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Lithium disilicate and zirconia as prosthetic restorative materials

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Abstract
Introduction: Metal-free restorations such as lithium disilicate and zirconia are an alternative to metal restorations; however, lithium disilicate presents enhanced optical characteristics, it possesses inferior mechanical properties when compared to zirconia.
Objective: To analyze the literature on lithium disilicate and zirconia as prosthetic restorative materials. Resistance, survival, antagonistic wear, and its use in digital flow will be analyzed.
Methodology: An electronic search of articles published in the last 5 years was carried out through PubMed and Google Scholar, using the terms "lithium disilicate", "zirconia", "e. Max", "lithium disilicate vs zirconia".
Results: When choosing a restorative material such as zirconia or lithium disilicate, it should be considered: Strength: zirconia does not offer the same translucency characteristics as lithium disilicate. Survival in the medium and long term is possible as long as the minimum thickness of the material is respected. Antagonist wear: in zirconia, if it is well polished, that wear is minimal. Digital flow offers greater predictability and a better marginal fit.
Conclusions: Zirconia and lithium disilicate provide good strength and survival. Zirconia does not offer the same translucency characteristics as lithium disilicate and is therefore not as aesthetically pleasing, but it is much more resistant.

Keywords: Lithium disilicate, zirconia, e. max, lithium disilicate vs, zirconia

1. Introduction

Metal-free restorations such as lithium disilicate and zirconia are an alternative to metal restorations; however, lithium disilicate presents enhanced optical characteristics, it possesses inferior mechanical properties when compared to zirconia [1].

The properties and adaptability of lithium disilicate and zirconia make them preferred materials in contemporary prosthetic dentistry. These materials are favored for their ability to deliver both excellent aesthetic and mechanical performances while supporting a minimally invasive approach. Consequently, the utilization of these ceramics has progressively gained widespread acceptance over time [2].

In 1998, IPS Empress®2 made its debut as the inaugural lithium disilicate glass-ceramic, composed of about 65% lithium disilicate in a crystalline phase along with a vitreous matrix. Around the same time, in 1998, yttria-stabilized tetragonal zirconia polycrystalline ceramic was introduced in dentistry. This material is processed using CAD/CAM techniques, marking a significant advancement in dental technology [3, 4].

Zirconia is characterized as a metastable ceramic featuring three crystalline phases: monoclinic, tetragonal, and cubic. At room temperature, zirconia typically exists in its stable monoclinic phase, but it has the ability to transform into tetragonal or cubic phases under specific conditions. In contrast, lithium disilicate is categorized as glass-ceramic and falls within the class of particle-filled glass materials [5, 2].

The search for restoring teeth with metal-free materials has led to advances in ceramic materials such as lithium disilicate and zirconia, hence the importance of knowing their indications and characteristics.

Therefore, this article analyzes the literature on lithium disilicate and zirconia as prosthetic restorative materials. Resistance, survival, antagonistic wear, and its use in digital flow will be analyzed.

2. Methodology

An electronic search of articles published in the last 5 years was carried out through PubMed and Google Scholar. Abstracts and full texts were identified that included information about lithium disilicate and zirconia as prosthetic restorative materials: resistance, survival, antagonistic wear, and their use in digital flow. within the keywords used for the electronic search: "lithium disilicate", "zirconia", "e.max", and “lithium disilicate vs. zirconia."

3. Results

3.1 Resistance

In both laboratory settings (*in vitro*) and real-life situations (*in vivo*), investigations have highlighted the exceptional characteristics of lithium disilicate and zirconia. These ceramics stand out for their unmatched optical and aesthetic qualities, coupled with high biocompatibility, robust mechanical strength, diminished thickness, and favorable resistance to wear. These unique attributes have progressively influenced the preference for these ceramics in various applications [2].

The fracture strength of 5-yttria zirconia varies from that of 4 or 3-yttria. The mechanical properties and dimensional specifications of 5-yttria are similar to those of lithium disilicate. Zirconia with 4-yttria, whether in monolayer or multilayer configurations, demonstrated fracture forces that are comparable. Wear rates were also similar among various zirconia systems and were lower when compared to both lithium disilicate and enamel [6]. Monolithic zirconia ceramics that are ultra-translucent show notably lower strength when compared to partially stabilized tetragonal ceramics. As a result, it is advisable to consider their application primarily in areas subjected to minimal bite forces. These areas typically include the anterior regions of the mouth. Additionally, they may be suitable for patients who do not exhibit functional habits or bruxism, as these factors can exert increased forces on dental restorations [7].

Lithium disilicate ceramics are characterized by a notable flexural strength ranging from 300 to 400 megapascals (MPa), a substantial fracture toughness falling within the range of 2.8 to 3.5 MPa, and outstanding optical properties [3]. The fracture strength of molar crowns made of CAD/CAM lithium disilicate varies according to occlusal thickness [8].

Crowns made of 5 yttria-stabilized zirconia exhibit flexural strength and translucency parameters that fall between those of 3 yttria-stabilized zirconia and lithium disilicate. Both the short- and long-term binding strengths of 5 yttria and 3 yttria zirconia were demonstrated to be comparable to lithium disilicate [9]. However, it's important to note that the strength of 3 yttria zirconia crowns was compromised when accessed with a fine diamond instrument. In contrast, there was no adverse impact observed on lithium disilicate crowns subjected to endodontic access [10].

Ceramic materials such as zirconia and lithium disilicate provide good strength as prosthetic materials; however, you must choose correctly when using each material. Zirconia does not offer the same translucency characteristics as disilicate and is therefore not as aesthetically pleasing, but it is much more resistant.

3.2 Survival

The survival rates for lithium disilicate restorations at 32 months reached 97.7%, and no cases of fracture were reported. Lithium disilicate posterior overlays demonstrated an outstanding complication-free survival rate, and the material enables the creation of conservative restorations with minimal thickness [11].

The survival rates for adhesively cemented zirconia crowns demonstrated a variability ranging from 83.3% to 100%. Similarly, conventionally cemented zirconia crowns showed survival rates within the range of 82.0% to 100%. Adhesively cemented lithium disilicate crowns exhibited survival rates ranging from 83.5% to 100%, while conventionally cemented lithium disilicate crowns reported a high survival rate of 98.5% [12].

Restorations made of lithium disilicate are reliable and can only be used predictably when proper guidelines and protocols are followed during manufacturing and clinical use. In addition, new lithium disilicate CAD/CAM blocks must be crystallized or heat-treated after milling for superior performance [13].

The survival rates for various types of all-ceramic crowns were comparable to those reported for metal-ceramic crowns, both in the anterior and posterior regions. However, it's noted that zirconia-based crowns should not be regarded as a primary choice due to their elevated incidence of technical problems [14].

The medium-term performance of lithium disilicate is considered ideal. Ceramic fracture emerged as the predominant cause of failure in both individual crowns and fixed partial restorations. Fixed partial restorations exhibited the highest failure rate when assessed for up to 5 years [15]. However, the introduction of subsequent monolithic zirconia crowns resulted in increased patient satisfaction up to 3 years after insertion. These crowns demonstrated good success in the medium term, presenting a promising alternative to traditional metal-ceramic crowns [16].

In the study conducted by Lawson *et al*. (2019), it was observed that the type of cement used had a notable impact on the fracture load of the crowns. Interestingly, the surface treatment did not exhibit a significant effect on the results. Crowns with a uniform thickness of 0.8 mm showed improved performance when resin cement was utilized, and this benefit was consistent across various types of ceramic materials [17].

Binding forces are greatly affected by lithium disilicate and its microstructures. The application of silane after hydrofluoric etching is deemed crucial for achieving long-term bonding. This remains true even when silane is present in the universal adhesive. The study suggests that, regardless of the adhesive used, the additional application of silane after hydrofluoric etching contributes significantly to the effectiveness of long-term bonding in the context of the investigated materials or processes [18].

Zirconia-based prostheses placed in vital teeth exhibited superior clinical outcomes compared to those placed in non-vital teeth. Furthermore, the type of cement used was identified as a factor influencing the final clinical outcome. This suggests that the choice of cement plays a role in determining the success and performance of zirconia-based prostheses, with variations in outcomes depending on whether the teeth involved are vital or non-vital [19].

Zirconia and lithium disilicate ceramic materials offer good survival in the medium and long term, as long as the minimum thicknesses of the material are respected and cementing protocols are followed.

3.3 Antagonist Wear
The statement suggests that monolithic zirconia crowns, as reported, do not have any detrimental impact on periodontal tissues and demonstrate good biocompatibility. This implies that the use of monolithic zirconia crowns is considered safe and well-tolerated by the surrounding periodontal structures. Biocompatibility is a crucial factor in dental materials, ensuring that they interact favorably with the biological environment, including the gums and other tissues in the oral cavity. Minimal antagonist tooth wear is observed, and there is a high success rate for restorations in the posterior region [20].

Polished monolithic zirconia causes less wear to opposing natural teeth, and polished monolithic and layered zirconia surfaces showed less tooth wear compared to glazed monolithic and layered zirconia surfaces [21]. The antagonistic wear of zirconia enamel was similar to or greater than that of natural teeth but less than that of porcelain metal [22].

Intraoral scanning and computer analysis revealed that the two-year wear ratios between enamel/enamel and lithium enamel/disilicate implant crowns did not exhibit significant differences [23]. However, wear depths and the number of wear traces differed between zirconia and lithium disilicate crowns. Zirconia crowns showed worn enamel with an underlying smooth surface exposure, while lithium disilicate crowns displayed deep wear facets [24].

When using a material with as much resistance as zirconia, it is believed that it can affect the antagonistic parts; however, studies show that if this material is well polished, this wear is minimal. Lithium disilicate, being a less resistant material, it offers less wear against antagonistic parts.

3.4 Digital Flow
Digital technology stands as a practical alternative to traditional impressions in the fabrication of lithium disilicate crowns and onlays. Most results indicate that restorations, whether produced digitally or conventionally, tend to have a high success rate for patients. However, numerous variables, including the types of scanners, milling machines, and 3D-printed models available on the market, introduce complexity, making it challenging to provide a conclusive answer regarding the superiority of one technique over the other [25].

Screw-retained monolithic single crowns made of lithium disilicate and zirconia, manufactured using computer-aided design and computer-aided fabrication (CAD-CAM) with a fully digital workflow, were determined to be reliable and suitable clinical options for the restoration of a posterior missing tooth in a dental implant [26].

Marginal and internal adaptation play crucial roles in the success and survival of dental restorations. Poor marginal and internal fit can negatively impact the longevity and functionality of dental restorations. Furthermore, in comparison to conventional impressions and production techniques, the digital workflow is considered more predictable and reliable. It implies that digital methods offer advantages in terms of accuracy, reducing errors in the fabrication process, and improving the overall fit of dental restorations. Digital workflows often involve technologies like intraoral scanning and computer-aided design and manufacturing (CAD/CAM), which can enhance precision and efficiency in creating dental prosthetics [27].

Crowns created from a CAD/CAM zirconia block with restricted marginal thicknesses of 0.6 mm and 0.4 mm exhibited noticeably reduced fracture strength values in contrast to those featuring the recommended margin thickness of 1.0 mm. [28]. Lithium disilicate CAD-CAM crowns exhibit a high survival rate after 4 years of function and prove to be a viable and reliable treatment option for posterior teeth [29].

The current use of technology in dentistry and increasingly adapting to fully digital dentistry offers greater predictability and better marginal fit in restorations. Milled ceramics offer a high survival rate.

4. Conclusion
Ceramic materials such as zirconia and lithium disilicate provide good strength and survivability as prosthetic materials. Zirconia does not offer the same translucency characteristics as lithium disilicate and is therefore not as aesthetically pleasing, but it is much more resistant. As for the antagonist wear in zirconia, it is minimal and its advantages are greater. The use of fully digital dentistry offers greater predictability and better marginal fit in restorations.

5. References
1. Chen Y, Yeung AWK, Pow EHN, Tsoi JKH. Current status and research trends of lithium disilicate in dentistry: A bibliometric analysis. J Prosthet Dent. 2021 Oct;126(4):512-522.
2. Zarone F, Mauro DMI, Ausiello P, Ruggiero G, Sorrentino R. Current status on lithium disilicate and zirconia: a narrative review. BMC Oral Health. 2019 Dec 4;19(1):134.
3. Hallmann L, Ulmer P, Kern M. Effect of microstructure on the mechanical properties of lithium disilicate glass-ceramics. J Mech Behav Biomed Mater. 2018 Jun;82:355-370.
4. Wertz M, Hoelzig H, Kloess G, Hahnel S, Koenig A. Influence of Manufacturing Regimes on the Phase Transformation of Dental Zirconia. Materials. 2021 Aug 31;14(17):4980.
5. Kwon SJ, Lawson NC, McLaren EE, Nejat AH, Burgess JO. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. J Prosthet Dent. 2018 Jul;120(1):132-137.
6. Rosentritt M, Preis V, Behr M, Strasser T. Fatigue and wear behaviour of zirconia materials. J Mech Behav Biomed Mater. 2020 Oct;110:103970.
7. Kontonasaki E, Giasimakopoulos P, Rigos AE. Strength and aging resistance of monolithic zirconia: an update to current knowledge. Japanese Dental Science Review. 2020 Nov;56(1):1-23.
8. Jurado CA, Pinedo F, Treviño DAC, Williams Q, Marquez-Conde A, Irie M, *et al*. CAD/CAM lithium disilicate ceramic crowns: Effect of occlusal thickness on fracture resistance and fractographic analysis. Dent Mater J. 2022 Sep 25;41(5):2022-2018.
9. Kwon SJ, Lawson NC, McLaren EE, Nejat AH, Burgess JO. Comparison of the mechanical properties of translucent zirconia and lithium disilicate. J Prosthet Dent. 2018 Jul;120(1):132-137.
10. Lucas TJ, Lawson NC, Englert B, Goldstein K, Goldstein R. Fracture strength of zirconia and lithium disilicate restorations following endodontic access. Journal of Esthetic and Restorative Dentistry. 2022 Apr 19;34(3):534-540.
11. Luciano M, Francesca Z, Michela S, Tommaso M, Massimo A. Lithium disilicate posterior overlays: clinical and biomechanical features. Clin Oral Investig. 2020 Feb 14;24(2):841-848.
12. Maroulakos G, Thompson GA, Kontogiorgos ED. Effect

of cement type on the clinical performance and complications of zirconia and lithium disilicate tooth-supported crowns: A systematic review. Report of the Committee on Research in Fixed Prosthodontics of the American Academy of Fixed Prosthodontics. J Prosthet Dent. 2019 May;121(5):754-765.
13. Phark J, Duarte S. Microstructural considerations for novel lithium disilicate glass ceramics: A review. Journal of Esthetic and Restorative Dentistry. 2022 Jan 7;34(1):92-103.
14. Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: Single crowns (SCs). Dental Materials. 2015 Jun;31(6):603-623.
15. Abdulrahman S, Von See Mahm C, Talabani R, Abdulateef D. Evaluation of the clinical success of four different types of lithium disilicate ceramic restorations: a retrospective study. BMC Oral Health. 2021 Dec 7;21(1):625.
16. Mikeli A, Walter MH, Rau SA, Raedel M, Raedel M. Three-year clinical performance of posterior monolithic zirconia single crowns. J Prosthet Dent. 2022 Dec; 128(6):1252-1257.
17. Lawson NC, Jurado CA, Huang C, Morris GP, Burgess JO, Liu P, *et al*. Effect of Surface Treatment and Cement on Fracture Load of Traditional Zirconia (3Y), Translucent Zirconia (5 Y), and Lithium Disilicate Crowns. Journal of Prosthodontics. 2019 Jul 11;28(6):659-665.
18. Alhomuod M, Phark JH, Duarte S Jr. Bond strength to different CAD/CAM lithium disilicate reinforced ceramics. J Esthet Restor Dent. 2023;35(1):129-137.
19. Alfadhli R, Alshammari Y, Baig MR, Omar R. Clinical outcomes of single crown and 3-unit bi-layered zirconia-based fixed dental prostheses: An upto 6- year retrospective clinical study. J Dent. 2022 Dec;127:104321.
20. Tang Z, Zhao X, Wang H, Liu B. Clinical evaluation of monolithic zirconia crowns for posterior teeth restorations. Medicine. 2019 Oct;98(40):E17385.
21. Shaik K, Reddy Km, Shastry Ym, Aditya Sv, Babu PjK. Comparative evaluation of enamel wear against monolithic zirconia and layered zirconia after polishing and glazing: An *in vitro* study. The Journal of Indian Prosthodontic Society. 2022;22(4):354.
22. Gou M, Chen H, Kang J, Wang H. Antagonist enamel wear of tooth-supported monolithic zirconia posterior crowns *in vivo*: A systematic review. J Prosthet Dent. 2019 Apr;121(4):598-603.
23. von der SA, Raith S, Reich S. Twenty-four months *in vivo* wear of enamel antagonists to lithium disilicate implant crowns – a pilot study. J Dent. 2022 Sep;124:104215.
24. Rosentritt M, Schumann F, Krifka S, Preis V. Influence of zirconia and lithium disilicate tooth- or implant-supported crowns on wear of antagonistic and adjacent teeth. J Adv. Prosthodont. 2020;12(1):1.
25. Patel T, Nathwani N, Fine P, Leung A. A Scoping Review of Marginal and Internal Fit Accuracy of Lithium Disilicate Restorations. Dent J (Basel). 2022 Dec 12;10(12):236.
26. De Angelis P, Passarelli PC, Gasparini G, Boniello R, D'Amato G, De Angelis S. *et al*. Monolithic CAD-CAM lithium disilicate versus monolithic CAD-CAM zirconia for single implant-supported posterior crowns using a digital workflow: A 3-year cross-sectional retrospective study. J Prosthet Dent. 2020 Feb; 123(2):252-256.
27. Abduljawad DE, Rayyan MR. Marginal and internal fit of lithium disilicate endocrowns fabricated using conventional, digital, and combination techniques. Journal of Esthetic and Restorative Dentistry. 2022 Jun 16; 34(4):707-714.
28. Kim SH, Yeo MY, Choi SY, Park EJ. Fracture Resistance of Monolithic Zirconia Crowns Depending on Different Marginal Thicknesses. Materials. 2022 Jul 12;15(14):4861.
29. Aziz A, El-Mowafy O, Tenenbaum HC, Lawrence HP, Shokati B. Clinical performance of chairside monolithic lithium disilicate glass-ceramic CAD-CAM crowns. Journal of Esthetic and Restorative Dentistry. 2019 Nov 29; 31(6):613-619.

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