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HIGH CLASS MATERIALS SUCCESSFULLY USED IN DENTAL PROSTHETICS FOR COMPLEX INTRAORAL REHABILITATION – LITERATURE REVIEW

Alina Mihaela Apostu[1] , Ovidiu Stamatin*[2], Lupu Iulian Costin[2]*, Laura Elisabeta Checherita[1]

[1]Department of Odontology, Periodontology and Fixed Prosthesis, Faculty of Dental Medicine, Grigore T. Popa University of Medicine and Pharmacy, 16 Universității Street, 700115, Iasi, Romania; [2]Department of Oral-implantology, Faculty of Dental Medicine, Grigore T. Popa University of Medicine and Pharmacy, 16 Universității Street, 700115, Iasi, Romania.

Correspondig authors :Ovidiu Stamatin: ovidiustamatin @yahoo.com
Lupu Iulian Costin : lupucostin @yahoo.com

ABSTRACT

Among the dental ceramics, zirconia(ZR O2) is the dental restorative material most commonly used in dental prosthetical restoration. This material has unique characteristics, such as high fracture toughness, biocompatibility and color approximating the natural tooth color. Choosing this type of material as a biomaterial in prosthetic solutions is represented by a very important reason given by the mimicity with the natural teeth of this material as well as ,its resistance, therefore it is preferred by both, patients and practitioners in the field but not least , by dental technicians due to the favored ease of digital software with which it is realizing .

Keywords: zirconia(ZRO2), materials,prosthetics,restauration, intraoral rehabilitation algorithm, rehabilitation treatment

INTRODUCTION

In the oral rehabilitation, dental prosthetics, occupies a very important position in the area of complex solutions through the fixed joint and plural gnatoprotective devices, on natural teeth but also through the implant, thus perceiving - in our days - quite a lot of perfectly and idealy demands requested at her address. [1-4]

In recent years, with the advent of the digitalization of the way of performing prosthetic works on the one hand and of the recording of dental impressions on the other hand, it has thus passed from the classical methods with individual impression and execution time - the time taken by the material, - therefore important latency periods - as well as certain deficiencies of execution as well as the occurrence of some changes in the quality of materials through material characteristics, volume changes in different directions, depending on the stage and work support, to modern, digital methods, namely the crowns on zirconia support that represents the optimal solution for the restoration of teeth, without limiting us only the front teeth.
An important objective of this sientifichal approach is done by the increased interest of patients for this kind of new material due to the results seen in fact and the unlike by

comparisation withthe old one other dental tissue replacement solutions. This new biomaterial solution is the one preferred by them because of appearance or similar to that of a natural tooth, also the increased aesthetics as well as the resistance that ensures greater durability.

Zirconia (ZrO2) is a type of ceramics first identified by German chemist Martin Heinrich Klaproth in 1789.Zirconia is a white ceramic material with a characteristic translucency,and the prosthetic works based on zirconium will have a special aesthetic because they will not contain any metal and it presents like different shapes and sizes. Pure zirconia is not used in dentistry, but a chemical combination of it called zirconium oxide, the zirconia thus appears as a type of synthetic diamond, which revolutionized dentistry and the prosthetic support being executed with computerized systems, for this reason the prosthetic works based on zirconia are of perfect precision and durable due to the superior mechanical properties of zirconia, such as high mechanical strength, as well as wear and friction resistance. (Chevalier , 2006 ; Denry și Kelly , 2008).[5-9]

Generally,literature daid that it is known the use of zirconia in orthopedics began more than 20 years ago (Chevalier and Gremillard, 2008). Meanwhile, in the field of dentistry, using zirconium in dental restoration applications has become a practice since 1998 (Glauser et al., 2004). The increased resistance of zirconia has encouraged its use for dentistry applications, such as dental inlays ,onlays, crowns, fixed partial dentures (FPD) and dental implants (Kohal et al., 2006). Difficulties in achieving good aesthetics in porcelain and metal restorations (GFP), have increased the use of zirconia (Jang et al., 2011). [10,11]

A variety of techniques and technologies, such as combustion, casting, pressing or injection molding, and processing with computer-aided design and Computer Aided Manufacturing (CAD / CAM) technology underlie the execution and use of this material in dentistry.
The pioneer of using CAD/CAM *Computer Assisted Dsesign – Computer Assisted Manufacture)* techniques for the fabrication of tooth restorations was Duret in the 1970s (Duret, 1988). Ten years later, the CEREC system was marketed by Siemens (now Sirona). Cercon from DeguDent was introduced in 1998. In 2001, Nobel Biocare unveiled Procera AllZircon (now Procera Zirconia), and In-Ceram YZ CUBES was introduced by VITA in 2004 (Ban, 2008). [12-14]

For a more complex vision, meant to help the dentist, but also the success of the intervention, in the design of the dental crown will be taken into account the neighboring teeth, but also the antagonistic teeth. Therefore the dentist using a minimally invasive technique will have to prepare the tooth with minimal tissue loss. After completing the computerized design, the information will be transferred to the milling machine, which has diamond tools, of high precision.[15-18]

CAD/CAM sistems *(Computer Assisted Dsesign – Computer Assisted Manufacture)*)are a method that involves the use of a video capture, performance, high accuracy of detail camera, connected / connected to a computer. The computer will carry out the complete restoration design based on the scanned / captured 3D images to be placed on the tooth prepared by the dentist.
From hystorycal of applicability , point of wieu ,zirconia (ZrO2) is widely used in orthopedics, in the recent past, it has also

become one of the preferred among prosthetic dentists, due to its favorable properties. ZrO2 was introduced to prosthetic dentistry about 30 years back; however, its use as in dental implants was reported only in 2004.

There are highly evolved systems with which you can perform both zirconium and ceramic works (facades, inlays, crowns, etc.). they consist, in large part, of 3 parts.

The first one **:• the scanner**

The scanner is a computerized system that produces 3D images of the dental impression or of the gypsum model. The image thus obtained is called the fingerprint. After recording these images, the computer can design a wide variety of dental works: single crowns, dental bridges, inlays, facets, etc. The device uses a technology similar to that of the space and aeronautics industry. After design, the computer sends the data, the milling machine.(Fig 1)

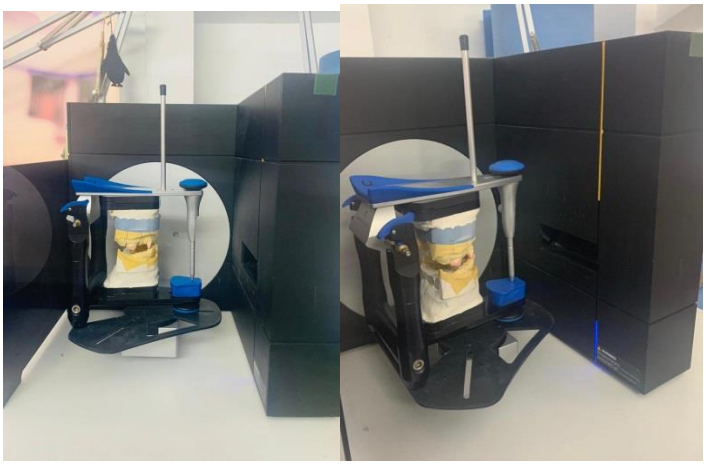


Fig 1. Images with the -CAD -CAM Scanner-componnents (Swing DOF) Private Dental laboratory IASI

:-the milling machine

Milling machine is the system that performs the milling of zirconium blocks according to the information received from the computer. It uses special milling machines with perfect precision. The milling machine is completely automated, the milling exchanges for processing, being carried out automatically during the milling process, due to the milling mill with which the milling machine is equipped.,(Fig2)

The milling machine works based on milling strategies and algorithms, which are transmitted online in the CAM (computer aided manufacturing) milling program, from the computer where the prosthetic work was designed**.**

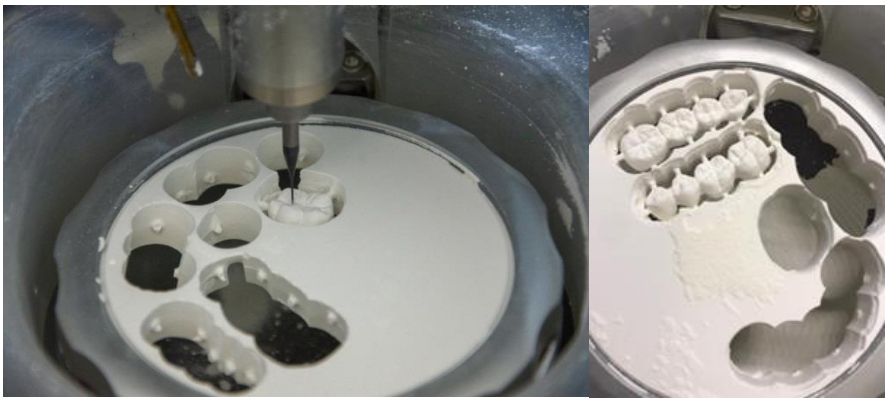


Fig. 2 Tehnological facts .Zirconium the crude product and its milling /Private Dental laboratory(IASI)

:Sintering furnace

The sintering furnace is the apparatus where the zirconium work is sintered at temperatures of 1500 degrees C for 6-18 hours, in order to achieve the hardness and translucency of the zirconia.



Fig 3. Computer Aided Manufacturing (CAD / CAM/private dental tehnicque / Supertherm Sintering Furnace/ Private Dental laboratory



FIG 4.Tehnological rezults used in prosthetic treatment by zirconium oxide(zn o2)- Private Dental laboratory-IASI.

Therefore, prosthesis using zirconium support does not solve only a functional problem, leaving the aesthetic part on account of other procedures to beautify the smile, but it is in itself an aesthetic solution to cover the dental implant or a tooth with rehabilitation needs, or even a situation. of edentation in which implantation has contraindications. Thus, from the point of view of the specialists in dental prosthetics, the zirconia-based crowns represent the optimal solution for the restoration of the teeth, without limiting us only the front teeth. Unlike other dental tissue replacement solutions, this is the one preferred by patients, due to its appearance similar to that of a natural tooth and to the resistance that ensures greater durability.19-21](fig 3,4)

Clinical Aspects of Zirconia Restorations:

One of the most important properties besides the physiognomic aspect undoubtedly is the biocompatibility and the degree of immediate adaptation of the tissues but also their functionality supported by the structural and mechanical characteristics of the material under study. Patients who are very allergic will not have any negative reaction, especially as the zirconium oxide ZrO2 has a rare and pure composition, does not corrode, has no electrical conductivity and does not irritate.). Unlike the rest of the crowns on metal support (chrome nickel; gaudent, paladium etc.) the zirconia layer is not oxidized by the fluids in the oral cavity, therefore it does not irritate the surrounding tissues with oxides and does not influence in any way the color of the natural teeth ,for this reason the biocompatibility are mandatory (George and Eichmiller, 1995).
After a very short time since the mounting of the zirconia-based crowns, they integrate perfectly, becoming inseparable from patients, this is because, unlike the rest of the crowns, the zirconium-based ones are very light

Inevitably in many cases where other types of conventional prosthetic solutions were used, other than those performed in the incidence of computerized milling being precisely impaired, periodontal level

disturbances were eliminated and thus completely eliminated in the case of the zirconia-based dental crown. (Fig 5.)

Zirconium-based dental crowns that are made by computerized milling (CAD-CAM process) and are aesthetically extraordinaryand also keep the conservative and biological principal stand up by a very importanrt caractheristic dental tissue preservation.[22]



Fig5.**Clinical images aspects of frontal zone , zirconia fixed restauration (self cazuistic).Private Dental Practice Iasi.**

Mechanical Properties:

In the construction of dental restoration, esthetics in terms of a color and translucency, for this reason is mainly used as a core material in endodontics intraoral rehabilitation , feldspathic porcelain is still needed for the veneers of zirconia-based restorative material and is only placed in the anterior region due to low mechanical stability and brittleness of porcelain(Conrad et al., 2007) The relevant mechanical properties are high flexural strength and fracture toughness. This means that the material has the ability to stop or limit crack propagation (Zarone et al., 2011)Mechanicalproperties, the highest fracture toughness compared with alumina and porcelain and has the highest critical stressintensity factor (KIC), between 6 MPam1/2 to 11 MPam1/2, which is more similar to that of metals than other materials (Piconi and Macauro, 1999; Denry and Kelly, 2008), and Structure properties also indicate that Nanometer-sized particles have gained research interest in the past few decades because of properties of the material change drastically as the grain size approaches the nanometer scale (Sun and Gao, 2003).[23-25]

Structure properties also indicate that nanometer-sized particles have gained research interest in the past few decades because of properties of the material change drastically as the grain size approaches the nanometer scale (Sun and Gao, 2003). Nanoparticleshave the capability to obstruct stress when under loading, thereby hindering crack propagation in semicrystallineand amorphous polymers (Zhang and Kim, 2010) stress when under loading, thereby hindering crack propagation in semicrystallineand amorphous polymers (Zhang and Kim, 2010)[27,28]

Conclusion

The optical property of dental materials plays an important role in matching the ceramic restorations to the natural appearance of teeth. Zirconia ceramics are selected for the fabrication of dental restorationsand it has a color similar to teeth but if translucency is needed then other ceramic materials should be considered.Zirconia-based dental materials have the potential for being use in constructing dental restorationapplications and are recommended in clinical practice. Furthermore, the introduction of stabilized zirconia has created a real possibility and

promise for the application of zirconia in dental reconstructions.

Use of ZrO2 across various fields of prosthetic dentistry is growing by the day and similar is the scenario on the research front. and exist also, considerable amount of focus in the market on ZrO2 -based materials

References

1. Denry, I. and J.R. Kelly, 2008. State of the art of zirconia for dental applications. Dental Materials, 24: 299-307.
2. Garvie, R.C., R.H. Hannink, R.T. Pascoe, 1975. Ceramic steel. Nature., 258: 703-4.
3. George, L.A., F.C. Eichmiller, 1995. Bioceramics: Materials and Applications. The American Society, Indianapolis., pp: 157.
4. Kohal, R.J., G. Klaus and J.R. Strub, 2006. Zirconia-implant-supportedall-ceramic crowns withstand longterm load: a pilotinvestigation. Clinical Oral Implants Research., 17: 56-71.
5. Lohmann, C.H., D.D. Dean, G. Koster, D. Casasola, G.H. Buchhorn, U. Fink, 2002. Ceramic and PMMA particles differentially affect osteoblast phenotype. Biomaterials., 23: 1855-63.
6. Mitsias, M.E., N.R. Silva, M. Pines, C. Stappert, V.P. Thompson, 2010. Reliability and fatigue damage modes of zirconia and titanium abutments. The International Journal of Prosthodontics., 23: 56-9.
7. Torricelli, P., E. Verne, C.V. Brovarone, P. Appendino, F. Rustichelli, A. Krajewski, 2001. Biological glasscoating on ceramic materials. Biomaterials., 22: 2535-43.
8. Vasylkiv, O., S. Yoshio, M. Yasuaki, V. V. Skorokhod, 2004. Nano-engineering of zirconia–noble metals composites. Journal of the European Ceramic Society., 24: 469-473.
9. Zarone, F., S. Russo and R. Sorrentino, 2011. From porcelain-fused-to-metal to zirconia: Clinical and experimental considerations. Dental Materials., 27: 83-96.
10. Ban, S., 2008. Reliability and properties of core materials for all-ceramic dental restorations. Japanese Dental Science Review., 44: 3-21
11. Forna NC (2011). Protetică Dentară, Vol. I si II, Ed. Enciclopedică, Iași.
12. Forna Norina Consuela, Checheriță Laura Elisabeta (2018). Muscular rehabilitation for the patiens with algodysfunctional syndrome vol I, II, publisher Grigore T. Popa, UMF Iași, ISBN: 978-606544-496-6
13. Burlui ,V.Morarasu C.Gnatologie Editura Apollonia IasI 2000.
14. Gegauff AG, Holloway JA. Interim fixed restorations. In: Rosenstiel SF, Land MF, Fujimoto J. Contemporary Fixed Prosthodontics. 4th ed. St Louis, MO: Mosby; 2006:466-504
15. Radz G.M., Minimum thickness anterior porcelain restorations Dental Clinics of North America 2011, 55(2) 353-370. 4 McLaren E.A., Garber D.A., & Figueira J., The Photoshop Smile Design technique (part 1): Digital dental photography Compendium of Continuing Education in Dentistry, 2013, 34(10) 772, 774, 776.
16. Coachman C., & Calamita M., Digital Smile Design: A tool for treatment planning and communication in esthetic dentistry Quintessence of Dental Technology, 2011, 35, 103-111.
17. Zahran M., El-Mowafy O., Tam L., Watson P. A., and Finer Y., Fracture strength and fatigue resistance of all-ceramic molar crowns manufactured with CAD/CAM technology, Journal of Prosthodontics, 2008, vol. 17, no. 5, pp. 370–377.

18. Walia S., Thomas P.M., Sandhu H., & Santos G.C. Jr., Restoring esthetics with metal-free ceramics: A case report Journal of the Canadian Dental Association, 2009, 75(5) 353-355.
19. Madfa A, Al-Sanabani F, Al-Qudami N, Al-Sanabani J, Amran A. Use of zirconia in dentistry: An overview. Open Biomater J 2014;5:1-7.
20. Volpato CA, Bondioli F, Garbelotto LG, Fredel MC. Application of Zirconia in Dentistry: Biological, Mechanical and Optical Considerations. InTech Open Access Publisher; 2011..
21. Guazzato M, Albakry M, Swain M, Ringer S. Microstructure of alumina-and alumina/zirconia-glass infiltrated dental ceramics. KEM 2003;240-242:879-82.
22. Sorensen J. The lava system for CAD/CAM production of high strength precision fixed prosthodontics. Quintessence Dent Technol 2003;26:57-67.
23. Denry IL, Holloway JA. Microstructural and crystallographic surface changes after grinding zirconia-based dental ceramics. J Biomed Mater Res B Appl Biomater 2006;76:440–448
24. Anusavice KJ. Informatics systems to assess and apply clinical research on dental restorative materials. Adv Dent Res 2003;17:43–48.
25. Curtis AR, Wright AJ, Fleming GJ. The influence of surface modification techniques on the performance of a Y-TZP dental ceramic. J Dent 2006;34:195–206
26. De Aza AH, Chevalier J, Fantozzi G, Schehl M, Torrecillas R. Crack growth resistance of alumina, zirconia and zirconia toughened alumina ceramics for joint prostheses. Biomaterials 2002;23:937–945. 65.
27. Vult von Steyern P, Carlson P, Nilner K. All-ceramic fixed partial dentures designed according to the DC-Zirkon technique. A 2-year clinical study. J Oral Rehabil 2005;32:180–187
28. Zhang Y, Lawn BR, Malament KA, Van Thompson P, Rekow ED. Damage accumulation and fatigue life of particleabraded ceramics. Int J Prosthodont 2006;19:442–448