REVIEW ARTICLE

Clinical and Biomechanical Performance of Occlusal Veneers: A Scoping Review

LuisGabriel Ladino[1], Martin Eduardo Sanjuan[2], Darell Josué Valdéz[3], Rosa Angélica Eslava[4]

Abstract

Aim: This manuscript aims to evaluate, through a scoping review, current knowledge of the biomechanical behavior, materials, preparations, and limitations of occlusal veneers.

Background: Occlusal veneers are a minimally invasive alternative for the additive restoration of posterior teeth with significant loss of the occlusal structure. This type of restoration has been emerged in recent years as an alternative to invasive treatment, which in the same way seeks to restore the structure of the posterior teeth. All this is because in recent years restorative dentistry has focused a large part of its objectives on conservative therapies.

Review results: Five electronic databases—PubMed, Cochrane, LILACS, EMBASE, and Google Scholar—were searched. Title and abstracts were independently screened by three reviewers, followed by a full-text review. A total of 42 articles met our inclusion criteria; most of these studies were *in vitro* ($n = 35$) and other studies were clinical studies ($n = 7$). These *in vitro* studies included 21 studies that analyzed the type of preparation and 6 studies that evaluated the limitations of occlusal veneers.

Conclusion: Thicknesses between 0.7 and 1.0 mm are recommended for ceramic materials; in addition, thicknesses less than 0.7 mm are recommended to use polymeric materials. The materials used for this type of restoration are plastic- and ceramic-based materials, whose load resistance values were found to exceed 2000 N in most studies. It is recommended to carry out a minimally invasive preparation or not to carry out a dental preparation, as long as there is a peripheral enamel to make an external bevel that redirects the eccentric forces to the axis of the tooth.

Clinical significance: Restorative dentistry has moved toward conservative treatments with the least amount of dental tissue being removed. Occlusal veneers appear to be a conservative option in the reconstruction of tooth tissues lost due to tooth wear and in cases where it is necessary to restore or increase the vertical dimension.

Keywords: CAD/CAM, Dental ceramics, Fracture resistance, Occlusal veneer, Tooth wear.

The Journal of Contemporary Dental Practice (2021): 10.5005/jp-journals-10024-3226

Introduction

The pathological loss of the coronal structure of the tooth can be attributed to an individual or combined etiological factors related to eating and oral habits that ultimately cause loss of the structure of enamel and dentin.[1] Scientific and technological advances have made it possible to guide dentistry toward a work methodology known as minimally invasive.[2] The considerable development of dental adhesion, ceramic materials, hybrid, and nonceramic CAD/CAM materials is part of the options to replace the dental structure with restorations that provide favorable biological and physical–mechanical properties to achieve success over time.[3–5] Occlusal veneers have become a conservative alternative to restore the lost tooth structure, indicated for teeth with occlusal wear, avoiding the use of conventional restorations, such as full-coverage crowns.[6,7] Among its characteristics is the recovery of the masticatory function with maximum preservation of the dental structure.[8,9]

The success of this type of restoration can be influenced by a combination of factors, such as the preparation design, geometry and thickness of the restoration, mechanical properties of the material, occlusal forces, type of cement, bonding technique, antagonist dentition, occlusal scheme, and habits for function among others.[10,11] Occlusal veneers are a conservative treatment option for patients with tooth wear with a need to reestablish the occlusal vertical dimension. However, the presence of an enamel substrate at the finish line of preparation could be important to the mechanical behavior. A particular characteristic of this type of restoration is the thickness of less than 1.0 mm. The purpose of this research is to evaluate, through a scoping review, current knowledge of the biomechanical behavior, materials, preparations, and limitations of occlusal veneers.

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How to cite this article: Ladino LG, Sanjuan ME, Valdéz DJ, *et al*. Clinical and Biomechanical Performance of Occlusal Veneers: A Scoping Review. J Contemp Dent Pract 2021;22(11):1327–1337.

Source of support: Nil

Conflict of interest: None

Materials and Methods

To guide the search strategy, the question Population, Intervention, Comparison, and Outcome (PICO) was considered; P = Tooth wear, I-C = Occlusal veneers, O = Materials, biomechanics, preparations, and resistance to fracture.

Search Strategy

An electronic search in the database was carried out in an advanced manner in PubMed, Cochrane, Scopus, LILACS, EMBASE, and Google

Scholar on August 4, 2020. Studies related to occlusal veneers were obtained from 1930 to 2020. MeSH terms were selected as occlusal veneers, materials, biomechanics, preparations, and resistance to fracture. There was a limitation of language for English, Portuguese, and Spanish. Forty-two articles met the inclusion criteria (Flowchart 1). Likewise, among the selected articles, 34 studies evaluated the material used for occlusal veneers, 21 articles evaluated the type of preparation, and six mentioned the limitations of occlusal veneers.[6,12–49] The remaining studies joined with *in vitro* studies that evaluated the type of preparations and the type of material to analyze the biomechanical performance.

The PRISMA Extension for Scoping Reviews (PRISMAScR) checklist was used for the correct reporting of the items required for this scoping review. An initial assessment of article eligibility was performed by screening titles and abstracts, followed by a full-text analysis. Titles and abstracts of the search results were initially screened for possible inclusion. The full texts of all possibly included studies were obtained for individual assessment.

Results

The aim of this scoping review is to evaluate current knowledge about the biomechanical behavior, materials, preparations, and limitations of occlusal veneers; five electronic databases—PubMed, Cochrane, LILACS, EMBASE, and Google Scholar—were searched. Title and abstracts were independently screened by three reviewers, followed by a full-text review. A total of 42 articles met our inclusion criteria; most of these studies were *in vitro* ($n = 35$) and other studies were clinical studies ($n = 7$). These *in vitro* studies included 21 studies that analyzed the type of preparation and 6 studies that evaluated the limitations of occlusal veneers. Findings from this study can help identify the clinical and biomechanical performance of occlusal veneers in restorative dentistry for tooth wear (Table 1).

Discussion

Indications for Occlusal Veneers

Progressive reduction of the enamel surface is a physiological condition resulting from the aging process that can be accelerated by pathological processes, such as biocorrosion, erosion, or bruxism, which can generate a substantial loss of tooth structure and in turn can generate o no, a loss of the vertical occlusal dimension.[6,25] Preservation of tooth structure is important for restorative dentistry and is essential to maintain the balance between biological, mechanical, functional, and aesthetic parameters.[24] In this sense, invasive treatment is considered inappropriate because the biomechanical balance will be invaded and compromise the success of restorations in the long term, for which the use of occlusal veneers is indicated.[34]

Restorations in patients with severe tooth wear present a challenge for the clinician since in most cases masticatory function, esthetics, and loss of the occlusal vertical dimension are seriously compromised, and this, in turn, can cause an alteration of the facial component. Severe occlusal wear can result in a dental pulp injury, occlusal instability, and alteration of esthetics.[25,47]

Currently, treatments for patients with severe tooth wear and advanced erosive lesions have a more conservative approach, using additive adhesive techniques, which allow a minimal reduction of the tooth structure and may be the best alternative, with indirect or direct partial restorations, with partial or total coverage of the cusps, depending on the degree of destruction that the tooth presents, which is why minimally invasive dentistry is currently a viable alternative.[6,47]

Progressive reduction of the enamel surface is a physiological condition resulting from the aging process that can be accelerated by pathological processes, such as biocorrosion, erosion, and bruxism. These pathological processes can generate a substantial

Flowchart 1: Flowchart depicts the selection and exclusion of articles for the scoping review

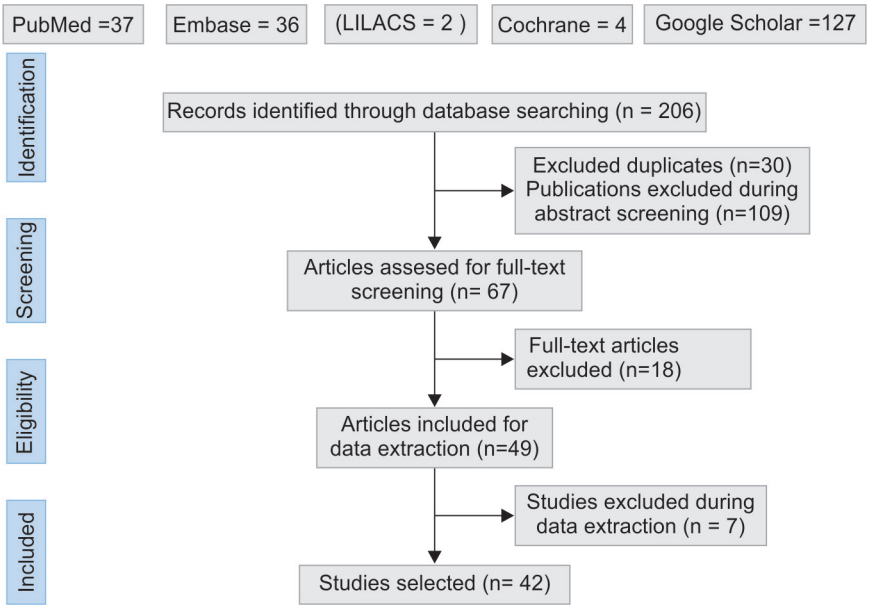

Table 1: Summary of selected articles

ID	*Author and year*	*Type of study*	*Objective*	*Sample*	*Conclusions*
1	Schlichting et al. (2011)[6]	*In vitro*	Evaluate the influence of the CAD/CAM restoration material (ceramic versus composite resin) on the fatigue resistance of ultrathin occlusal veneers.	40 molars extracted	Both composite resins (MZ100 and XR) increased the fatigue resistance of ultrathin occlusal veneers compared to the evaluated ceramics (Empress CAD and e.max CAD).
2	Schlichting et al. (2016)	Case report	Describes a complete oral rehabilitation with ultrathin computer-aided design and fabrication (CAD-CAM) composite resin occlusal veneers in a patient with severely eroded dentition.	One patient	Minimally invasive treatment through CAD-CAM composite resin ultrathin occlusal veneers, biomechanics, function, and esthetics were combined, resulting in a remarkable improvement in a patient's oral health and appearance.
3	Politano et al. (2018)	Case report	Create a biomechanical restorative unit of adhesively cemented ceramic, composite cement, residual tooth structure, that performs in the most favorable way and results in a durable restored tooth.	One patient	The clinical efficacy of this nonretentive bonded ceramic partial crown concept is strongly influenced by the preparation design and the adhesive protocol confirmed by studies by the high survival rates.
4	Abd et al. (2020)[12]	*In vitro*	To investigate the resistance to fracture of two types of hybrid ceramic posterior occlusal veneers with different thicknesses	80 molars divided into 2 groups	Lava Ultimate had a significantly higher fracture strength than the Vita Enamic (p <0.05). The highest resistance was found in the nanoceramic resin
5	Emam and Aleem (2020)[13]	*In vitro*	To assess the effect of preparation materials, variables, and designs on marginal fit and fracture resistance of CAD-/CAM-fabricated occlusal veneers.	60 premolars divided into 3 groups (n = 20)	Posterior occlusal veneers made of CAD/CAM composite resin were superior to ceramic in terms of resistance to fracture. All materials with different preparation designs, before or after fatigue loading, presented a marginal gap that did not exceed this acceptable range.
6	Saber Rabeae et al. (2020)[14]	*In vitro*	Evaluate the fracture strength of occlusal veneer restorations with ceramic material (lithium di-silicate) and hybrid ceramic. (VITA Enamic) (CAD/CAM) with different thicknesses after thermocycling.	30 CAD/CAM occlusal veneers	The thickness of the material has a great effect on the strength of the restoration, as increasing the thickness also increases the fracture strength. A thin thickness of 0.3 has questionable survival in the oral environment. It is recommended to use a restoration thickness of not less than 0.5 mm for patients with bruxism.
7	Falahchai et al. (2020)[15]	*In vitro*	To evaluate the effect of tooth preparation design on the fracture strength of zirconium-reinforced lithium silicate overlay.	50 molars divided into 5 groups (n = 10)	All preparation designs used in this study provided acceptable fracture strength. The types of failure were recoverable, regardless of the design of the preparation. Restorations with a conservative preparation design provided greater resistance to fracture.
8	Falahchai et al. (2020)[16]	*In vitro*	Evaluate the marginal adaptation of zirconium-reinforced lithium silicate (ZLS) overlay restorations with different preparation designs.	40 molars divided into 4 groups (n = 10)	For teeth that do not have defects and require occlusal restoration, occlusal surface preparation alone would be sufficient to achieve optimal marginal adaptation. Cementation produces a significant increase in marginal space.

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Table 1: *(Contd...)*

ID	Author and year	Type of study	Objective	Sample	Conclusions
9	Heck et al. (2019)[17]	*In vitro*	To investigate the resistance to fracture of ultrathin occlusal veneers with different designs (CAD/CAM) under mechanical and cyclic loading to restore combined enamel–dentin defects.	84 molars 2 groups	Ultrathin lithium disilicate ceramic and nanoceramic composite occlusal veneers showed higher fracture strength under mechanical and cyclic loads. But those made of IPS Empress CAD are less durable than those of IPS e.max CAD lithium disilicate ceramic. Also, Lava Ultimate CAD/CAM ceramic showed similar results in terms of few cracks as IPS e.max CAD which means that these two were superior to IPS Empress CAD in terms of fatigue load.
10	Al-Akhali et al. (2018)[18]	*In vitro*	To evaluate the influence of thermomechanical fatigue load on the fracture resistance of minimally invasive occlusal veneer restorations manufactured with different CAD-CAM materials and bonded to human maxillary premolars using the self-etching technique.	64 premolars, in 4 groups ($n = 16$)	The authors do not recommend using a self-etching technique for ultrathin veneers bonded to enamel as this technique can affect the long-term survival of the veneers.
11	Krummel et al. (2019)[19]	*In vitro*	To assess the influence of bonding method and type of dental bonding surface on fracture strength and survival rate of resin-bonded occlusal veneers made of lithium disilicate ceramic after cyclic loading.	48 molars divided into 3 groups ($n = 16$)	Occlusal ceramic veneers with a minimum thickness of 0.3–0.6 mm may compromise the strength of the restoration and therefore the authors do not recommend these thicknesses in the posterior sector.
12	Maeder et al. (2019)[20]	*In vitro*	Check whether the load-bearing capacity of dentin-bonded ceramic or hybrid occlusal veneers differ from that of porcelain-fused metal or lithium disilicate glass–ceramic crowns.	80 molars, 8 groups ($n = 10$)	At their maximum load-bearing capacity, minimally invasive occlusal veneers made of ceramic, hybrid materials, or polymeric materials can be applied to correct the occlusal wear of teeth with exposed dentin and thus replace conventional crown restorations in the cases of normally expected intraoral bite forces.
13	Al-Akhali et al. (2019)[21]	*In vitro*	To evaluate the influence of the adhesive cementation technique and thermomechanical fatigue load on the durability and resistance to fracture of minimally invasive occlusal veneer restorations fabricated from four CAD/CAM materials.	128 upper premolars, ($n = 32$)	All four tested CAD/CAM occlusal veneer restorations bond to enamel, etch, and rinse technique improved the overall stability, reliability, longevity, and fracture resistance of the four tested CAD/CAM occlusal veneer restorations compared with the self-etching technique, which cannot be recommended for occlusal veneers bonded to enamel.
14	Yazigi et al. (2019)[22]	*In vitro*	Evaluate the fracture strength and determine the failure mode of metal-free occlusal veneers made up of lithium disilicate and bonded to exposed dentin and compare the fracture strength of the groups that immediately followed dentin sealing with those who joined conventionally.	96 upper premolars, 3 groups ($n = 32$)	Selective pre-etching of the enamel margins was as effective as the traditional etch and rinse protocol. The most common failure mode for all groups was mode IV, which consists of a longitudinal fracture in both the ceramic and the tooth, accumulating up to 39%.
15	Edgerley et al. (2019)[23]	*In vitro*	To study the impact of overdried preparations prior to cementation with a thermocycled, self-adhesive resin cement on the fracture of hybrid ceramic occlusal veneer restorations.	60 upper molars, 3 groups ($n = 20$)	Thermal cycling of the samples and excessive drying of the preparations did not show a significant difference in resistance to failure. However, the fracture patterns indicated more veneer-only fractures under desiccated conditions, suggesting compromised restoration adhesion.

16	Perez Torres et al. (2009)[24]	*In vitro*	Compare the effect of the thickness (0.4, 0.6, and 0.8 mm) of two ceramic materials on fracture resistance for the fabrication of occlusal veneers (IPS e-max press lithium disilicate from Ivoclar Vivadent, and silicate from Lithium Celtra Press from Dentsply).	60 healthy premolars, 6 groups ($n = 10$)	Lithium disilicate (IPS e.max Press - Ivoclar Vivadent) and zirconium-reinforced lithium silicate (Celtra Press—Dentsply) can be considered a treatment option for minimally invasive rehabilitation. According to the type of failures, it is observed that the lower the thickness of the material (0.4 mm) the lithium silicate behaves better and the greater the thickness (0.8 mm) the lithium disilicate, reducing the probability of vertical fracture failure. both material and tooth.
17	Cárdenas et al. (2019)[25]	Case report	Describe a minimally invasive conservative treatment with composite resins.	A 73-year-old male patient	Comprehensive treatment in patients with biocorrosion, with composite resins in teeth and implants, is a treatment alternative that simplifies clinical procedures, reducing costs, clinical feasibility, and easy maintenance for the benefit of the patient.
18	Risco et al. (2019)[26]	*In vitro*	Evaluate microfiltration in tabletop ceromer inlays cemented with three different cements.	In 36 third molars divided into 3 groups ($n = 12$)	Tabletop restorations had a lower degree of microfiltration when cemented with a thermoplastic resin ($p \leq 0.05$), with a statistically significant difference compared to other cements. There was no difference in microfiltration between self-etch resin cements relative to universal resin cement.
19	Ascanio Roa et al. (2019)[27]	*In vitro*	To evaluate the resistance to fracture against compressive forces, between a restoration of lithium silicate reinforced with zirconium cemented on enamel and enamel–dentin in premolar teeth.	38 premolar teeth, divided into 2 groups ($n = 19$), plus 6 from pilot tests	The occlusal veneers cemented on dentin showed a lower registration in the time of the fracture, but did not present statistically significant differences than the cemented-on enamel. According to the standard deviation, the decision to cement the occlusal veneers exclusively on a tissue evaluated based on the variable time and displacement cannot be made. Keywords: *In vitro* comparison, premolar teeth, enamel-dentin, compressive forces, resistance, lithium silicate, cemented zirconium.
20	Baldissara et al. (2019)[28]	*In vitro*	To assess the effect of ceramic thickness on the survival rate and failure pattern of LD molar veneer restorations using a simplified fatigue testing machine.	60 molars, divided into three groups ($n = 20$)	Progressive damage was observed as a function of cycle time. Survival was significantly influenced by the thickness of the restoration ($p = 0.002$, log-rank test), and thicker restorations showed a higher survival rate. The thinner restorations (0.5 mm) showed a significantly lower survival rate than the 0.8 and 1.2 mm restorations ($p < 0.016$); no significant differences were observed between the 0.8 and 1.2-mm restorations.
21	Andrade et al. (2018)[29]	*In vitro*	Evaluate the influence of different CAD/CAM materials (IPS e.max CAD, Vita Enamic and Lava Ultimate) and thicknesses (0.6 and 1.5 mm) on strength to the fracture of the occlusal veneers.	60 third molars, divided into 6 groups ($n = 10$)	The faults were predominantly fixable. Occlusal veneers made up of IPS e.max CAD, Vita Enamic and Lava Ultimate, with thicknesses of 0.6 and 1.5 mm, obtained fracture strengths similar to those associated with healthy teeth.

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Table 1: *(Contd...)*

ID	Author and year	Type of study	Objective	Sample	Conclusions
22	Resende et al. (2018)[30]	Case report	Report through a full mouth rehabilitation of a patient with moderate biocorrosion.	One patient with biocorrosion	The upper anterior teeth were restored using the bilaminar technique (lingual direct composite veneers with labial ceramic veneers) and the posterior teeth using ultrathin CAD-CAM ceramic occlusal veneers.
23	Aqlan and Kheiralla (2018)[31]	*In vitro*	Evaluate the resistance to fracture of thin occlusal veneers made up of hybrid ceramic (Cerasmart).	12 upper first molars ($n = 12$)	Hybrid ceramic thin occlusal veneers with a thickness of 1.2 and 1.8 mm can resist masticatory forces posteriorly, providing a conservative treatment for tooth wear.
24	Abdelhameed et al. (2018)[32]	*In vitro*	To evaluate the effect of different types of ceramic materials and preparation designs on the resistance to fracture of occlusal veneers.	60 upper first molars, divided into 2 groups ($n = 30$)	Occlusal veneers made up of IPS e.max CAD, Lava Ultimate and Vita Suprinity have comparable strength and can be used as an alternative treatment for severely worn dentition. Furthermore, neither the type of material nor the design of the preparation influences the resistance to fracture of the occlusal veneers.
25	Singh et al. (2018)[33]	Case report	Highlight the concept of precast veneers and occlusal vertical dimension and a series of clinical cases using the Edelweiss precast veneer system.	There have been reports of cases treated with a laser-sintered precast composite veneer system.	The prefabricated veneer contributes greatly to the direct application of the composite, helping more of our patients to receive more conservative and affordable esthetic restorations.
26	Magne et al. (2010)[34]	*In vitro*	Evaluate and compare the fatigue resistance of composite resin and ceramic posterior occlusal veneers.	30 molars extracted.	Posterior occlusal veneers made up of composite resin had significantly higher fatigue resistance compared to IPS Empress CAD and IPS e.max CAD.
27	Bahillo et al. (2014)[35]	Case report	Describe the step-by-step procedure of full-mouth composite restoration with CAD/CAM ultrathin composite veneers and overlays in a young patient with a combination of erosion and wear disorder.	One patient	The development of new dental materials, technologies and adhesives has made possible alternative minimally invasive treatments facilitating the preservation of tissues. The use of adhesive and composite techniques in this patient shows its potential in the treatment of moderate and severe dental wear.
28	Johnson et al. (2014)[36]	*In vitro*	To determine the effect of the type of material and the thickness of the restoration on the resistance to fracture of the posterior occlusal veneers made up of composite materials (Paradigm MZ100) and composite ceramics (Lava Ultimate) milled by computer.	Upper 60 molars	The resistance to fracture of the occlusal veneer restorations was above the forces produced by the human masticatory system.
29	Egbert et al. (2015)[37]	*In vitro*	It compared the fracture strength and failure modes of ultrathin (0.3 mm) occlusal composite or hybrid ceramic veneers.	Upper 60 molars	The highest resistance was found with the resin nanoceramic material (Vita Enamic).
30	Sasse et al. (2015)[38]	*In vitro*	To assess the influence of ceramic thickness and type of dental bonding surface on the fracture resistance of adhesive-retained non-retentive full-coverage occlusal veneers made up of lithium disilicate ceramic.	62 molars	The results suggest using a thickness of 0.7–1 mm for lithium disilicate ceramic restorations.
31	Al-Akhali et al. (2019)[39]	*In vitro*	To evaluate the influence of thermodynamic loading on the durability and resistance to fracture behavior of occlusal veneers manufactured with different biomedical dental CAD/CAM materials.	64 extracted premolars	Occlusal veneers made up of lithium disilicate and zirconium-reinforced lithium silicate showed greater resistance to fracture than those made up of polymer-infiltrated ceramics and PMMA resin.

32	Yazigi et al. (2018)	*In vitro*	To evaluate the efficacy of immediate dentin sealing and the effects of different adhesion protocols on the fracture resistance of CAD/CAM occlusal veneers bonded to exposed dentin.	96 maxillary premolars extracted	Significantly higher fracture strength of the restorations was obtained when immediate dentin sealing was followed.
33	Llompart and Lopez (2018)[40]	*In vitro*	Compare the marginal microfiltration of ceromeric occlusal veneers with different endings: shoulder, chamfer, and a control group without.	33 premolar teeth	The distribution of microfiltration was greater in the group with a shoulder-type termination line, while the chamfer group and without a termination line were the ones that presented the lowest increase in microfiltration.
34	Abu-Izze et al. (2018)[41]	*In vitro*	Investigate the fatigue life, failure modes, and stress distribution of ultrafine partial posterior restorations in different ceramics.	Sixty standard tabletop preparations in G10 epoxy resin	Thin zirconium-reinforced lithium silicate ceramic restorations exhibited lower fatigue resistance compared to 1.0 mm thick hybrid ceramic restorations (PIC).
35	Ioannidis et al. (2020)[42]	*In vitro*	Compare the load-bearing capacity of ultrathin occlusal veneers made up of 3D-printed zirconia by CAD/CAM milling of zirconia or pressed lithium disilicate	Three groups ($n = 20$ each)	Regarding their load-bearing capacity, 3D-printed CAD/CAM-milled zirconia CAD/CAM and subtractive technique, as well as pressed lithium silicate, can be recommended to fabricate ultrathin occlusal veneers for occlusal wear of teeth.
36	Albelasy et al. (2020)[43]	Systematic review	Evaluate the resistance to fracture and fatigue *in vitro* of occlusal veneers in different thicknesses, CAD/CAM materials, and under different aging methodologies.	12 studies were included	Polymeric materials performed better in fatigue tests compared to ceramics. The fracture strength values in all included studies exceeded the maximal chewing forces in the posterior region. Polymer-infiltrated ceramics and resin nanoceramics could be used successfully with a thickness of less than 1.0 mm.
37	Angerame et al. (2019)[44]	*In vitro*	To evaluate the fracture strength and marginal quality of the upper molars restored using lithium disilicate glass–ceramic occlusal veneers with two preparation designs.	16 molars divided into two groups ($n = 8$).	Most of the samples observed exhibited restorable fractures and continuous margins. No differences emerged between the groups.
38	Huang et al. (2020)[45]	*In vitro*	To examine the fracture strength of four types of occlusal veneers and a conventional full-crown ceramic restoration and the influence of preparation design on the tension of restorations.	40 premolars divided into 5 groups ($n = 8$)	Type O veneers showed greater resistance to fracture than POF and POFP-type veneers ($p < 0.05$) which means that the design of the preparation significantly affects the resistance to fracture of the occlusal veneer. As the number of axial walls prepared increased, the fracture strength of the restorations decreased. Both type O and OF veneers exhibited greater resistance to fracture than the full crown ($p < 0.05$).
39	Zhang et al. (2020)[46]	*In vitro*	Compare the *in vitro* fracture load, surface wear, and roughness after thermal cycling and cyclic mechanical fatigue load between ceramic occlusal veneers and microhybrid resin-based cemented composite fabricated in two thicknesses (1.5 and 2.5 mm)	64 premolars in 4 groups ($n = 16$)	MC and FMC wear was significantly higher than HPC and CCC ($p = 0.001$), but was similar in terms of the rate of tooth enamel wear. All samples showed a fracture load that exceeded the maximum occlusal force in the posterior sector.

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Table 1: *(Contd...)*

ID	Author and year	Type of study	Objective	Sample	Conclusions
40	Ferrando-Cascales et al. (2020)[47]	Case report	Present the application of a digital workflow for the complete oral rehabilitation of a patient with severe dental wears, executed by creating a 3D virtual patient and adopting an additive approach with a minimum. dental preparation	1 patient 12 machined resins 16 occlusal veneers in lithium disilicate	CAD/CAM composite resins and lithium disilicate are considered as the materials of choice for ultrathin occlusal veneers are of high performance; however, the biomechanical performance of high-performance composite resins and their modulus of elasticity is closer to that of a dentin, giving these materials greater resistance to fracture under extreme loads, In addition, they are less abrasive to opposing teeth.
41	Hassan and Moustafa (2020)[48]	*In vitro*	Investigate the marginal adaptation of two different occlusal veneer designs made from two different ceramic materials before and after aging.	20 molars divided into 2 groups ($n = 10$)	The choice of preparation design must be associated with the material properties of the occlusal veneers. The zirconium-reinforced lithium silicate had a marginal adaptation that survived with better qualitative and quantitative values, after the thermal cycler.
42	Abbas et al. (2020)[49]	*In vitro*	To evaluate the fatigue resistance of zirconium-reinforced lithium silicate (VS) and hybrid ceramic (VE) occlusal veneers, with two different thicknesses.	20 molars in 2 groups ($n = 20$)	Vita Suprinity (VS) and Vita Enamic (VE) occlusal veneers have comparable fatigue resistance and can be used as an alternative treatment for severely worn teeth. The thickness of the occlusal veneer does not affect its resistance to fatigue, which implies that the thin (1.2 mm) and ultrathin (0.6 mm) in terms of fatigue resistance are not critically affected.

loss of tooth structure and a possible reduction in the vertical occlusal dimension.[25]

In the cases of severe tooth wear, performing an invasive treatment may be considered inappropriate due to the violation of this biomechanical balance, which can lead to compromise of the performance of restored teeth in the long term.[25,47] Therefore, minimally invasive treatment is suggested, based on simple procedures, with indirect or direct partial restorations, with partial or total cusp coverage, depending on the degree of destruction.[24]

Materials for the Manufacture of Occlusal Veneers

Ioannidis et al.[42] made a comparison of materials and manufacturing techniques and reported that materials, such as zirconium and lithium disilicate, have better fracture resistance and greater flexural resistance compared to conventional glass–ceramics. Monolithic zirconia and pressed lithium disilicate, in restorations with 0.5 mm thicknesses, can withstand normal clinical conditions, and the authors reported that the flexural strength of zirconia is 800 MPa and for pressed lithium disilicate ceramic it is 470 MPa which means that the load resistance exceeded the maximum masticatory forces. In two studies, Ioannidis et al.[50] and Maeder et al.[20] reported that 1.0 mm lithium disilicate occlusal veneers showed values of resistance to fracture similar to conventional crowns. However, when the thickness of the lithium disilicate glass–ceramic was decreased to 0.5 mm, the fracture strength values were significantly lower than conventional porcelain metal crowns.

Lauvahutanon et al.[51] reported that lithium disilicate has a relatively high flexural strength of nearly 400 MPa, in comparison to composite resin blocks and polymer-infiltrated ceramic blocks which have a flexural strength of 200 MPa. Schlichting et al.[6] evaluated and compared the fatigue resistance of composite resin and ceramic posterior occlusal veneers and demonstrated that posterior occlusal veneers made of composite resin had a significantly higher fatigue resistance compared to glass–ceramics. This could be related to the relative similarity between the modulus of elasticity of the composite resin material (approximately 16–20 GPa) and dentin (approximately 17.7–29.8 GPa).

Sasse et al.[38] recommended thicknesses of 0.7–1.0 mm for occlusal ceramic restorations. However, the authors reported that it was difficult to precisely control the thickness of the pressable lithium disilicate glass–ceramic. Therefore, an attempt was made to maintain the thickness of the ceramic using silicone matrices, wax, and digital calipers. However, Johnson et al. reported that there are no significant differences in resistance to the fracture of occlusal veneers with different thicknesses (0.3, 0.6, and 1.0 mm). On the other hand, studies show that very thin thicknesses less than 0.5 are usually difficult to manufacture and show less resistance.[20]

A systematic review conducted by Albelasy et al.[43] reported that glass–ceramic occlusal veneers with a thickness of 0.7–1.0 mm reported resistance values higher than the minimum recommended values for resistance to fracture in posterior restorations, which vary between 500 and 700 N. According to Sasse et al.,[38] these results coincided with an earlier study by Bakeman et al.,[52] in which

the decrease in ceramic thickness to 1.0 mm did not influence the fracture resistance of posterior partial coverage of ceramic restorations.

Other authors, such as Huang et al., reported that as the number of axial walls restored increased, the resistance to fracture decreased. Besides, the authors reported that the average fracture resistance was 1743.52 N ± 425.78 N, these results are greater than the bite force; therefore, good clinical performance of the occlusal veneers can be expected. These results agree with other studies reported by the literature that showed that the fracture resistance values of the materials seem to exceed the chewing forces, which vary between 585 and 880 N, and in the posterior sector in adults, it varies between 300 and 800 N.

Type of Preparation

Huang et al. evaluated the fracture strengths of four types of occlusal veneers, and a traditional full-crown ceramic restoration and the influence of preparation design on the stress of restorations were examined. The results of the fracture resistance tests for the different designs and the influence of the preparation design on the stress of the restorations were compared, and according to the results reported by this study, it says that as the number of walls increased axial restorations, the fracture resistance decreased and the maximum principal stress in the restoration was increased. However, four different types of veneers showed better performance than the conventional crown. Similar is the case in other studies, which show that, when sectioning enamel prisms obliquely, stresses will be relocated primarily centrifugally within the tooth, not outside the tooth. The restoration will have the most stable support in the areas where the maximum eccentric stress is concentrated, showing that the result of a preparation that is surrounded by an enamel collar with external bevels has a better redirection of occlusal forces on the longitudinal axis of the tooth, which seems to have a better biomechanical behavior.[11,13,15,16]

It has been described that the type of preparation and treatment of the dental substrate plays a fundamental role in the marginal adaptation and longevity of occlusal veneers.[38,48] Thus, significantly higher resistance to fracture was obtained for glass–ceramic occlusal veneers, when immediate dentin sealing was performed, regardless of the etching protocol prior to cementation (total etching or self-etching) providing a more favorable substrate for adhesion.[34,43] Marginal adaptation of the restoration is one of the most important factors for the survival of restorations in order to prevent dissolution of cement and microfiltration.[48] Therefore, it is important to know that when rehabilitating with a composite material that is exposed to oral media with a low pH, inorganic fillers tend to fall off the resin material and the matrix components break down, leading to cracks at the resin–filler interface causing weakening of the material.[26,44,48] With recent advances in CAD/CAM system technologies, marginal adjustment should be considered more precise within clinically acceptable parameters.[17] The study by Hassan and Moustafa[48] considered that almost 94.9% of the values measured in the literature were less than or equal to 1.2 mm.

Angerame et al.[44] reported that the occlusal veneers with dental preparations with a 90-grade rounded shoulder margin showed an average marginal space of 103.83 ± 54.97 µm, while the conservative preparation design with chamfer was 120.43 ± 58.92 µm. The difference between the two preparation designs in terms of marginal fit was not significant. Compared with the study by Falahchai et al., the authors reported lower values of marginal adjustment of 71.59 ± 14.60, when an anatomical reduction is performed in preparation.[16]

Edgerley et al.[23] mention that the dental substrate is one of the factors that can influence the adhesion of restorations and their mechanical behavior and resistance to fracture. In reported studies, it is found that wet dentin and dry dentin surfaces compromise the adhesive strength, and this is because overdrying the preparation causes significant differences in fracture patterns. A poorly bonded restoration can be expected to be more likely to fracture.

Lauvahutanon et al.[51] reported that lithium disilicate has a relatively high flexural strength of nearly 400 MPa. In comparison, composite resin blocks and polymer-infiltrated ceramic blocks have flexural strengths of 200 MPa.

Limitations and Future Research

Limited clinical evidence was found evaluating the performance of occlusal veneers; most of the articles selected were *in vitro*, which are very important to assess the biomechanics; however, could be important differences in relation to the clinical behavior. Further investigations should be researched examining the survival and complications of occlusal veneers and management of eventual failures.

Conclusion

The indications for occlusal veneers include dental wear caused by biocorrosion processes, bruxism, and restoration/increase of occlusal vertical dimension. Thicknesses between 0.7 and 1.0 mm are recommended for ceramic materials; in addition, thicknesses less than 0.7 mm are recommended to use for polymeric materials. The materials used for this type of restoration are plastic- and ceramic-based materials, whose load resistance values were found to exceed 2000 N in most studies. It is recommended to carry out a minimally invasive preparation or not to carry out a dental preparation, as long as there is a peripheral enamel to make an external bevel that redirects the eccentric forces to the axis of the tooth.

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