

# Antagonist wear in posterior crowns supported by monolithic zirconia



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## 1. Introduction:

For decades, porcelain-fused-to-metal (PFM) restorations were considered to be the first choice, and were the gold standard for dental prostheses, due to satisfying requirements for durability, and fit to abutment. PFM is made by veneering porcelain on a metal coping. The latter provides the required strength to brittle porcelain, which offers a natural look to the restorations [1]. However, using a metal coping presents significant esthetic limitations, since masking the dark metal color is difficult and hence ceramic restorations are becoming popular since they are metal free and have excellent esthetics and biocompatibility [2].

Two systems of all-ceramic material for prostheses are in place [3].

### 1. Using a single material as a full contour restorations (monolithic):

Reinforced glassy materials were used to make single crowns and short-span bridges, which, are limited to anterior and premolar regions. However, polycrystalline zirconia with improved translucency is introduced for full contour crowns and bridges in any region of the mouth [2].

### 2. Using layered materials, fused or bonded, composing veneered restorations:

Porcelains and glass-ceramics are fused or bonded to a stronger framework, composed of high-strength ceramics, such as densely sintered polycrystalline zirconia instead of alloys [1]. This system provides the strength of zirconia with superior esthetics of veneering materials [3].

Besides, the zirconia framework offers greater translucency and helps easier masking than metal copings, allowing for a more tooth like appearance [4].

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With these two systems, ceramics are now the main class of materials used for fixed dental prosthesis; especially monolithic zirconia, which is replacing metal due to its higher flexural strength and better esthetic properties. However, veneered ceramic restorations have a high incidence of chipping and delamination [5]. The reasons include mismatch between thermal coefficients of the zirconia framework and veneer and the fast cooling rate. Although the prevalence of chipping can be lessened by reducing the cooling rate of porcelain, translucent monolithic zirconia restorations without any veneering have become popular. Nevertheless, monolithic zirconia restorations have high strength and hardness. Therefore, the abrasion between the zirconia and the opposing natural tooth caused by high hardness and surface roughness is a major concern [6].

Oral wear can be defined as “ the ultimate consequence of interaction between surfaces which is manifested in gradual removal of material”[7]. Restorations and teeth are generally subjected to physical and chemical degradation in the oral cavity [7]. Although the progression of oral wear is slow, the extent and rate can be exacerbated by many patient factors. Oral wear can lead to vertical loss of tooth height, poor esthetics, increased tooth sensitivity, reduced masticatory function, and eventually lead to temporomandibular joint dysfunction [8]. The wear mechanism involves 3 processes: attrition, that is caused by tooth-to-tooth contact (2-body wear); erosive wear, caused by dissolution of hard tissue by acidic substances; and abrasive wear, which is the interaction of 3 factors including teeth and another material, such as food. All the 3 processes combine together to contribute to tooth wear and rarely act alone.

Among factors causing of enamel wear related to prosthetic materials, hardness, surface roughness and fracture toughness are chiefly concerned. Conventionally, higher hardness was thought to cause more antagonist enamel wear [9]. Zirconia has higher surface hardness ( $\geq 13$  GPa) than feldspathic ceramic (4.9 GPa) or enamel (3.14 to 3.72 GPa) [8]. Hence, zirconia might be expected to cause more wear. However, in-vitro studies have shown that the zirconia caused less antagonist enamel wear than the feldspathic ceramics or natural tooth which attributes to its high fracture strength that can maintain a smooth zirconia surface [10, 11]. However, if zirconia is left rough, may cause greater antagonist enamel wear [12]. As roughness affects zirconia and antagonist wear, surface treatments are important to decrease tooth wear. Glazing or polishing is a common technique to decrease roughness. Moreover, polishing also enhances the flexural strength and fatigue resistance of zirconia [8, 13]. Yttria-stabilized zirconia polycrystal (Y-TZP) can undergo a toughening effect from the phase transformation, that arrest the crack propagation. Y-TZP also undergoes transformation toughening and low-temperature degradation (LTD). Transformation toughening contributes to high fracture strength of Y-TZP and is look upon as a self-healing mechanism [14]. When tensile stresses are generated at the tip of a crack, the tetragonal phase converts to the monoclinic phase with volumetric expansion and subsequent compressive stresses around the crack. This results in partial closure of the crack and prevents its further extension [14]. Therefore, transformation toughening helps zirconia to achieve a smooth surface that results in decreased antagonist enamel wear. However, LTD causes decreased strength, surface roughening, and microcracking. Precisely, with water penetration of <https://assignbuster.com/antagonist-wear-in-posterior-crowns-supported-by-monolithic-zirconia/>

crystalline structure, the tetragonal phase transforms into the monoclinic phase [14]. This phenomenon is widely reported in vitro. One clinical study indicated that LTD did indeed occur in the mouth at a rate comparable with the lifespan of dental restorations (approx. 15 years) [15]. Further, the study conducted by Zhao et al [16] reported that electrolytes present in artificial saliva did not have an additional effect on LTD. However, LTD increased from neutral to alkaline environment and further to acidic environment [16].

In vitro studies have shown that monolithic zirconia crowns cause less antagonist enamel wear than other ceramic or metal-ceramic restorations [17, 18]. Moreover, polished zirconia presents less enamel wear than glazed zirconia [19]. Nevertheless, intraoral wear is a complex phenomenon that is affected by physical, chemical, and biologic factors. The form of enamel wear is influenced by the type of restorative material, surface texture, masticatory force, dietary habits etc. [7, 15, 19]. Thus, in vitro studies cannot fully simulate actual clinical wear. Therefore, a systematic review was conducted to determine the extent and characteristics of enamel wear caused by monolithic zirconia in vivo, focusing on measurement methods that were used, wear parameters, and surface treatment [6, 8, 20-22].

## 2. Material and Methods:

This review was done with a PubMed search from 2015 and 2018. The search was completed using the following key words: tooth wear, dental enamel, antagonist, occlusal wear, enamel wear, zirconia, and zirconium dioxide. The full text of articles was obtained where possible. Electronically available abstracts were collected if full text of articles couldn't be obtained. Thus,

the inclusion criteria for articles were as follows: human in vivo studies, studies on antagonist tooth enamel wear caused by Y-TZP crowns, and publications appearing in dental literature with mean follow-up time  $\geq 6$  months. The case reports containing the terms veneered zirconia crowns, participants with bruxism, ceramic crowns supported by implants were excluded from this review.

### 3. Result and Discussion:

The articles published between 2015 and 2018 are included here. Seventy-four participants between 18 and 73 years who needed tooth supported posterior crowns with no TMD or parafunctional habits were involved. All zirconia crowns were Y-TZP, with a follow-up time of 12 to 24 months. Enamel was reported as control in 2 studies [22, 23]. whereas, enamel and metal-ceramics were the controls in a study conducted by Mundhe et al [8]. Two other studies had no controls [20, 21] (Table 1). Zirconia crowns were polished without glazing in 4 studies; one study included, zirconia crowns that were glazed after polishing [22]. Zirconia crowns were polished again after occlusion adjustments in all the studies.

Table 1: Characteristics of reviewed studies[12].

Studies	Patients Number	Age (y)	Position of Crowns	Control	Follow (mont
Mundhe et al	10 (NA)	18-35	Molars & premolars	Enamel vs enamel; enamel vs metal-ceramics	12

Studies	Patients Number	Age (y)	Position of Crowns	Control	Follow (month)
Stober et al	20	21-73	Molars	Enamel vs enamel	24
Esquivel-Upshaw et al	25	> 21	Molars & premolars	Enamel vs enamel	12
Lohbauer et al	10	40-45	Molars & premolars	No	24
Hartkamp et al	9	NA	Molars & premolars	No	24

Four studies used indirect methods for measuring the antagonist wear [8, 21-23]. Polyvinyl siloxane impressions were made at different times, and casts were poured. 3D scanner scanned the cast with different accuracies ranging from 5 to 20 mm, and data was analyzed with different thresholds. Hartkamp et al however used a direct measurement method [20]. An intraoral scanner was used to scan the teeth after air drying. A thin layer of powder was applied onto the teeth surface before scanning and the data was analyzed with a software. Antagonist enamel wear of zirconia was measured as loss of height or volume loss. Mundhe et al [8] and Stober et al [22] concluded that antagonist enamel wear of zirconia was less than that of metal-ceramics but more than that of natural tooth. However, Esquivel-Upshaw et al [23] found that antagonist enamel wear of zirconia was less than that of metal-ceramics and enamel at 6 months but increased later at 12 months. Moreover, zirconia wear increased over time, but the rate of <https://assignbuster.com/antagonist-wear-in-posterior-crowns-supported-by-monolithic-zirconia/>

antagonist enamel wear decreased with time [6, 8, 20-22, 24]. A possible reason is running in wear occurs immediately after the placing of restoration, and stable wear takes over after 2 years[12]. The cusps become short and flat, whereas the base surface area increases larger with time. As the area and number of wear facets increase, the occlusal force per unit of surface area decreases, and so does the vertical height loss. In addition, higher wear rates may also be self-limiting because of the reduction in occlusal stress. The wear of molars was reported to be more than that of premolars because molars have greater occlusal force [8]. The degree of wear varied widely among different studies because of the difference in age, sex, diet, occlusal force, position of restorations, and bruxism. Other factors that could lead to differences in degree of antagonist enamel wear of monolithic zirconia crowns are measurement methods, surface treatment, and wear parameters.

Mundhe et al measured the antagonist enamel wear of polished zirconia without glazing. Stober et al evaluated the antagonist enamel wear of glazed zirconia in vivo but lacked a polished zirconia control. In vitro studies reported that glazed zirconia showed more tooth wear than polished unglazed zirconia [25]. Polished then glazed zirconia demonstrated slightly less antagonist enamel wear than glazed zirconia alone.[25] Overall, polished zirconia caused less antagonist tooth wear than glazed zirconia because thin glaze layers wears off within the first 6 months after insertion of the restorations. This exposes the rough surface and increases the possibility of wear [25]. Also, particles from the glaze may act as third-body abrasives [25]. The surface roughness of polished zirconia could be less than 0.2 mm, which is less than glazed zirconia. Therefore, polishing is



recommended to prevent antagonist enamel wear and maintain the structural strength of zirconia [26]. Volume loss is a better wear parameter choice because wear is defined as the volume loss of tooth tissue [9]. In addition, the volume of wear increases with time because the base surface area increases in relation to a proportional decrease in the vertical height. Similarly, height and area of loss are not good parameters because they are affected by time and occlusion [9]. Most of the included articles chose height loss as the wear parameter, which increased the discreteness of the wear value and decreased the reliability of the results.

#### IV Conclusion:

Based on our findings, the following conclusions were drawn:

- 1 Well-polished monolithic zirconia caused less enamel wear than the metal-ceramics and showed similar or greater antagonist enamel wear than natural teeth.
- 2 Studies which have bigger sample sizes, longer observation times, and that can have uniform measurement methods are required.

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