TECHNOLOGIES FOR ALL CERAMIC FIXED DENTAL PROSTHESIS REALIZATION

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Abstract:

In recent years, the demand for all ceramic fixed dental prosthesis as prosthetic solutions has greatly increased. That is justified by the biomechanical and optical properties similar to those of dental tissues. The new generation of ceramic systems recover all the morphological characteristics of the teeth, properly restoring the continuity of the dental arch and the normal occlusal contacts. The choice of the appropriate material and technology, in order to make prosthesis that meet all the functional requirements, is a decision of both the dentist and the dental technician, according to the patient's expectations and the clinical situation.

Keywords: ceramic materials, fixed dental prosthesis, dental technologies

INTRODUCTION

Ceramic materials tend to replace, in recent years, the other restorative materials used in fixed prosthodontics, due to their special properties - optimal biocompatibility, very good mechanical strength, durability, chemical and dimensional stability [1,2].

A number of clinical studies indicate that many of the all-ceramic prosthetic constructions are less durable than metal-ceramic prostheses [3,4,5]. In the 1980s and 1990s, restorations of glass-based ceramic masses (Dicor, Dentsply / Caulk, Milford, DE) and leucite-based (IPS Empress, Ivoclar, Schaan, Lichtenstein) were widely used, but did not demonstrated a satisfactory survival rate. Therefore, an attempt was made to realize crowns and dental bridges on a harder ceramic framework, which would later be veneered with ceramic materials that have mechanical and optical properties close to those of dental tissues. Clinical studies have shown that the most common cause of failures in all-ceramic prosthesis is fracture and cracking of ceramic cladding masses [6-9]. The question that arose in this situation was what is the cause of these fractures, despite the fact that ceramic is a material with a high mechanical strength; it was also studied what should be the optimal mechanical parameters for a ceramic material to be resistant to functional stress over time. Research in this area continues, aiming to improve the properties of materials and current technologies [10-13].

Today, dental technicians and dentists benefit on a very wide range of materials and methods to get full ceramic fixed prostheses, which can satisfy the highest aesthetic requirements.

In recent years, the tendency to choose all-ceramic crowns as unitary and plural prostheses has increased greatly. One of the most common reasons was the fact that these prosthetic constructions have optical properties similar to tooth enamel (fluorescence, opalescence, light transmission); also, different studies showed that these devices are characterized by a very good mechanical strength [14-17].

The choice of the appropriate material and technology used to make prosthesis that meet all the functional requirements is a decision of both dentist and dental technician, according to the patient's expectations and the clinical situation.

Depending on the technology used to perform the prosthetic restoration, all-ceramic systems are divided into additive and subtractive techniques.

The additive techniques are represented by the stratification technique, the casting technique, the infiltration and sintering technique and the injection (pressing) technique, at low or high temperature.

Subtractive techniques are represented by digital CAD-CAM milling methods.

Ceramics have the ability to restore in optimal conditions the functions of the stomatognathic system presenting, from many points of view, similar properties to natural teeth. But these restorations also have a number of limitations, which have to be known before choosing this therapeutic solution: shorter longevity than metal-ceramic restorations, more complex technologies, higher costs.

Studies showed an increasing of the demand for all-ceramic prostheses, therefore, research in this field has accelerated the sense of diversifying techniques and equipment for digital technologies and finding new materials with optimized properties [18-20].

For each material the basic components must be very well known and the most appropriate technology must be chosen. Between the ceramic systems produced by the manufacturers are a lot of differences; even if it is the same type of material, there are differences in translucency, strength or marginal adaptation of the crowns. These things must be very well known because they can affect the clinical performance of the future prosthetic elements [21, 22].

The technologies for all-ceramic prosthetic constructions suppose two big steps: the hard ceramic framework realization, in order to ensure the resistance and its veneering with ceramics, in order to restore the teeth morphology and occlusal contacts.

Additive or subtractive methods are used to obtain the ceramic frameworks.

I. ADDITIVE MANUFACTURING SYSTEMS involve a layer-by-layer ceramic core construction, building the framework step by step.

The technique successive layers is the procedure that allows the best control over the morphology and the final aspect of the restoration, being today frequently used in dental prosthesis technology, especially for obtaining small amplitude prosthetic restorations (inlay, onlay, crowns, veneers) [23-25].

In this case the application of ceramics is done directly on a refractory cast, resistant to high temperatures; after the complete construction of the framework, sintering in special furnaces follows.

The clinical and technological steps of a prosthetic construction performed by this method involve the preparation of the abutments, taking the impression, cast realization, duplication of the working cast, application and sintering of ceramic layers. Studies show that these methods can successfully achieve inlays, veneers, and even partial crowns, but there must be precautions against the indication of the procedure in making full crowns or bridges.

The infiltration technique involves the introduction of a vitreous material into a porous nucleus of aluminum oxide, followed by sintering. The procedure was introduced in dentistry by Michael Sadoun and implemented in practice by Vita through the In-Ceram system.

The principle of the system consists in the realization in a first phase of a ceramic structure with high content of aluminum and zirconium oxides, which is subsequently infiltrated with a lanthanum aluminosilicate glass.

Then the morphology of the restoration is finalized by successive applications of the classic ceramic layers. The introduction of aluminum oxides into the composition of ceramic structure limits the propagation of cracks, and infiltration with lanthanum aluminosilicate glass reduces the porosity of the core. To date, several variants of the In-Ceram system are known:

In-Ceram Alumina uses a ceramic with a high content of aluminum oxides (85%) to make the framework. The aluminum oxide core can be used for single crowns and small bridges in the frontal area.

In-Ceram Spinell differs from the first system by adding crystallized magnesium aluminate particles to the composition of the ceramic structure.

This method gives restorations with a better aesthetic appearance, but with a lower mechanical resistance than those made with In-Ceram Alumina technique. The method is used especially to make all-ceramic crowns in the frontal area.

In-Ceram Zirconia - consists in incorporation in the ceramic structure of zirconium oxides, on a percent of 30% and of aluminum oxides, in 70%, in order to improve the mechanical parameters of the restoration. However, the zirconium oxide content of the framework induces a certain opacity; that is why In-Ceram Zirconia cores have certain limitations for prosthetic restorations where major aesthetic requirements predominate. The increased mechanical strength following the use of zirconium oxide indicates this technology for small bridges.

The three mentioned techniques use ceramic masses with a different composition, but they present the same technological working flow. [26, 27].

Pressed ceramic method involves injecting a fluid ceramic mass into a mold, in order to obtain the framework of all-ceramic prostheses. The idea of modeling plastic ceramics has been advanced since 1936 by Scefelder. The stages of making entirely ceramic prosthetic restorations by injection are similar to those encountered for casting alloys. In a first step, the patterns of the framework are waxed onto a die, correctly adapted and undersized with 1.5 mm, in all directions. (fig.1)

Fig.1 The wax patterns of the framework

After investing and wax elimination, the mold is obtained; small ceramic discs, called ingots, are melted to a honey-like consistency and then pressed into that mold (fig.2). Depending on the melting temperature of the ceramic, two types of systems are distinguished:

systems with high injection temperature (1100ºC) and systems with low injection temperature (160ºC)

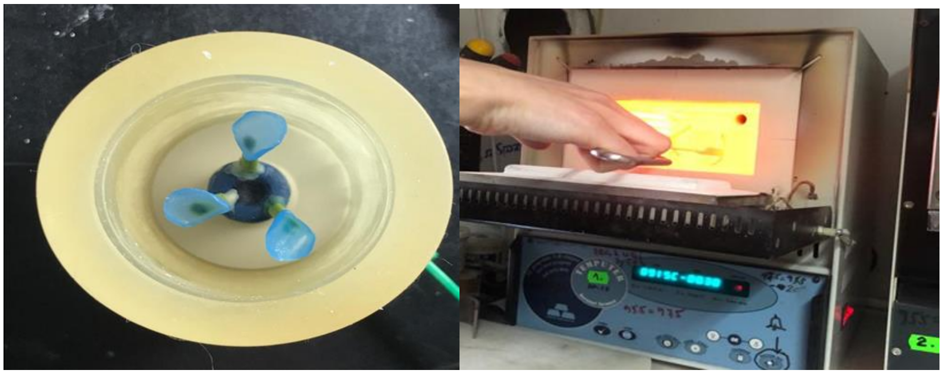

Fig.2 Investing and mold realization

The procedure of introducing the ceramic in the mold is done under pressure, so that the molten material penetrates all the details of the pattern (fig.3). The ceramic used for injection has a high percentage of leucite (40-50%), which significantly improves the resistance to bending of the structure.

Fig.3 Pressing the ceramic in the mold

After divesting, the ceramic framework, is finished and polished (fig.4); the reaction layer formed on the surface during the pressing process can be removed with special solutions.

Before applying the ceramic layers for veneering, the infrastructures must be checked in the oral cavity, in order to establish the marginal adaptation and the relationship with the other teeth; also, at this stage, the appropriate color shade is established.

Fig.4 Divesting the ceramic framework

After the intraoral verification, the veneer ceramics are applied on the framework, layer by layer, each layer being sintered separately (fig.5). After the prosthesis is checked and finished, the last layer of ceramic-the glaze- is applied (fig.6).

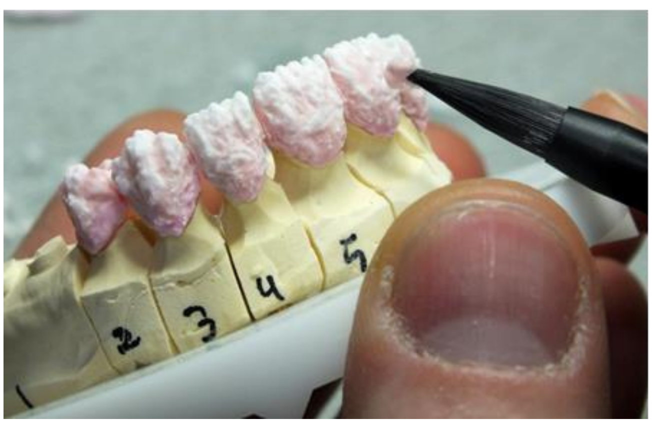

Fig.5 Veneer ceramics application

Fig.6 The final prosthesis

II. SUBSTRACTIVE MANUFACTURING SYSTEMS includes those techniques that allow the obtaining of prosthetic constructions by successive reduction, from a block of material, until reaching the final shape of the restoration. The technology involves a first step of collecting clinical information, after the intraoral optical impression or after scanning the working model, obtained after the classic impression of the prosthetic area [28-30].

Based on the recorded data, the treatment solution will be chosen and the prosthetic construction will be designed, establishing the size and position of the infrastructure. Depending on the processed data, the most appropriate infrastructure design is chosen, in the respective clinical situation. (fig.7)

The information is saved, to be sent later to the work unit, the CAD component of the system.

Fig.7 Die scanning and designing treatment solutions

The ceramic block is then chosen and the milling unit will make, according to the previously established project, the prosthetic construction (fig.8).

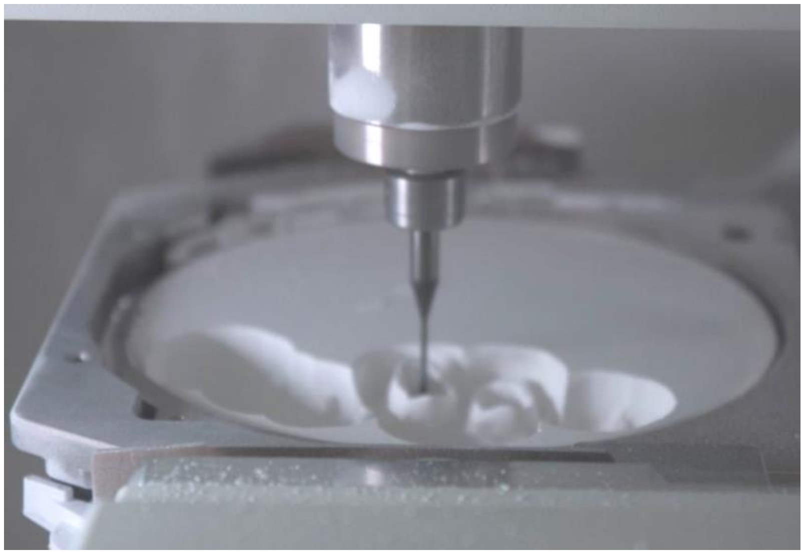

Fig.8 Milling of ceramic framework

The ceramic masses used for milling are industrially fabricated, which offers them a series of special properties: homogeneous structure, excellent biocompatibility, aesthetics close to natural teeth, very good mechanical strength, well tolerated by periodontal tissues, stable characteristics over time, chemical stability and volumetric, longevity over time Also, digital technologies considerably reduce working time, eliminating a multitude of laboratory steps.

The frameworks are checked, on the model and in the oral cavity then they are veneered with ceramics, in order to completely restore the morphology of the teeth. (fig.9).

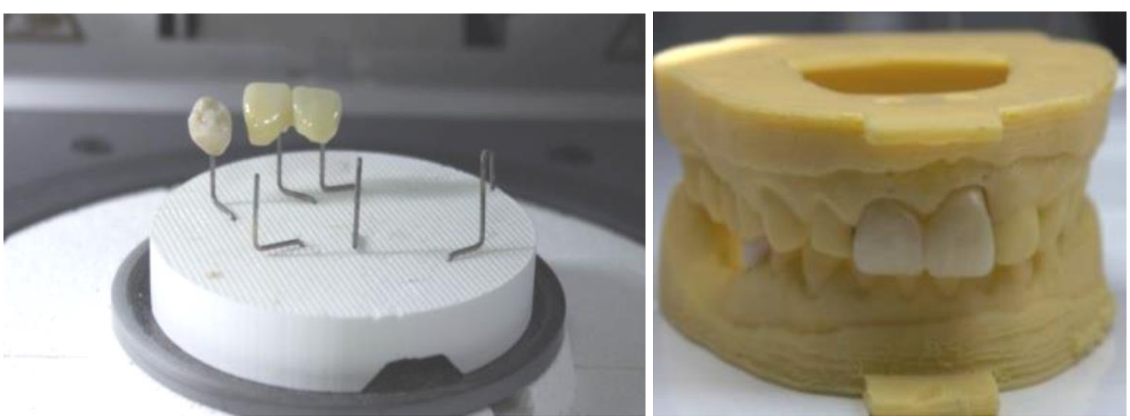

Fig.9 Application and sintering of veneering ceramic layers

CONCLUSIONS

Aesthetic rehabilitation has a special importance among the objectives of prosthetic treatment. In order to achieve this goal, the therapeutic solution must consider a realization of fixed prostheses made of physiognomic materials. Ceramic materials are in a continuous evolution, the disadvantages of first generation ceramic systems being completely removed; the new ceramic systems used now in current practice presenting mechanical, biological and optical properties similar to those of natural teeth

Knowing the characteristics of each material, their advantages and disadvantages allow the choice of the optimal therapeutic solution for each clinical case. In this situation, the participation of the dental laboratory in the effort to modernize the dental treatment possibilities became obvious.

Both the dentist, who has all the current and future information from the prosthetic area, and the dental technician, who knows the characteristics of the materials and the particularities of each technology, must participate equally in the choice of the dental treatment solution.

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