse, Cergogold.

(b) Feldspate porcelain reinforced with lithium oxide. The chemical composition in this case comprises quartz (57-80%), lithium oxide (11-19%) and aluminum oxide (0-5%). The incorporation of these crystalline particles increases the flexion resistance to 320-450 MPa, thanks to their important volume (60%), homogeneous interlocking structure of densely distributed elongated crystals, and the increase in crystal size after pressing – thereby yielding a more homogeneous microstructure. These porcelains are only used to manufacture the inner coping of the restorations; the latter are in turn covered with fluor-apatite ceramics (21). Examples of this type of porcelain include IPS Empress II, Style-Press (figure 1).

1.2.- Alumina porcelains

These porcelains contain an increased proportion of alumina (40-85%), while the silica oxide concentration is reduced from 60% to 15% (22). This group is the same as the Con-

ventional alumina porcelains. The proportion of aluminum oxide in this case does not exceed 50%. These materials are indicated for the preparation of complete crowns and for porcelain coating with aluminum oxide and metal – though facets can also be manufactured. Examples of this type of porcelain include Vitadur N, Alpha Vitadur, NBK 1000, Vita Omega 900.

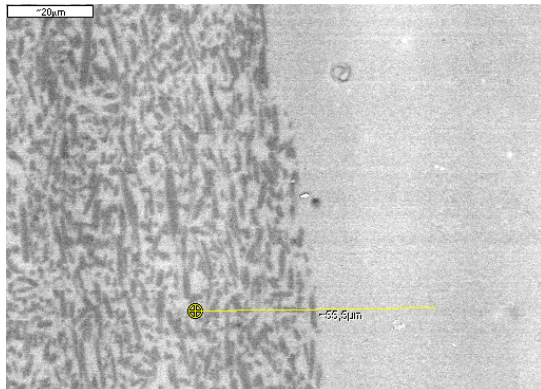


Fig. 1. Specimen IPS-Empres 2 at 1000 X
1: Internal coping.
2: Interface.
3: Overlay ceramic.

2.- OXIDE CERAMICS

The oxide ceramics comprise both simple oxides such as aluminum oxide, zirconium dioxide and titanium dioxide, as well as complex oxides such as spinelle, ferrite, etc. Strictly speaking, oxide ceramics contain only oxidant components, though the same term is commonly used in reference to ceramics with blended oxide components (16). These are polycrystalline materials with little or no vitreous phase – the latter representing the weak point of porcelain. Due to their great opacity, they are used as internal copings in ceramic restorations.

2.1.- Aluminum oxide ceramics

Examples of this type of porcelain include: (a) In-Ceram Alumina (85% aluminum oxide particles measuring 2-5 mm in diameter). This high alumina content affords a resistance to flexion of 400-600 MPa; (b) In-Ceram Spinelle, where the substitution of alumina with mixed magnesium and aluminum oxide affords increased porcelain coping translucency. This is attributable both to the crystalline origin of the spinelle, which confers isotropic optic properties, and to the low refraction index of the crystals; (c) In-Ceram Zirconium, comprising 67% aluminum oxide and 33% zirconium oxide and yielding a resistance to flexion of up to 600-800 MPa (23); and (d) Procera All-Ceram, developed in 1993 by Andersson and Odén (24). This material contains 99.9% aluminum oxides, with a fracture resistance of 680 MPa, and is in turn coated with conventional alumina ceramic (figure 2).

2.2.- Zirconium oxide ceramics

Zirconium oxide is a polycrystalline material with a tetragonal structure partially stabilized with yttrium oxide

The internal copings are formed by a mass of compacted and practically fused crystals – thus giving rise to a near absence of porosities thanks to the core processing applied in the dental laboratory, based on CAD-CAM techniques (25-27) (figure 3).

An example of this ceramic is DC-Zircon (DCS), pertaining to the CDS-Preident system and composed of 95% zirconium oxide and 5% yttrium oxide. The zirconium moreover reinforces the porcelain thanks to its great fracture modulus (900 MPa) and hardness (1200 Vickers units). Other available products are Lava and Everest.

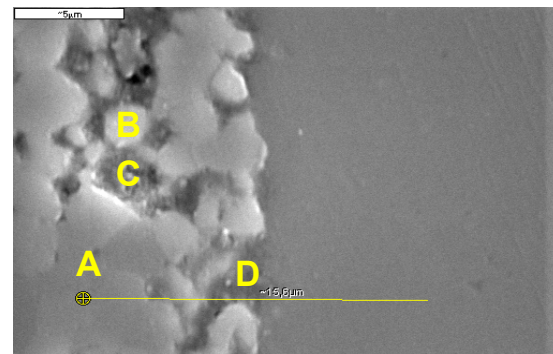


Fig. 2. Specimen Procera All-ceram. Detail of the interface at 5000 X.
A: Compact mass. B: Isolated particle. C: Porosity. D: Irregularity.

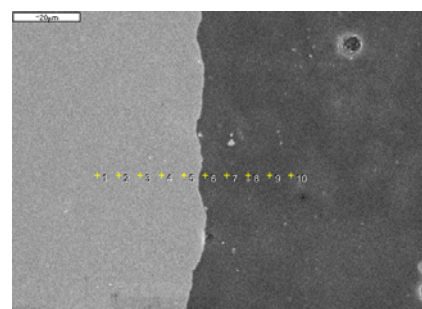


Fig. 3. Specimen DC-Zircon at 2000 X.
1: Núcleous. 2: Interface. 3: Overlay porcelain.

CHOICE OF CERAMIC MATERIAL FOR MANUFACTURING PORCELAIN LAMINATE VENEERS ACCORDING TO CLINICAL INDICATION

For correct ceramic choice, we first divide the patients in terms of the PLVs once placed in the mouth, and according to whether they are to be subjected to functional loading or not: (a) Type I patients: in these cases the facets are not exposed to functional loading, and are referred to as simple esthetic facets; (b) Type II patients: in these cases the facets are exposed to functional loading, and are referred to as functional esthetic facets.

In this context, type I patients are candidates for conventional ceramics, while type II patients require high resistance

ceramics. However, this first division is incomplete, since it only contemplates aspects relating to resistance of the ceramic material – without considering the optic characteristics, which are so important for ensuring good esthetic results. Type I patients are therefore in turn classified into two subgroups according to the background color characteristics of the treated teeth: (a) Type I-A patients: these are subjects programmed to receive simple esthetic facets where the substrate teeth present no color alterations. The only objective in this case is to apply PLVs for shape modifying purposes; (b) Type I-B patients: these patients are likewise programmed to receive simple esthetic facets, though in this case the substrate teeth present color alterations. Therefore, and independently of the need for shape modifications, the selected ceramic material must be able to hide the underlying substrate color.

Once the patients programmed for porcelain facet treatment have been classified, we only need to select the dental porcelain material best suited to the physical and optic requirements of each case, based on the above described material classification.

Type I-A patients

Since these are patients with facets that will not be subjected to functional loading and present a clear substrate, the material used only aims to solve problems relating to tooth shape. These are consequently favorable cases, since moreover only a small ceramic material thickness is required.

In these situations we therefore recommend the use of conventional feldspate ceramics, in view of their excellent optic characteristics that afford optimum esthetic results. The absence of occlusal stress in these cases, and the use of the currently available adhesion techniques (which improve resistance to fracture of these ceramics) contribute to ensure prolonged restoration survival (figures 4a y 4b).

The exception to the above is represented by cases in which the problem is medium or large (over 2 mm) interincisal diastemas in the presence of a clear dental substrate. In this setting it must be taken into account that as the porcelain extends beyond the adhesion zone, it loses the “protective” increase in elastic modulus afforded by the adhesion and composite resin. In these patients we therefore recommend the use of high resistance feldspate ceramics – since their good esthetic qualities combine with adequate resistance to fracture.

Type I-B patients

These patients present facets that will not bear functional loading but which show moderate to severe alterations in dental color that must be effectively masked by the restoration. In these situations both the porcelain and cement must present various degrees of opacity in order to hide the color alterations, and this in turn implies problems to secure the desired optic effects in terms of translucency and reflectance, and consequently also esthetic outcome (figures 5a and 5b).



Fig. 4a. Clinic case with multiple diastemas.



Fig. 4b. Diastemas restoration with PLVs of conventional feldspate ceramic.



Fig. 5a. Central incisor with endodontic treatment decoloration.



Fig. 5b. Incisor (2.1) restoration with Empress I ceramic with opacity grade 2.

Other characteristics to be taken into account in these cases refers to dental preparation, which will be more aggressive (0.8-1 mm), and to the finishing line – which should be slightly subgingival and involving a curved chamfer in order to increase the ceramic thickness and prevent an overly notorious tooth-restoration transition zone (figure 6).

The materials indicated in such cases are ceramics offering the possibility of selecting the opacity of the base material, regardless of the degree of resistance.

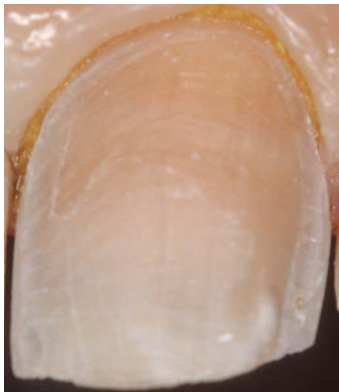


Fig. 6. Tooth preparation for a PLVs.



Fig. 7a. Clinic case with lost anterior guide because of bruxism.



Fig. 7b. Restoration of the anterior guide with PLVs of high resistance feldspate porcelain.

Type II patients

In these cases the existence of functional loading in both the mandibular static position and during excursive movements requires the use of a material with great resistance to fracture. Accordingly, feldspate or alumina ceramics of high resistance, and oxide ceramics are indicated.

Consequently, we recommend the use of high resistance ceramics with the lost-wax casting technique (IPS Empress II, Style Press, IPS Empress I, Optec HSP, Mirage, Finesse, Cergogold y Empress esthetic), because of its esthetic properties and predictability, in long term studies, in the oral rehabilitation of the anterior guide (figures 7a and 7b).

CONCLUSIONS

The use of porcelain facets to solve esthetic and/or functional problems in the anterior sector has been shown to be a valid management option. Years of experience with both the technique and the materials employed offer satisfactory, predictable and lasting results.

The simple ceramic classification and definition of the types of patients amenable to ceramic facet application proposed in the present study will help the clinician to resolve the problem of selecting the ceramic material best suited to each individual case.

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