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Enamel Wear Induced By Dental Prostheses: Material Selection, Surface Characteristics and Clinical Implications -An Overview

Dr Jayasharath T.R, Dr V Vidyashree Nandini, Dr Russia M, Dr Abinaya S

1. Intern, Department of Prosthodontics and Implantology, SRM Kattankulathur Dental College and Hospital.
2. Professor and HOD, Department of Prosthodontics and Implantology, SRM Kattankulathur Dental College and Hospital.
3. Associate Professor, Department of Prosthodontics and Implantology, SRM Kattankulathur Dental College and Hospital.
4. Assistant Professor, Department of Prosthodontics and Implantology, SRM Kattankulathur Dental College and Hospital.

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ABSTRACT: Dental prosthesis are essential for restoring function and aesthetics in edentulous and partially edentulous patients. Crowns, bridges, and dentures are common dental prosthesis used to replace lost or damaged teeth, thus improving function and esthetics . However, these restorations may cause wear on the opposing enamel, a phenomenon affected by the hardness, surface roughness, and polishing methods of the prosthetic material. This can happen owing to friction between the prosthetic material and enamel, especially if the prosthesis is made of a harder material, than enamel. Over time, this wear can cause enamel to weaken, increasing tooth sensitivity or leaving teeth more prone to decay and further damage. The wear of enamel caused by dental prosthesis is a multifaceted problem that requires material optimization, suitable surface treatments and meticulous clinical planning to achieve a balance among durability, aesthetics and enamel conservation.Thereby this article reviews the impact of various prosthetic materials on the surface deteriotion of the enamel in the antogonist teeth.

I. INTRODUCTION:

Dental prosthesis which includes crowns, bridges, and veneers, are necessary for restoring function and aesthetics in patients who are eduntulous and partially eduntulous.Ceramics and other recent materials have improved their biocompatibility and durability, improved their resistance to wear and fracture, improved their aesthetics, and reduced the negative impacts on opposing enamel.The natural enamel of the opposing tooth may be worn by these restorations.Enamel, the hardest substance in the human body, is designed to withstand masticatory forces, but contact with harder prosthetic materials can accelerate its wear, leading to sensitivity, functional impairments, and aesthetic concerns. The degree of enamel damage depends on a number of factors, including the hardness of the material, surface roughness, and finishing procedures. The aim of the review is to evaluate the impact of the materials used for fabrication of dental prosthesis on enamel wear and optimize material selection.

MATERIALS IN DENTAL PROSTHESIS:

Dental prostheses are critical components of modern dentistry, providing functional, aesthetic, and restorative solutions to patients who have lost teeth due to trauma, decay, or disease. The choice of materials for dental prostheses depends on their strength, biocompatibility, aesthetics, durability and the clinical scenario in the oral cavity. Over the years, advances in materials science have revolutionized the field of prosthodontics, enhancing both the longevity and performance of dental prosthetics. The choice of suitable materials is crucial for the prosthesis to effectively replicate natural teeth and satisfy the biomechanical requirements of the oral cavity.

CERAMICS:

Ceramics are extensively employed in dentistry owing to their exceptional aesthetic qualities, biocompatibility, and mechanical robustness. Feldspathic, leucite-reinforced, lithium disilicate, zirconia, and hybrid ceramics are the general categories into which dental ceramics can be divided.

FELDSPATHIC CERAMICS:

Feldspathic ceramics are among the oldest and most traditional materials utilized in dental restorations due to their remarkable aesthetic properties and ability to mimic the colors of natural tooth structure [1].It goes through a vitrification process where a silica-based glassy matrix envelops many crystalline cores therefore this material is categorized as porcelain-based. Traditional dental ceramics are primarily composed of 70–75% potash feldspar, 15–20% quartz as the crystalline phase, and the remaining kaolin as a binder. Aluminum oxide is added to quartz to enhance mechanical performance because it is not a strong material. However, they are more prone to chip or fracture because to their brittle nature and poor flexural strength (60–100 MPa), particularly in high-stress or load-bearing areas. As a result, they are typically limited to anterior restorations or low-stress applications.

GLASS CERAMICS:

Glass ceramics are a category of dental materials extensively utilized in prosthetic applications . The materials mostly consists of a glassy matrix interspersed with crystalline phases that enhance their mechanical capabilities while preserving translucency. Widely utilized glass ceramics in dentistry comprise lithium disilicate and leucite-reinforced ceramics. [1]Their mechanical performance and fracture resistance are enhanced by the addition of different crystalline phases, such as leucite, lithium disilicate, or fluorapatite, to a glassy matrix.

LEUCITE REINFORCED FELDSPATHIC CERAMICS:

This subclass of dental ceramics incorporates leucite crystals to enhance mechanical qualities while maintaining the aesthetic benefits of conventional feldspathic ceramics. This glass ceramic has a high Coefficient of Thermal Expansion, adjustable translucency, and the ability to be colored with metal oxide pigments. Its strength is nearly twice that of conventional feldspathic porcelains, but not sufficiently so for use as posterior fixed dental prostheses.

LITHIUM DISILICATE:

Lithium disilicate is a commonly employed glass-ceramic material in dentistry, distinguished for its remarkable blend of strength, durability, and aesthetic qualities [1]. Its translucency and capacity to replicate natural enamel render it optimal for attaining realistic aesthetics, especially in regions where appearance is paramount. Recently, the cores have been veneered with a very translucent fluorapatite ceramic that has 19–23% fluorapatite crystals set in a glassy matrix to create an aesthetically pleasing replication of the optical properties of natural teeth. Additionally, Lithium disilicate exhibits exceptional translucency, which is around 30% greater than that of standard zirconia , which containswhich typically contains yttria-stabilized tetragonal zirconia polycrystals (3Y-TZP), making it less translucent but highly durable. On the other hand, certain drawbacks, such wear and abrasiveness, which heavily rely on the restoration's surface properties, may restrict its use.

ZIRCONIA:

Primarily composed of zirconium dioxide (ZrO_2), it is stabilized with oxides like yttria to improve its mechanical characteristics and toughness. Zirconia has many benefits, including as better flexural strength, biocompatibility, biofunctionality. Advanced ceramics based on zirconia are widely used in oral rehabilitation as prosthetics to replace implants and lost teeth, particularly in patients who have parafunctional habits like bruxism. [2] Zirconia is commonly utilized in dentistry, but it has a number of drawbacks that need to be addressed for the best possible clinical results. Although high translucency zirconia helps to some extent, its relative opacity, particularly in conventional forms, is a significant disadvantage that may restrict its aesthetic use in anterior restorations.

METALS AND ALLOYS:

Metals and alloys are essential materials in dentistry because of their exceptional mechanical qualities, endurance, and biocompatibility. Frequently utilized metals comprise gold, cobalt-chromium, nickel-chromium, and titanium, each presenting distinct benefits. Their ability to withstand significant masticatory forces in the oral cavity, ensuring long-lasting restorations.let them to endure the substantial masticatory stresses in the oral cavity, guaranteeing enduring restorations. [3] Metals and alloys such as titanium, cobalt-chromium, and gold are less likely to cause adverse tissue reactions because of their exceptional biocompatibility. The use of metal crowns on anterior teeth is restricted by their metallic appearance, even though they are long-lasting, corrosion-resistant, and require little tooth reduction.

ACRYLIC RESIN:

Acrylic resin is a common material in dental practice, recognized for its versatility, ease of manipulation, and cost-effectiveness. It is mostly utilized in the production of dentures, temporary crowns. Polymethyl methacrylate is the predominant form of acrylic resin. One primary drawback is its relatively low mechanical strength, making it prone to fracture or deformation under high-stress conditions.

COMPOSITES:

Resin composite is commonly used for the fabrication of temporary crowns because to its superior cosmetic qualities, ease of manipulation, and responsiveness to clinical requirements. Temporary crowns fabricated from resin composite closely resemble natural teeth, featuring customisable colors and translucency for a realistic appearance. [5]The material enables it to endure masticatory forces while preserving the prepared tooth and preserving appropriate occlusion and alignment. Their lower mechanical strength in comparison to permanent restorative materials is a major drawback, making them more prone to wear or fracture under high masticatory loads. One of the topics that is most frequently discussed is polymerization shrinkage. A major drawback in resin composite curing is material shrinkage, which creates tension and may lead to interfacial debonding between the tooth and the resin composite material.[6]

ENAMEL:

The highly mineralized outer layer of the tooth is called dental enamel, distinguished by its exceptional hardness and durability. Enamel predominantly consists of hydroxyapatite, a crystalline form of calcium phosphate, accounting for roughly 96% of its mass. The remaining 4% comprises water and organic substances, including proteins and lipids, which enhance the enamel's structural integrity and mineralization process. The hydroxyapatite crystals are organized into densely packed, elongated prisms or rods, aligned to optimize strength and resistance to mechanical forces. Enamel, functions as the principal protective shield against mechanical stress, chemical degradation, and thermal stressors. The distinctive prismatic architecture enhances its strength and capacity to endure masticatory stresses, protecting the underlying dentin and pulp.

HOW WEAR OF ENAMEL OCCURS?

Enamel wear transpires by multiple mechanisms, chiefly mechanical, chemical, and biological activities. The predominant type of mechanical wear is attrition, caused by the grinding or friction of teeth against one another, frequently intensified by bruxism. This type of wear is generally noted on the occlusal surfaces and is affected by factors such as occlusal forces and the contact patterns between opposing dentition. Erosion, a notable contributor to enamel degradation, occurs due to extended contact to acids that dissolve the hydroxyapatite crystals within the enamel. Acidic meals, beverages, gastric acid reflux, and diseases may contribute to this phenomenon. Abrasion denotes the deterioration resulting from external mechanical forces, including the use of a hard toothbrush, abrasive toothpaste, or foreign particles in the oral cavity, resulting in surface damage. Prosthetic restorations, such as crowns, bridges, and dentures, are essential for restoring function and aesthetics, but their interaction with natural teeth can lead to wear on enamel surface. Ultimately, frictional wear, arising from the contact between enamel and restorative materials, is a challenge in dental restorations when materials like crowns exhibit differing hardness or surface roughness compared to natural enamel.

WEAR OF ENAMEL BY FELDSPATHIC PROSTHESIS:

Feldspathic prosthesis and its engagement with opposing enamel may lead to considerable abrasion owing to its intrinsic hardness and surface properties. Feldspathic porcelain possesses greater hardness than enamel, and when its surface is unpolished or inadequately prepared, it may exhibit abrasive properties. While glazed porcelain initially offers a smoother surface, the glaze coating deteriorates over time, revealing the coarser underlying material, which exacerbates enamel wear. Polished feldspathic porcelain possesses a smoother surface and exhibits less abrasiveness, rendering it advantageous for minimizing wear. Factors such as occlusal forces, malocclusion, and parafunctional habits like bruxism can exacerbate enamel wear[7]. Thus, feldspathic produces greater wear of the antagonist tooth from ceramic restorations linearly and volumetrically.

WEAR OF ENAMEL GLASS CERAMICS

Lithium disilicate and leucite-reinforced ceramics are dental crown materials which possess significant hardness.[8]Lithium disilicate is preferred among glass ceramics due to its resilience and aesthetic appeal, resulting in reduced enamel wear when polished. However, in vitro and in vivo research has shown that friction against contemporary glass ceramics can cause

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considerable damage to enamel surfaces. For this reason, various factors, including the type of glass ceramic, wear setup, surface finishing, environment, and surface treatment, have been extensively evaluated. [9] Lithium disilicate undergo occlusal wear that is comparable to that of natural enamel. To make lithium disilicate wear compatible with enamel, polishing them after adjustment is preferred. Polished lithium disilicate surfaces are superior in minimizing enamel wear, while glazed surfaces may pose a higher risk over time.The main cause of tooth wear is the interaction between enamel and an antagonistsurface¨Leucite-reinforced glass-ceramics, esteemed for their aesthetic appeal and durability, may induce moderate enamel abrasion owing to their hardness and surface roughness. Polished surfaces exhibit lower abrasiveness compared to glazed or roughened surfaces, hence greatly diminishing wear.[10]

WEAR OF ENAMEL BY ZIRCONIA:

When polished, zirconia displays a smooth surface that induces less abrasion on opposing enamel, rendering it advantageous. Furthermore, zirconia's hardness and minimal coefficient of friction diminish it's propensity to induce abrasive wear relative to other ceramics. Nevertheless, suboptimal modifications or insufficient finishing may result in surface roughness, substantially elevating the wear rate of natural enamel.[11]Polished zirconia is smooth and demonstrates superior enamel-friendly characteristics, resulting in low wear that is comparable to or even less than that of natural enamel. Conversely, glazed zirconia may initially exhibit a smooth surface; nevertheless, it gradually turns rough as the glaze layer deteriorates, resulting in heightened enamel abrasion.

WEAR OF ENAMEL BY METAL AND ALLOYS:

The abrasion of enamel by metals and alloys is typically less than that caused by ceramics, owing to their advantageous mechanical qualities and smoother surface finishes.[12] Gold alloys are regarded as the most enamel-compatible restorative materials due to their malleability and low hardness, which closely mimic natural tooth structure, leading to less abrasive wear. Cobalt chromium and titanium alloys, although tougher than gold, demonstrate minimal enamel wear when polished to a smooth finish, rendering them appropriate. Nevertheless, inadequate surface finishing or the existence of surface imperfections can exacerbate enamel wear, particularly with harder alloys like Cobalt-chromium and titanium alloys. Moreover, these ceramics, hence significantly mitigating the danger of enamel abrasion. According to the study by H. Nathanson, et al.'[13] revealed that softer metals, such as gold alloys, caused minimal enamel wear due to their lower hardness and favorable wear characteristics. In contrast, harder base-metal alloys were found to be more abrasive, especially under high occlusal loads. The study also emphasized the importance of surface finishing and polishing, noting that smoother surfaces significantly reduced the rate of enamel wear.

WEAR OF ENAMEL BY ACRYLIC RESIN:

Acrylic resin, frequently utilized in removable prosthetics and provisional restorations, typically induces less enamel wear than ceramics and metals owing to its reduced hardness and elastic characteristics. It's malleability enables it to absorb occlusal stresses, diminishing the occurrence of enamel abrasion. Nonetheless, the inferior wear resistance of acrylic resin may result in surface deterioration of enamel and the emergence of roughened regions over time, thereby exacerbating enamel wear. The wear of enamel caused by acrylic resin was significantly less than that caused by ceramic materials.[14]

WEAR OF ENAMEL BY RESIN COMPOSITE :

Resin composite, frequently employed for direct restorations, demonstrates wear properties that are typically advantageous to enamel, assuming its surface is adequately polished and preserved [16]. Its hardness and elastic modulus are more akin to natural dentin and enamel than to ceramics or metals, hence reducing abrasive wear on opposing teeth. The long-term impacts of resin composite on enamel wear are contingent upon elements like the material's filler content, surface polish, and deterioration over time.[16] Imperfectly polished or coarse resin composite surfaces can elevate friction, resulting in increased enamel abrasion. Furthermore, as resin composite experiences wear, the exposed filler particles may function as abrasives, leading to enamel deterioration.It has been reported thatwear behavior of resin composites and their impact on opposing enamel. The research demonstrated that well-polished resin composites possess wear properties that are less abrasive to enamel, owing to their lower hardness and elastic modulus compared to ceramics or metals.[16]

II. DISCUSSION:

The wear of enamel by prosthetic materials is a significant issue in restorative dentistry, directly affecting the durability and performance of both natural and replaced teeth.The wear of enamel in the presence of prosthetic materials is affected by various parameters, including the hardness, surface roughness, and mechanical qualities of the restorative material. The surface finish of the prosthesis—polished, glazed, or untreated—determines the degree of enamel degradation.

Teeth that come into contact with zirconia may wear down more quickly because of its extreme hardness .A study done by Preis,et al.[17]emphasize the considerable influence of surface preparation on enamel deterioration in interaction with zirconia restorations. Polished zirconia, with its smooth and refined surface, demonstrates enhanced wear resistance against opposing enamel relative to its glazed version. The polished zirconia's smoothness diminishes friction and abrasive forces during occlusal contact, thereby reducing enamel wear.These findings indicate that the clinicians have to emphasize polished zirconia restorations, particularly in patients with significant functional loads or parafunctional habits, to maintain the structural integrity of the opposing natural teeth. Additionally, consistent follow-ups are crucial to assess the status of zirconia restorations and guarantee their efficacy in minimizing enamel abrasion. Research by Soh et al.[18] indicated that fluoride treatments and remineralization therapies can help reduce the enamel wear caused by prosthetic materials. By increasing enamel hardness and resistance to abrasion, these treatments can reduce the wear potential during contact with restorations. As such the surface finish of the ceramic material has a major impact on enamel wear against lithium disilicate restorations. Research indicates that polished lithium disilicate results in reduced enamel wear relative to its glazed version. Similarly, Al-Hiyasat, A. S., Saunders, W. P., & Sharkey, S. W.[19] demonstrated that polished surfaces are advantageous for single restorations composed of heat-pressed lithium disilicate, since they diminish wear on the opposing enamel. The data indicate that choosing polished lithium disilicate for dental restorations may reduce enamel wear in patients.A study done by Siqueira et al.**[20]**to evaluate the wear of antagonist tooth in ceramic restoration, lithium disilicate exhibits the least enamel wear,(0.018µm), followed by zirconia at(0.257µm). Feldspathic ceramics cause the highest wear, with a mean linear wear of 8.914µm .Gold alloys may be more effective in protecting opposing enamel than other materials such as glazed porcelain.[21]Research by .Larrabee, M. G., Pearson, A. J., & Johnston, W. M. where the natural enamel opposing artificial resin prosthesis has limited to negligible deterioration due to acrylic resin and did not cause substantial wear on opposing enamel surfaces[21].Nonetheless, it is essential to acknowledge that although acrylic resin is mild on adjacent enamel, it is more prone to abrasion than alternative materials. Acrylic resin prostheses are beneficial for protecting opposing enamel due to their minimal abrasiveness. However, their intrinsic vulnerability to deterioration requires consistent oversight and possible substitution to preserve excellent performance and appearance in dental restorations.[22]

Polished lithium disilicate despite being less abrasive than numerous other ceramics, its hardness nevertheless results in greater enamel wear compared to the softer acrylic resin. For patients prioritizing enamel preservation, acrylic resin prostheses are preferable, contingent upon addressing their durability limits by consistent maintenance.As acrylic resin is a temporary prosthetic material it cannot be used in long term as a permanent solution.

III. CONCLUSION:

The selection of a prosthetic material must strike a balance between aesthetics, biocompatibility, and mechanical durability, all while minimizing the negative impact on the opposing enamel. Clinicians should prioritize materials and surface finishes that optimize enamel preservation and provide functional stability that is customized to the unique requirements of each patient.Remineralization protocols, can improve the resistance of enamel to abrasion and erosion. It is imperative to conduct routine follow-ups to monitor the condition of restorations and guarantee their long-term effectiveness.

REFERENCE :

[1]. Pereira, R. M., Ribas, R. G., Montanheiro, T. L. D. A., Schatkoski, V. M., Rodrigues, K. F., Kito, L. T., Kobo, L. K., Campos, T. M. B., Bonfante, E. A., Gierthmuehlen, P. C., Spitznagel, F. A., & Thim, F. P. (2021). An engineering perspective of ceramics applied in dental reconstructions. Journal of Applied Oral Science, 29, e20200966.

[2]. Silva, L. D., De Lima, E., Miranda, R. B. D. P., Favero, S. S., Lohbauer, U., & Cesar, P. F. (2017). Dental ceramics: A review of new materials and processing

methods. Brazilian Oral Research, 31(suppl 1), e58.

[3]. Delgado-Ruiz, R., & Romanos, G. (2018). Potential causes of titanium particle and ion release in implant dentistry: A systematic review. International Journal of Molecular Sciences, 19(11), 3585.

[4]. Zheng, J., Huang, H., She, M. Y., Zheng, L., Qian, L. M., & Zhou, Z. R. (2011). In-vitro study on the wear behaviour of human tooth enamel in citric acid solution. Tribology International, 44(11), 2345–2351.

[5]. Setting stress in composite resin in relation to configuration of the restoration**.**Fertilize, A. J., De Gee, A. J., & Davidson, C. L. (1987). Journal of Dental Research, 66(11), 1636–1639.

[6]. Ashtiani, A. H., Azizian, M., & Rohani, A. (2019). Comparison of the degree of enamel wear behavior opposed to polymer-infiltrated ceramic and feldspathic porcelain. Journal of Prosthetic Dentistry, 121(1), 110–117.

[7]. Ashtiani, A. H., Azizian, M., & Rohani, A. (2019). Comparison the degree of enamel wear behavior opposed to polymer-infiltrated ceramic and feldspathic porcelain. Dental Research Journal (Isfahan), 16(2), 71–75.

[8]. Kyaw, O., Inokoshi, M., & Kanazawa, M. (2021). Tribological aspects of enamel wear caused by zirconia and lithium disilicate: A metanarrative review. Japanese Dental Science Review, 57, 125–135.

[9]. Lee, A., Swain, M., He, L., & Lyons, K. (2014). Wear behavior of human enamel against lithium disilicate glass ceramic and type III gold. Journal of Prosthetic Dentistry, 112(6), 1399–1405.

[10]. Janyavula, S., Lawson, N., Cakir, D., Beck, P., Ramp, L. C., & Burgess, J. O. (2013). The wear of polished and glazed zirconia against enamel. Journal of Prosthetic Dentistry, 109(1), 22–29.

[11]. S. W. Lee, J. Y. Kim, and D. K. Park (2017) Comparative Evaluation of Enamel Wear Caused by Dental Metals and Ceramics.Journal of Advanced Prosthodontics, 9(5), 335–343

[12]. Nathanson, H., Oilo, B. R., & Mitchell, A. C. (1979). In vitro wear of enamel caused by metallic dental restorations. Journal of Dental Research, 58(6), 1382–1389.

[13]. Osiewicz, M. A., Werner, A., Roeters, F. J. M., & Kleverlaan, C. J. (2019). Wear of direct resin composites and teeth: Considerations for oral rehabilitation.Dental Materials, 35(2), 272–280.

[14]. Dionysopoulos, D., & Gerasimidou, O. (2021). Wear of contemporary dental composite resin restorations: A literature review. Clinical, Cosmetic and Investigational Dentistry, 13, 233–245.

[15]. Preis, V., Behr, M., Hahnel, S., Handel, G., & Rosentritt, M. (2012). Influence of surface treatment on the wear of zirconia against natural enamel. Journal of Prosthetic Dentistry, 107(5), 314–321.

[16]. Soh, G., Lee, C., & Tan, S.Remineralization of Enamel Subsurface Lesions by Resin-Modified Glass-Ionomer Cements and Fluoride Treatments".Journal of Prosthetic Dentistry ,76(9),1587-1595.

[17]. Al-Hiyasat, A. S., Saunders, W. P., & Sharkey, S. W. (2016). The wear of enamel opposing different ceramic restorations: An in vitro study.Journal of Prosthetic Dentistry, 115(5), 543–549.

[18]. Siqueira, G. P., Leme, A. M., Sartori, I. A., & Bonfante, E. A. (2022). Enamel wear of antagonist tooth caused by dental ceramics. Materials, 15(3), 1001.

[19]. Larrabee, M. G., Pearson, A. J., & Johnston, W. M. (2014). Wear of denture materials and their impact on opposing natural tooth enamel.Journal of Prosthetic Dentistry, 112(5), 1211–1217.

[20]. Della Bona, A., & Rosa, A. L. (2004). Wear of acrylic resin denture teeth in relation to opposing enamel: A study of fatigue-type wear.Journal of Prosthetic Dentistry, 92(3), 255–260.