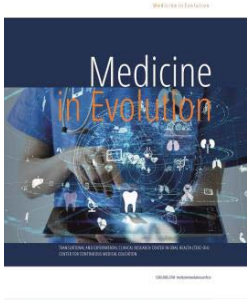
Fixed prosthetic restorations on zirconium oxide infrastructure



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Abstract

Fixed prosthetic restorations on zirconium oxide infrastructure have become increasingly popular in modern dentistry due to their exceptional properties, including high durability, biocompatibility and superior esthetics. Zirconium oxide offers an alternative to traditional metal restorations, eliminating potential allergic reactions and providing a more natural appearance due to its color similar to tooth enamel. This material is used for a wide range of prosthetic applications, including crowns, bridges and implants, due to its ability to withstand high mechanical loads and resist wear. Studies show that zirconium oxide restorations have a high clinical success rate with minimal complications and a high level of patient satisfaction. This study examines the technical and clinical properties of zirconium oxide fixed prosthetic restorations, the advantages compared to other materials, a nd the perception of patients benefiting from the new technology regarding its aesthetic, functional and pecuniary aspects.

Keywords: zirconium oxide, fixed prosthesis, CAD/CAM technology, oral rehabilitation

INTRODUCTION

In recent years, dental ceramics has had a remarkable technological evolution, new materials and technologies for processing ceramic masses being constantly introduced. The improvement of physical and optical properties has made it possible to expand the range of indications of all-ceramic and polymer restorations or hybrid materials from long-lasting fixed partial dentures, all-ceramic crowns, inlays, onlays, veneers, abutments and implants dental [1].

Due to the unparalleled mechanical properties of partially stabilized zirconia, its introduction to the dental market a decade ago has greatly expanded the range of applications of ceramics in dentistry, a field where they are classically in demand due to their chemical inertness and a wide combination of optical properties, allowing excellent aesthetics. Even though the current trend is towards the development of all-ceramic systems, ceramics are still widely used for plating metal infrastructures for metal-ceramic dental restorations. At the same time, ceramic abutments and implants are now becoming available offering certain advantages [2].

Ceramic masses are the therapeutic option in dentistry due to their increased resistance, precision in adapting restorations to dental abutments and special translucency. The absence of metallic infrastructure guarantees superior aesthetics, reduced thermal conductivity, biocompatibility and chemical stability. The natural appearance and chromatic integration of restorations considering the appearance of the remaining teeth is a difficult task, due to the complex optical characteristics of natural teeth and the increased standards and demands of doctors and patients [3].

Pressed ceramics, feldspathic ceramics, zirconium oxide, are processed through subtractive and additive technological processes that allow the creation of all-ceramic prostheses with favorable biomechanical behavior, aesthetics and a reduced thickness; CAD/CAM technology significantly reducing work time [4].

Purpose and objectives

The aim pursued in this study is to highlight the versatility of ceramic materials and all-ceramic restorations on zirconium oxide support which, adapted and processed to the clinical case, can restore facial aesthetics. We pursued a measurement of the degree of satisfaction of patients benefiting from this technology to identify the extent to which the functional and aesthetic comfort rises to the level of the related financial costs. Patients are not always willing to undergo a complex and interdisciplinary treatment for various reasons such as costs or long waiting time, and thus the doctor and the patient agree on a compromise situation, since the ideal aesthetic results cannot be obtained.

Brief History of Fixed Prosthodontics

The first forms of fixed dentures date back to ancient Egypt, where lost teeth were replaced with human or animal teeth, bound with gold wires. In ancient Rome and Greece, gold was also used to create rudimentary bridges. In the Middle Ages, prostheses were often made of bone and ivory, but the methods remained primitive and rarely functional in the long term. As metallurgical techniques improved in the 18th and 19th centuries, gold and other precious metals began to be used to make dental crowns and bridges. In 1728, Pierre Fauchard, considered the father of modern dentistry, described in his book "Le Chirurgien Dentiste" the use of wires to fix artificial teeth to natural teeth [5,6].

19th century: The development of dental ceramics marked an important stage with the invention of dental faience by Alexis Duchâteau in 1774 and further development by the

French dentist Nicolas Dubois de Chemant. In 1800, William H. Goodwin patented the first technique of using ceramics for dental crowns. The 20th century brought porcelain crowns as a novelty, and the use of dental cements to fix prosthetic restorations became a common practice. The discovery and use of metal alloys such as gold, palladium and platinum have significantly improved the durability and functionality of fixed prostheses. The 1950s saw the advent of composite resin materials and bonding techniques that revolutionized fixed restorations. In the 1960s, Dr. Per-Ingvar Brånemark discovered osseointegration, leading to the development of bone-integrated dental implants, which revolutionized fixed prosthodontics [7].

With the 90s and the introduction of zirconium oxide as an infrastructure material brought a qualitative leap in the aesthetics and biocompatibility of fixed prostheses. The development of CAD/CAM (Computer-Aided Design/Computer-Aided Manufacturing) has enabled the precise and efficient production of prosthetic restorations. Digital technology continues to improve the design, fit, and functionality of fixed prostheses [8,9].

Fixed prosthodontics have evolved from rudimentary solutions to sophisticated and customized techniques, responding to the increasingly high aesthetic and functional demands of modern patients. This evolution continues to redefine the standards in oral rehabilitation and restorative dentistry.

The clinical-technical stages of a restoration

The first stage of the patient's examination is the extra-oral examination that monitors the proportionality of the facial floors, the facial symmetry that is evaluated according to the median line. In the case of patients who require the restoration or improvement of aesthetics, special attention should be paid to the smile line, the degree of exposure of the teeth during speech and smiling, the symmetry or deviation of the smile line and the nasolabial or lipo-chin grooves. During the smile, the evaluation of the oral corridor and the degree of exposure of the teeth [10].

The intra-oral inspection aims to evaluate the correctness and fit of odontal restorations, existing prosthetic restorations, the appearance of mobile and attached mucosa. It is of maximum interest to follow the appearance of the mobile mucosa, the floor of the mouth, the insertion of the frenulum, the absence of any suspicious lesions or formations. The attached mucosa covering the alveolar processes and hard palate should have an orange peel appearance and pale pink color. Overflowing and marginally infiltrated fillings are replaced as well as ill-fitting prosthetic restorations and those restoring teeth with gingival recession.

The documentation of the case can be done photographically, through videos in which the patient speaks, smiles and laughs because the aesthetics must be considered and evaluated during the functions. Study models are used and help the doctor in collaboration with the dental technician and the dental laboratory in establishing the treatment and the possibilities of optimizing the aesthetics. Based on the study model, the dentist can evaluate how to prepare the teeth, if he can or should modify the coronal axis, measure the overjet and overbite and orient himself towards obtaining predictable aesthetic results [11].

After establishing the treatment plan and completing the conservative therapy, the dental abutment preparations are made. Until the treatment is completed, the patient is restored prosthetically, with provisional works. Provisional restorations can be of long or short duration, depending on the clinical situation and treatment stages.

From an aesthetic point of view, not only the color, shape and alignment of the teeth must be taken into account, but also the gingival zenith, which is defined as the highest position of the gingival line at the level of the teeth, where the gingiva is attached to the enamel of the buccal surface. The zenith is defined as the most apical point of the convexity of

the marginal gingiva. This important landmark has been described as having a specific spatial orientation in the apico-coronal and mesio-distal directions.

The gingival zenith is an essential factor in achieving optimal aesthetic results and depends on its placement, which can create a symmetrical gingival line that greatly improves the aesthetic appearance. The gingival zenith is determined by the position and axis of insertion of the teeth in the alveolar processes, by the contour and thickness of the gum. Certain factors such as the size, shape and position of the crowns can influence the positioning of the gingival zenith.

The ideal position of the zenith is 1-2 mm below the point where the gum meets the tooth enamel. The appearance of the zenith can be improved by contouring, repositioning, dental veneers or orthodontic treatment.

After all these stages, the treatment plan is established which includes:

- correction of asymmetric gingival zenith and coronal lengthening at the level of the upper and lower frontal group
- measurements made on the study model
- performing the wax-up with the design of the future position of the gingival zenith limit
- correction by surgical excision of the insertion of the marginal periodontium and the frontal coronal elongations of the upper and lower arches
- making and preconfiguring the upper and lower mock-up
- soft tissue healing and stabilization for 3 weeks
- preparation of abutments
- imprinting of the prosthetic field with silicones with a two-time addition reaction
- cementing the provisional prosthetic restoration
- intra-oral test of the sintered zirconium oxide framework and verification of static and dynamic occlusal relationships
- definitive cementation of the upper and lower all-ceramic fixed prosthetic restoration

Interspersed with some clinical stages, there are also some laboratory stages for the preparation of the working model, the scanning and CAD design of the dental work, the CAM realization of the zirconium oxide support and its ceramic veneering [12].

MATERIAL AND METHODS

The study included 33 patients of different sexes, from different backgrounds and with different dentition classes of a dental clinic in Timişoara who benefited from such prosthetic works in the last year. We present in the following graphs the distribution of the group of patients presents in our study according to their biological gender (Fig. 1) and by their age group (Fig. 2):

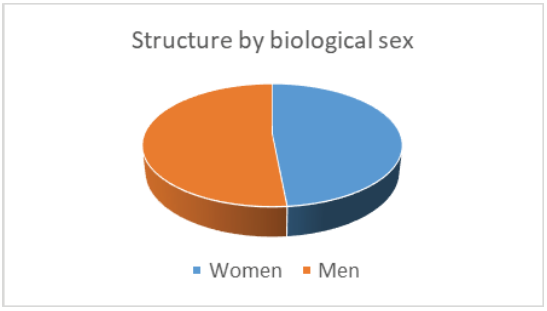

Figure 1. The studied group according to the biological gender

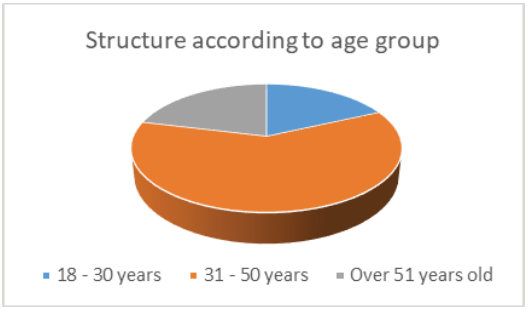

Figure 2. The studied group according to age group

As a function of the main reason for choosing dental work on zirconium oxide support, the results obtained are shown in Fig. no. 3 and in Fig. no. 4 we present the age in the oral cavity of the fixed prosthesis:

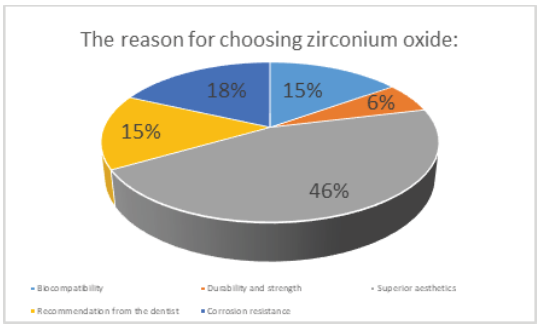

Figure 3. Distribution of the group of patients according to the reason for choosing zirconium oxide

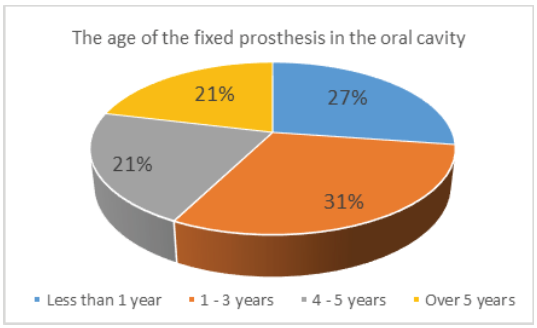

Figure 4. The studied group depends on the age of the prosthetic work in the oral cavity

Depending on the areas in the oral cavity that are the subject of the patients fixed prosthetic works for which they opted for zirconium oxide, they are shown in the graph in Fig. no. 5. In the graph from figure no. 6, we present the ratio between the occurrence or absence of health problems or complications in the cementation of these prosthetic works.

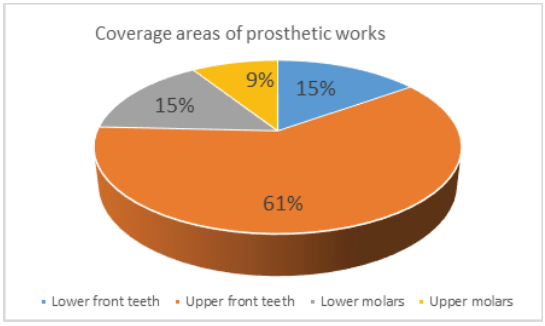

Figure 5. Distribution of the group of patients depending on the areas covered by the prosthetic work

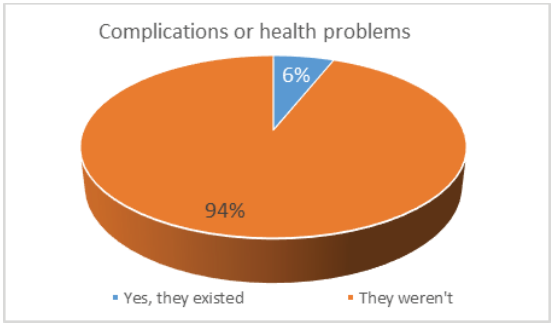

Figure 6. The batch studied according to the complications that occurred

We also analyzed the increase in aesthetic and functional comfort and the results are included in the graphs in fig. no. 7 and fig. no. 8.

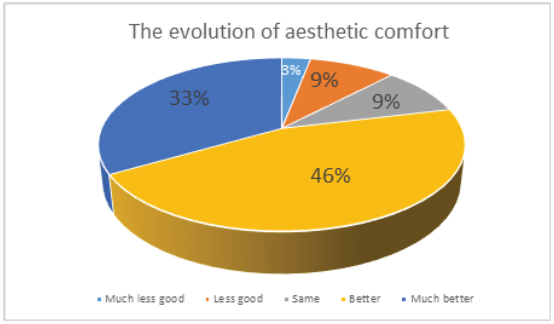

Figure 7. Patients' perception of the evolution of aesthetic comfort after prosthetics

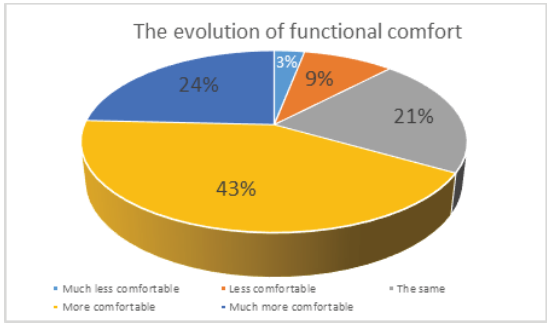

Figure 8. Patients' perception of the evolution of functional comfort after prosthetics

In the graph from Fig. no. 9 I represented the general level of satisfaction on the resistance of the prosthetic work on ceramic-plated zirconium oxide support. The answer had

5 degrees of satisfaction from "Very dissatisfied" to "Very satisfied". It is noteworthy that none of the patients indicated the answer of "Very dissatisfied".

Also closely related to the overall level of satisfaction is the extent to which patients would further recommend this type of work and the services of the dental clinic to friends. The centralization of these responses is presented in the graph in figure no. 10. Only 1 patient indicated that they were "very unlikely" to recommend the work or the clinic and another one that they were "unlikely".

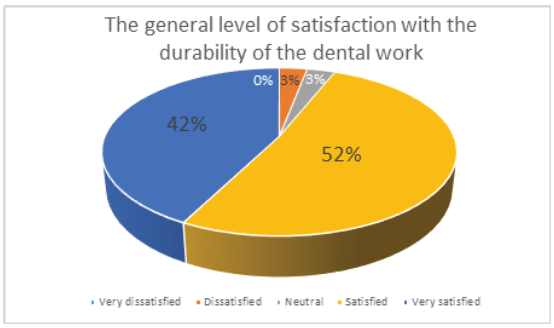

Figure 9. Patients' perception of the general level of satisfaction regarding the durability of dental work

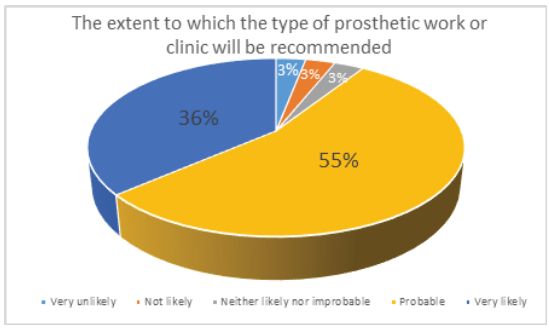

Figure 10. The extent to which the type of prosthetic work or clinic will be recommended

At the end of the survey, we asked each participant to indicate the main advantage of prosthetic work on zirconium oxide support. The answers given are expressed in the graph in figure 11. Figure 12 includes the main improvements they expect from this type of work, answers that also indirectly indicate the minuses of this type of material.

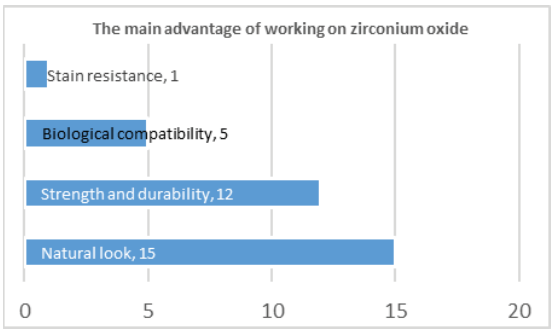

Figure 11. The main identified advantage of ceramic works on zirconium oxide support

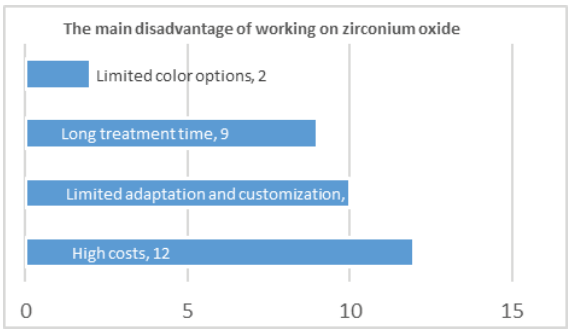

Figure 12. The main identified disadvantage of ceramic works on zirconia support

RESULTS

From the measurements we could see that more than 57% of the patients have the prosthetic work for less than 3 years and 79% for less than 5 years. Only a little over 1/5 of patients enjoy this prosthesis time of more than 5 years. This aspect suggests the novelty of this technology on the one hand, but also its financial inaccessibility. To the same extent, it is a work preferred by the active population (under 50 years – 79% of patients).

The main reason why zirconium was chosen by patients was its aesthetic appearance (46%) but also its resistance (24%). In equal proportions of 15%, the patient's information regarding biocompatibility, respectively the dentist's recommendation, weighed in the decision taken.

Almost 2/3 of the prosthetic works concerned the upper frontal area (61%) and 30% for the lower arch. Only 9% represented the upper molars. The answers fall under the main concern for the aesthetic aspect offered by zirconia-supported ceramic works.

The biocompatibility of the material (94% of patients) is also evidenced by the small number of cases in which complications or other health problems were registered.

Over 3 quarters of patients appreciate the aesthetic improvement of the facial appearance (79%) and over 2/3 of them recognize a very good or good increase in functional comfort (67%). The durability and resistance over time of the work is appreciated by 94% of the respondents who benefited from the type of work analyzed.

To a high extent (91%) it is very likely or likely that zirconium will be recommended by patients to their friends.

The main advantage seen by patients of prosthetic work on zirconia support is naturalness (45%) closely followed by the strength of the material (36%). The major disadvantage remains the high cost (36% of patients) but also limited personalization (30%) and longer treatment time (27%).

DISCUSSIONS

Zirconium-supported prosthetic work has become a popular choice in dentistry due to its combination of aesthetics and durability. These works involve the use of zirconium, a high-performance ceramic material, to create the basic structure of crowns, bridges or dentures. Zirconium has a natural, translucent color similar to tooth enamel, which makes it ideal for work in the frontal area of the oral cavity. Unlike metals, zirconium does not create dark shadows around the gum line, thus contributing to superior aesthetics [13,14].

Zirconium is extremely wear-resistant and can withstand high masticatory forces, being suitable for posterior teeth. It has high fracture resistance compared to other ceramic materials, making it suitable for extended bridges. Zirconium is biocompatible, meaning it has a low risk of causing allergic reactions or irritation of oral tissues. Its smooth surface reduces the accumulation of bacterial plaque and the risk of gingival inflammation [15,16].

Zirconium can be precisely machined using CAD/CAM technologies, allowing for high-precision, customized work. This reduces laboratory work time and can improve the accuracy of fit and fit on prepared teeth. Processing zirconium requires special equipment and specific techniques, given the hardness of the material. Cutting and grinding must be done carefully to avoid microfractures, which can compromise the integrity of the work [17].

Zirconia is generally more expensive than other materials for prosthetic work, such as metal-ceramics, however, the higher cost is justified by the extended lifespan and superior esthetics.

Marginal adaptation is essential to prevent bacterial infiltration and subsequent gingival problems and gingival recession. Despite the excellent esthetics, if it is not properly fitted, gingival retraction may occur, exposing the restoration margin [18].

Professional discussions in dentistry often focus on the balance between aesthetics, functionality and cost, evaluating the advantages and disadvantages of each material to provide patients with durable and esthetic prosthetic solutions. Zirconia support is a modern solution with multiple benefits that continues to evolve as technologies and materials develop [19].

CONCLUSIONS

In conclusion, we can state with solid arguments that ceramic works on zirconium support have become a popular choice in restorative and prosthetic dentistry due to the many

advantages they offer. Specialists in dentistry have reached a number of conclusions regarding their use, based on studies and clinical observations.

First of all, zirconium offers a translucency and a color that imitates the natural tooth very well, making it ideal for dental work in the aesthetic area. Due to the absence of a metal substrate, a dark border does not appear at the level of the gum, unlike metal-ceramic works[20,21].

Next, zirconia is known for its high resistance to masticatory forces and fracture, making it suitable for crowns and bridges, even in high-load areas. This makes it a preferred choice for long-term restorations. Zirconia-supported restorations demonstrate outstanding wear and abrasion resistance, which contributes to the longevity of dental restorations and the maintenance of the structural integrity of adjacent teeth.

Third, zirconium is a biocompatible material, which means that the risk of allergic reactions or tissue irritation is very low. It is not only safe for the patient, but also contributes to the maintenance of gingival health by reducing the risk of inflammation.

The possibility of being processed with the help of modern CAD/CAM technologies allows the realization of prosthetic works with a very high precision. This leads to a better fit and a reduction in the time required for subsequent adjustments.

Zirconium is an excellent solution in modern dental prosthetics, offering a complete package of esthetic, functional and safety benefits. Due to these advantages, it continues to be the material of choice for high-quality dental restorations.

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