ECRONICON OPEN ACCESS

EC DENTAL SCIENCE

Mini Review

The Wear of Natural Tooth Antagonists due to Monolithic Zirconia

Rakintzaki Theofania[1]*, Marios Ferizi[2] and Filippatos Gerasimos[3]

[1,2]National and Kapodistrian University of Athens, School of Dentistry, Greece

[3]Department of Fixed Prosthodontics, National and Kapodistrian University of Athens, Greece

***Corresponding Author:** Rakintzaki Theofania, School of Dentistry, National and Kapodistrian University of Athens, Greece.

Received: December 28, 2023; **Published:** February 02, 2024

Abstract

The importance of even more aesthetic restorations led to the increasing use of zirconia, which could be either veneered or full-contour monolithic zirconia. Especially in posterior areas, because of the limited aesthetic demands of patients, the use of monolithic zirconia becomes even more common. However, it is well known for its high roughness, so its behaviour against the antagonists is questionable. The purpose of this article is through literature review to examine the wear of antagonists and if this one is higher in contrast to other materials. To conclude, the result seems to be in favor of the monolithic zirconia which presents a high success rate and provokes less wear to antagonists than other materials, which are also used for final restorations, such as porcelain. Nevertheless, long term randomized control studies are required for a more adequate documentation.

Keywords: *Zirconia; Wear; Monolithic Zirconia; Porcelain; Opposing Teeth; Metal-Ceramic Restorations*

Introduction

The smallest possible loss of dental tissues has been the main goal of the clinics to ensure the required space for the prosthetic restoration of the patient. In this effort, the use of monolithic zirconia plays a crucial role as it enables full contour restorations with minimal invasive preparations. This is possible because these restorations can be fabricated with a thickness as low as 0.5 millimeters. Notably, *in vitro* studies have demonstrated that even at this minimum thickness, they exhibit exceptional resistance to fractures. Apart from their mechanical properties, composite materials offer good biological and aesthetic characteristics. However, they may not match the aesthetic performance of other materials like lithium bisilicate due to their higher opacity, making them less than ideal for use in the front area. Nevertheless, they are becoming increasingly popular for use in the back area. Until recently, metal-ceramic restorations have been considered the gold standard for immovable prosthetic restorations. However, the metal used in these restorations can cause graying at the cervical border, which can affect the final aesthetic outcome and undermine the overall appearance of the restoration. This is particularly important in areas where patients are increasingly seeking aesthetic solutions [2]. To address the issue caused by the presence of the metal frame, an alternative method was tried. This involved substituting the metal frame with a zirconia core, which was then layered with porcelain. However, these types of restorations are characterized by a weak bond between the core and porcelain, which often leads to the porcelain peeling off [3-5]. To prevent the errors mentioned above, it was necessary to find suitable material. Monolithic zirconia is one such material that meets all the requirements of the current time and is compatible with CAD/CAM techniques. It allows for a fully digital approach at both clinical and laboratory levels. The processing methods for monolithic zirconia restorations are simpler and require less time, making them a promising alternative.

Zirconia is a bioceramic material discovered by the German chemist Martin Heinrich Klaproth in 1969. The first research paper on the use of zirconia as a violin was published by Helmer and Driskel in 1969. It is a polycrystalline ceramic dioxide from the transition metal zirconium and belongs to the group of reinforced cores. Its high resistance to bending and compression, withstanding up to 1200MPa and 2000MPa respectively, its biocompatibility, and its aesthetic excellence are some of the notable characteristics of this material. Unlike other ceramic materials, it lacks a glassy phase and is found in three crystalline phases, which are dependent on the temperature of its environment. For temperatures above 2370°C, the material is present in a cubic phase and takes the form of a straight prism with square edges. It exhibits moderate mechanical properties in this phase. Between temperatures of 1170°C and 2370°C, the material takes on a square phase and appears as a straight prism with rhomboid edges. The mechanical properties of the material are improved in this phase. At temperatures below 1170°C, the material takes on a monoclinic phase and exhibits a degraded prism shape with parallel edges. Mechanical efficiency is also reduced in this phase [3-5,11]. When the temperature drops, the zirconia lattice takes a cubic or square shape and expands to return to the monoclinic phase. But, the cooling process causes considerable strain on the lattice, because as the temperature decreases, the lattice becomes inflexible and is unable to keep up with the accompanying expansion [8,12]. These internal stresses can cause catastrophic material breakage, or residual stresses contribute to the propagation of surface cracks and fractures over time. The transformation from square to monoclinic form is called aging of the material and is a major problem in dental applications, where ceramic restorations are cast into the final form, and cooling them will certainly lead to fracture of the work. Aging causes the degradation of mechanical properties, microfracture, and destruction of the external surface structure of the material. For the restorations to display improved mechanical information, the need arose to stabilize them in the tetragonal phase even at room temperature. This can be achieved by adding oxides and specifically by using yttria [2,13]. The stabilization of zirconia in the tetragonal phase paved the way for its use in monolithic restorations by addressing the porcelain exfoliation that often occurred in zirconia core and porcelain veneer restorations [13]. Something that is a unique characteristic of zirconia and worth analyzing is the ability of crystallographic conversion, that is, when a force is applied to a surface that can cause a crack in the material, then a volumetric change of the crystals occurs, which from the square phase passes to monoclinic with a parallel increase in their volume of 3% - 5%. This results in the crack being intercepted and preventing further propagation [2]. This fact also affects the aging effect of monolithic zirconia, as the loading of its restorations is done continuously in the oral environment [13]. However, more studies are needed to evaluate this effect. Ceramics based on zirconia are chemically inert materials that do not show adverse reactions in the tissues, in contrast to several metal alloys used to construct metal-ceramic restorations. Since the ceramic prostheses have been manufactured with highly polished surfaces, they can contribute to the maintenance of the gum architecture, preventing the retention of dental microbial plaque and allowing the adhesion of cells to their surface, making them an ideal material for the mouth's soft tissues. Various studies confirm the predominance of yttria-stabilized zirconia as the most biocompatible form. Although zirconia, which is used to construct the core in all-ceramic systems, is characterized by excellent mechanical properties, including flexural, compressive, and fracture strengths, it is cosmetically disadvantaged by its opacity [3-5,11]. Although it excels mechanically compared to monolithic zirconia, the latter has better optical characteristics [14]. After all, a factor that affects the transparency is the thickness of the restoration, since the smaller it is, the higher the transparency. As restorations of even 0.5 mm are obtained, the visual advantage of monolithic zirconia becomes clear.

Materials and Methods

A literature search was conducted using the 'PubMed' and 'Google Scholar' database.

Wear of opposing teeth

Another element essential to be taken into consideration for the success of restorations is the behavior of materials in relation to opposing teeth. Another crucial aspect to consider for the success of restorations is the behavior of materials concerning opposing teeth. The wear resistance of restorative materials should closely mimic that of natural teeth. Excessive wear beyond the normal range can adversely impact the entire stomatognathic system, resulting in the loss of vertical dimension in the face, poor aesthetics, and limited chewing ability.

It is not unreasonable for one to expect that harder materials can wear down competitors more easily. Zirconia, for instance, is an exceptionally hard material, with twice the hardness of porcelain and three times that of enamel. Therefore, it is reasonable to question to what extent it wears down the opponent when it comes to a natural tooth. Wear seems to depend not only on the hardness of the material but also on the surface roughness of the restoration [13,15]. Additionally, factors such as the presence of pores, crystalline structure, flexural strength, fracture toughness, and ceramic layering, in turn, influence the potential for causing wear of opposing teeth [11].

In order to examine whether monolithic zirconia poses a risk to the teeth of the opposing dentition, numerous studies have been conducted, both *in vitro* and *in vivo*. These studies involved the collection of impressions and 3D imaging for a comparative analysis between the initial and subsequent states. Specifically, a study was conducted to assess the wear of opposing dentition, which was examined at three time intervals: one week after bonding, six months, and one year later. To conduct the study, impressions of the opposing teeth were taken, replicas were fabricated, and scanning and digitization were performed at each of the three phases mentioned above. To assess the wear of opposing dentition and the contact points on these teeth, intraoral articulating paper was used to mark the interocclusal contacts, serving as reference points for occlusion. Graphic comparisons of the scans of the replicas, derived from the initial impression, and scans of the replicas from subsequent visits were conducted using software. Thus, average deviations of 15.5 μm were observed in the first semester and 16.3 μm over the course of the year [13]. These results are consistent with findings from other studies by Stober., *et al*. and Mundhe., *et al*. who reported higher mean wear values of opposing dentition (42.10 μm) over the span of one year [13,16,18]. However, it is essential to interpret their results with caution, as their sample size was significantly smaller than that of the aforementioned study [13]. Numerous studies concur on the significant role played by the surface of the restoration material. More specifically, monolithic zirconia, when polished without undergoing glazing, caused less enamel wear. This can be justified by the fact that the thin layers of glazed zirconia, within the first six months of the restoration in the oral cavity, degrade, exposing the rough surface of the material. Consequently, this makes it possible to induce wear on opposing dentition [15,18]. Therefore, well-polished zirconia seems not to adversely affect the teeth of the opposing dentition when used as a restoration material. At this juncture, it is important to note that studies suggest that other materials, such as metal-ceramic restorations, appear to cause more detrimental issues to enamel compared to monolithic zirconia. Directly in line with this, Mundhe., *et al*. demonstrated that the average wear values of opposing dentition against metal-ceramic restorations one year post-bonding were 69.20 ± 4.10 μm for premolars and 179.70 ± 8.09 μm for molars, whereas for monolithic zirconia restorations, they were 42.10 ± 4.30 μm and 127.00 ± 5.03 μm, respectively [16]. However, it's important to note that the latter is not a cure-all and may indeed wear down opposing dentition to a greater extent than natural teeth (17.30 ± 1.88 μm in premolar regions and 35.10 ± 2.60 μm in molar regions) [16]. From the following, the need for good polishing of monolithic zirconia becomes evident due to its impact on the opposing dentition. In this scenario, there is no significant risk to the antagonistic teeth, at least not greater in comparison to other restoration materials. However, it is deemed essential to monitor monolithic zirconia restorations because if the surface gloss diminishes, the potential for wear significantly increase [18].

Conclusion

In conclusion, the failure of the zirconia core - porcelain veneer bond has predominantly driven the adoption of full-contour monolithic zirconia. This material is distinguished by its favorable chemical, biological, and aesthetic properties, steadily gaining prominence in contemporary prosthetic restoration. Furthermore, its performance against competitors appears to be commendable, causing less wear even compared to metal-ceramic restorations. Nevertheless, these observations do not imply that monolithic zirconia is a cure-all and devoid of disadvantages. Therefore, the necessity for further research on the material and its impact on the opposing dentition is imperative.

Bibliography

1. Konstantinidis I., *et al*. "Clinical outcomes of monolithic zirconia crowns with CAD/CAM technology. A 1-year follow-up prospective clinical study of 65 patients". *International Journal of Environmental Research and Public Health* 15.11 (2018): E2523.
2. Badami V and Ahuja B. "Biosmart materials: breaking new ground in dentistry". *Scientific World Journal* (2014): 986912.
3. Aqustin-Panadero R., *et al*. "Zirconia in fixed prosthesis. A literature review". *Journal of Clinical and Experimental Dentistry* 6.1 (2014): e66-e73.
4. Oilo M., *et al*. "Fractographic features during clinical function". *European Journal of Oral Sciences* 122.3 (2014): 238-244.
5. Oilo M., *et al*. "Simulation of clinical fractures for three different all-ceramic crowns". *European Journal of Oral Sciences* 122.3 (2014): 245-250.
6. Goyveia DNM., *et al*. "A Fully digital approach to fabricating a CAD-CAM ceramic crown to fit an existing removable partial denture". *Journal of Prosthetic Dentistry* 121.4 (2019): 571-575.
7. Soldatos., *et al*. "Zirconia properties, clinical applications and presentations of clinical cases". *Stomatology* 66.1 (2009): 3-16.
8. Hatzikyriakos., *et al*. "Zirconia as a material for prosthetic restorations". *Stomatology* 40 (2012): 249-260.
9. Tzanakakis *et al*. "Zirconia. Contemporary views of a much-discussed material, structure, applications and clinical considerations". *Greek Dental Years* 57 (2013): 101-137.
10. Koyrentas S. "Systems CAD/CAM in restorative dentistry 1". *Greek Dental Years* 55 (2011): 109-123.
11. Pathan MS., *et al*. "Assessment of antagonist enamel wear and clinical performance of full-contour monolithic zirconia crowns: one-year results of prospective study". *Journal of Prosthodontics* 28.1 (2019): e411-e416.
12. Koyrentas S. "Systems CAD/CAM in restorative dentistry 1". *Greek Dental Years* 55 (2011): 203-214.
13. Silva LHD., *et al*. "Dental ceramics: a review of new materials and processing methods". *Brazilian Oral Research* 31.1 (2017): e58.
14. Stawarczyk B., *et al*. "Comparison of four monolithic zirconia materials with conversional ones: Contrast ratio, grain size, four-point flexural strength and two-body wear". *Journal of the Mechanical Behavior of Biomedical Materials* 59 (2016): 128-138.
15. Gundugollu Y., *et al*. "Comparison of the effect of monolithic and layered zirconia on natural teeth wear: An *in vitro* study". *Journal of Indian Prosthodontic Society* 18.4 (2018): 336-342.
16. Mundhe K., *et al*. "Clinical study to evaluate the wear of natural enamel antagonistic to zirconia and metal ceramic crowns". *Journal of Prosthetic Dentistry* 114.3 (2015): 358-363.
17. Stober T., *et al*. "Clinical assessment of enamel wear caused by monolithic zirconia crowns". *Journal of Oral Rehabilitation* 43.8 (2016): 621-629.
18. Gou M., *et al*. "Antagonist enamel wear of tooth-supported monolithic zirconia posterior crowns *in vivo*: A systematic review". *Journal of Prosthetic Dentistry* 121.4 (2018): 598-603.

Volume 23 Issue 2 February 2024