Review

Resistance of CAD/CAM composite resin and ceramic occlusal veneers to fatigue and fracture in worn posterior teeth: A systematic review

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Abstract

Severe tooth wear is related to substantial loss of tooth structure, with dentin exposure and significant loss (≥1/3) of the clinical crown. The objective of this systematic review was to summarize and analyze the scientific evidence regarding the mechanical performance of computer-aided design/computer-aided manufacturing (CAD/CAM) composite resin and CAD/CAM lithium disilicate ceramic occlusal veneers, in terms of fatigue and fracture resistance, on severely worn posterior teeth. Currently, occlusal veneers are an alternative for treating worn posterior teeth. Although scientific evidence demonstrates the good performance of lithium disilicate occlusal veneers, there are less brittle materials with a modulus of elasticity more similar to dentin than ceramics, such as resin CAD/CAM blocks. Therefore, it is important to identify which type of material is best for restoring teeth with occlusal wear defects and which material can provide better clinical performance. This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A comprehensive search of the PubMed, Embase, Web of Science, Scopus, Cochrane, OpenGrey, Redalyc, DSpace, and Grey Literature Report databases was conducted and supplemented by a manual search, with no time or language limitations, until January 2022. We aimed to identify studies evaluating the fatigue and fracture resistance of CAD/CAM composite resin and ceramic occlusal veneers. The quality of the full-text articles was evaluated according to the modified Consolidated Standards of Reporting Trials (CONSORT) criteria for in vitro studies, and 400 articles were initially identified. After removing duplicates and applying the selection criteria, 6 studies were included in the review. The results demonstrated that the mechanical performance of CAD/CAM composite resin occlusal veneers is comparable to that of CAD/CAM lithium disilicate occlusal veneers in terms of fatigue and fracture resistance.

Keywords: tooth wear, ceramics, survival rate, composite resin, CAD/CAM

Introduction

In the first clinical study measuring tooth wear in young patients, the authors observed a mean annual occlusal enamel wear of 29 µm in molars and 15 µm in premolars.[1] A 2015 report estimated that the mean height of the maxillary incisor crown at 10 years of age was 11.94 mm, and decreased to 10.93 mm in 70-year-old patients, corresponding to a loss of 1.01 mm (1,010 µm) in 60 years.[2] The wear was greater in the mandibular incisors, with the mean crown height at 10 years of age being 9.58 mm, which decreased to 8.12 mm in patients aged 70 years old, resulting in a loss of 1.46 mm (1,460 µm) over the course of 60 years. These values correspond to a physiological annual wear rate of 16.8 µm for the maxillary incisors and 24.3 µm for the mandibular incisors.[2]

It is important to differentiate between severe tooth wear and pathological tooth wear. The latter refers to atypical tooth wear for the patient's age that causes pain or discomfort, functional problems, or deterioration of the aesthetic appearance which, if progresses, can lead to undesirable complications of increasing complexity.[2] Severe tooth wear is related to substantial loss of tooth structure, with dentin exposure and significant loss (≥1/3) of the clinical crown.[3] However, not all cases of severe tooth wear can be considered pathological, especially among elderly people. According to an epidemiological study conducted in 2015, the estimated prevalence of erosive tooth wear in children and adolescents was 30.4%.[4] The most recent European consensus on the management of severe tooth wear[3] recommends the use of indices such as the Basic Erosive Wear Examination (BEWE)[5] and the Tooth Wear Evaluation System (TWES)[6] for diagnosis. Severe tooth wear can be attributed to a number of factors, including excessive consumption of carbonated beverages, a high-acid diet, gastric diseases, anorexia, bulimia, teeth grinding, and the use of highly abrasive pastes.[7–12] These factors can affect the patient in several ways, including the loss of vertical dimension, sensitivity due to dentin exposure, poor aesthetics, and neuromuscular disorders.[7,11,12]

Restorative alternatives have been sought to solve these problems, such as the placement of metal-free crowns. Although this technique has shown a high survival rate (92% at 5 years and 85.5% at 10 years),[13] it requires mechanical retention, necessitating the removal of more dental tissue, including healthy tissue. Advances in dental materials and adhesive techniques have led to a reduction in the indications for crowns.[14,15] Occlusal veneers have emerged as a viable alternative for the treatment of posterior tooth wear, as they require minimal tooth preparation, ranging from 0.4 mm to 0.6 mm at the level of the developmental groove and from 1 mm to 1.3 mm at the tip of the cusp, largely preserving healthy dental tissue. Due to the bonding characteristics of these materials and the more intuitive preparation guided by anatomical considerations, there are instances where no dental tissue is removed.[16–18]

Advances in computer-aided design/computer-aided manufacturing (CAD/CAM) technology and bonding procedures (immediate dentin sealing)[19,20] have enabled the fabrication of thin occlusal veneers without compromising their performance.[16] Scientific evidence indicates that lithium disilicate occlusal veneers exhibit excellent performance.[21,22] However, less brittle materials with a modulus of elasticity comparable to that of dentin, such as composite resin, are also available.[17,19,23] A number of studies, the majority of which were conducted in a laboratory setting, have evaluated the mechanical properties of occlusal veneers using universal test machines and mastication simulators under physiological and/or pathological occlusal loading conditions.[19,23–25] However, there is no up-to-date systematic review that allows the clinician to make an informed decision regarding the most appropriate material for restoring teeth with occlusal wear. Therefore, the objective of this systematic review is to analyze and summarize the scientific evidence evaluating the mechanical performance of CAD/CAM composite resin and lithium disilicate ceramic occlusal veneers in severely worn posterior teeth, with a particular focus on the fatigue and fracture resistance.

Material and methods

Registration protocol

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[26] Additionally, the review was registered in the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) (doi:10.37766/inplasy2021.10.0036; https://inplasy.com/inplasy-2021-10-0036).

Search strategy

The purpose of the search was to address the following question: in posterior teeth with severe tooth wear, can occlusal veneers made from CAD/CAM composite resin blocks perform better mechanically in terms of fatigue and fracture resistance compared to CAD/CAM lithium disilicate occlusal veneers? The research question was developed in accordance with the Population, Intervention, Comparison, and Outcome (PICO) framework.

Three independent researchers (KM, JE and DA) conducted an exhaustive electronic search of the following databases: PubMed, Scopus, Cochrane, Embase, and Web of Science, to identify relevant articles published before January 2022. The Medical Subject Headings (MeSH), Embase subject headings (Emtree) and free terms were used without restrictions in terms of language and year of publication. A search strategy is presented in the supplementary materials (available on request from the corresponding author). To identify other potentially relevant articles, 2 researchers (KM and JE) conducted a manual search of the bibliographic citations of the included articles and the following journals: Dental Materials; Journal of Dental Restoration; Journal of Dentistry; Journal of Oral Rehabilitation; Journal of Esthetic and Restorative Dentistry; Dental Materials Journal; Journal of Material Sciences. The search for grey literature was performed by KM and JE in the OpenGrey, Redalyc, DSpace, and Grey Literature Report databases.

Eligibility criteria

The present systematic review included studies on the indirect restoration of worn posterior teeth with machined materials. The studies compared the mechanical properties of CAD/CAM composite resin and ceramic materials, including the fatigue and fracture resistance. This review included randomized controlled trials, non-randomized controlled trials and in vitro studies.

Studies investigating CAD/CAM restorations on endodontically treated teeth, as well as crown, inlay, onlay, and implant restorations, case reports, literature reviews, expert opinions, and systematic reviews were excluded.

Screening and selection

Two researchers (KM and JE) independently selected the studies for inclusion based on their titles and abstracts. If a decision regarding inclusion could not be made because of insufficient data in the title and abstract, the complete manuscript was obtained for further analysis. The articles in which both researchers concurred were selected. The articles selected for full-text reading were evaluated independently by 2 researchers (KM and JE). Any disagreement regarding the eligibility of the included studies was resolved through discussion and consensus, or by a third reviewer (DA). Only papers that met all the eligibility criteria were included.

The modified Consolidated Standards of Reporting Trials (CONSORT) tool[27] was employed to assess the methodological quality of the articles included in the study in terms of their correct implementation and the structure of the abstract, introduction, methods, results, discussion, and funding.

Data extraction

A data extraction protocol was defined and evaluated by 2 authors (KM and JE). The data was extracted independently from the full-text articles using a standardized form in electronic format (Microsoft Excel 2016; Microsoft Corporation, Redmond, USA). The information was classified according to the authors, year of the study, study design, type of material, sample size, objectives, testing machine used, and conclusions (Table 1).

Risk of bias assessment

Two authors (KM and JE) independently evaluated the risk of bias in the studies included in this review based on a previous study.[28] The following parameters were assessed: tooth randomization, the use of teeth free of caries or restorations, the use of materials following manufacturers' instructions, the use of teeth with similar dimensions, tooth preparation by the same operator, the description of sample size calculations, and blinding of the testing machine operator. If the author reported the parameter, the article received a "yes" (Y) for that specific parameter; if the information was not found, the article received a "no" (N). Articles reporting 1 to 3 items were classified as exhibiting a high risk of bias, 4 or 5 items as a medium risk of bias, and 6 or 7 items as a low risk of bias. Any disagreements regarding the risk of bias were resolved through consensus. If a consensus could not be reached, the third author (DA) intervened.

Results

Selection of studies

A PRISMA flowchart, which provides a summary of the selection process, is presented in Fig. 1. A total of 400 studies were identified through the search process, with 25 duplicate records being removed. Another 4 studies were

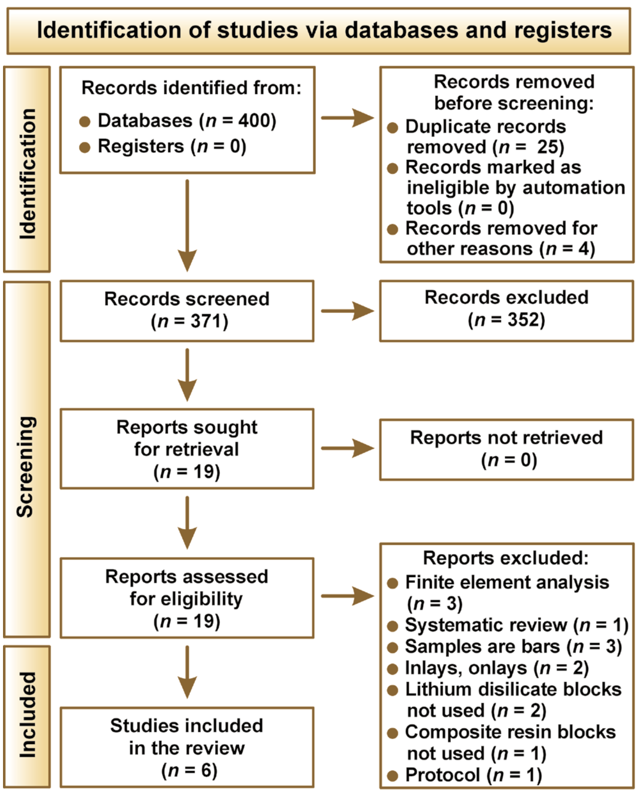

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram

Table 1. Summary of the studies included in the systematic review

Study	Study design	Material	Sample size	Objectives	Testing machine	Conclusions
Andrade et al. 2018[23]	in vitro	• IPS e.max CAD • VITA ENAMIC® • Lava™ Ultimate	70 human third molars	To evaluate, in vitro, the influence of CAD/CAM restorative materials and their thickness (0.6 mm and 1.5 mm) on the fracture resistance of teeth restored with occlusal veneers.	• cyclic mechanical loading: ER-11000 (ERIOS, São Paulo, Brazil) • fracture resistance testing: EMIC DL-2000 (EMIC, São José dos Pinhais, Brazil)	The occlusal veneers exhibited the fracture resistance similar to that of sound teeth.
Al-Akhali et al. 2017[25]	in vitro	• IPS e.max CAD • VITA ENAMIC®	64 human maxillary first premolars	To evaluate the influence of thermodynamic loading on the durability and fracture resistance behavior of occlusal veneers fabricated from different dental CAD/CAM materials.	• cyclic loading fatigue: dual-axis computerized chewing simulator (Willytec, Feldkirchen-Westerham, Germany) • fracture resistance testing: Zwick Z010/TN2A (Zwick GmbH, Ulm, Germany)	The materials tested may be considered a viable treatment for the restoration of occlusal surfaces of posterior teeth.
Al-Akhali et al. 2019[29]	in vitro	• IPS e.max CAD • VITA ENAMIC®	64 human maxillary first premolars	To evaluate the influence of thermomechanical fatigue loading on the fracture strength of minimally invasive occlusal veneer restorations fabricated from different CAD/CAM materials and bonded to human maxillary premolars using the self-etching bonding technique.	• cyclic loading fatigue: dual-axis computerized chewing simulator (Willytec) • fracture resistance testing: Zwick Z010/TN2A (Zwick GmbH)	Thermomechanical fatigue decreased the survival rate and fracture strength of all tested CAD/CAM materials when bonded to enamel using the self-etching technique.
Heck et al. 2019[30]	in vitro	• IPS e.max CAD • Lava™ Ultimate	84 human molars	To determine whether ceramics or nanoceramic composites with an ultrathin layer thickness of 0.3–0.5 mm could be used to restore pressure-loaded occlusal dentin and enamel defects.	• fatigue simulations: computer-controlled chewing simulator (MUC 2; Willytec GmbH, Gräfelfing, Germany)	The tested occlusal veneers are recommended for the treatment of occlusal tooth loss with ultrathin veneers.
Magne et al. 2010[19]	in vitro	• IPS e.max CAD • Paradigm™ MZ100	30 human maxillary molars	To assess and compare the fatigue resistance of composite resin and ceramic posterior occlusal veneers.	• fatigue testing: closed-loop servohydraulics (Mini Bionix II; MTS Systems Corp., Eden Prairie, USA)	CAD/CAM composite resin posterior occlusal veneers had a significantly higher fatigue resistance when compared to the ceramic veneers.
Schlichting et al. 2011[17]	in vitro	• IPS e.max CAD • Paradigm™ MZ100 • XR experimental blocks (reinforced with short polyethylene fibers)	40 human maxillary molars	To assess the influence of CAD/CAM restorative materials (ceramic vs. composite resin) on the fatigue resistance of ultra-thin occlusal veneers.	• fatigue testing: closed-loop servohydraulics (Mini Bionix II; MTS Systems Corp.)	CAD/CAM composite resin ultrathin occlusal veneers had a significantly higher fatigue resistance when compared to the ceramic veneers.

CAD/CAM – computer-aided design/computer-aided manufacturing.

removed because they were book chapters, and 352 studies were excluded as they did not meet the eligibility criteria. The remaining 19 studies were subjected to a full-text review. Three studies were excluded because they employed finite element analyses, 1 study was a systematic review, and 9 studies did not meet the inclusion criteria. Therefore, a total of 6 studies were included in the systematic review. Three of these examined the fracture resistance,[23,25,29] while the remaining 3 examined the fatigue resistance.[17,19,30]

Risk of bias

Of the 6 included studies, 2 were identified as having a medium risk of bias,[23,25] while 4 had a high risk of bias.[17,19,29,30] The results are described in Table 2, according to the parameters considered in the analysis. The most commonly identified risks of bias among the studies were a lack of blinding of the testing machine operator, a lack of description of the sample size calculation, and tooth preparation performed by the same operator.

Main findings

The characteristics of the materials used in the studies included in this systematic review are presented in Table 3. The fracture resistance of CAD/CAM occlusal veneers was evaluated in 3 studies.[23,25,29] Two of these studies had restorations of the same thickness and used thermocycling.[25,29] The results indicate that there is no statistically significant difference between the use of CAD/CAM composite occlusal veneers and CAD/CAM lithium disilicate veneers (Table 4).

Table 2. Assessment of the risk of bias

Study	Teeth randomization	Teeth free of caries or restoration	Materials used according to the manufacturer's instructions	Teeth with similar dimensions	Tooth preparation performed by the same operator	Sample size calculation	Blinding of the operator of the testing machine	Risk of bias
Andrade et al. 2018[23]	Y	Y	Y	Y	N	N	N	medium
Al-Akhali et al. 2017[25]	N	Y	Y	Y	N	Y	N	medium
Al-Akhali et al. 2019[29]	Y	Y	Y	N	N	N	N	high
Heck et al. 2019[30]	N	Y	Y	Y	N	N	N	high
Magne et al. 2010[19]	N	Y	Y	N	N	N	N	high
Schlichting et al. 2011[17]	N	Y	Y	N	N	N	N	high

Y – yes; N – no.

Table 3. Characteristics of the materials used in the included studies

Material	Classification	Manufacturer	Composition
IPS e.max CAD	lithium disilicate glass ceramic	Ivoclar Vivadent AG, Schaan, Liechtenstein	SiO_2 (57.0–80.0%), Li_2O (11.0–19.0%), K_2O (0.0–13.0%), P_2O_5 (0.0–11.0%), ZrO_2 (0.0–8.0%), ZnO (0.0–8.0%), Al_2O_3 (0.0–5.0%), MgO (0.0–5.0%), coloring oxides (0.0–8.0%)
Lava Ultimate	resin nanoceramic	3M ESPE, St. Paul, USA	silica nanomers (20 nm), zirconia nanomers (4–11 nm), nanocluster particles derived from the nanomers (0.6–10 nm), silane coupling agent, resin matrix (Bis-GMA, Bis-EMA, UDMA, and TEGDMA)
VITA ENAMIC	hybrid ceramic (glass ceramic in a resin interpenetrating matrix)	VITA Zahnfabrik, Bad Säckingen, Germany	inorganic ceramic content: 86 wt% (silicon dioxide (58–63%), aluminum oxide (20–23%), sodium oxide (9–11%), potassium oxide (4–6%), boron trioxide (0.5–2%), zirconia (<1%), calcium oxide (<1%)) organic polymer content: 14 wt% (UDMA and TEGDMA)
Paradigm MZ100	zirconia–silica ceramic in a resin interpenetrating matrix	3M ESPE, St. Paul, USA	Paradigm MZ100: 85 wt% ultrafine zirconia–silica ceramic particles that reinforce a highly cross-linked polymer matrix polymer matrix: Bis-GMA and TEGDMA

Bis-GMA – bisphenol A-glycidyl methacrylate; Bis-EMA –bisphenol-A ethoxylated dimethacrylate; UDMA – urethane dimethacrylate; TEGDMA – triethylene glycol dimethacrylate.

On the other hand, the fatigue resistance was evaluated according to the survival rate in 3 investigations,[17,19,30] with 1 study demonstrating no statistically significant difference in the survival rate.[30] However, in 2 studies, the survival rate was higher in CAD/CAM composite resin occlusal restorations (Table 5).

The results of this study indicate that the use of CAD/CAM composite and lithium disilicate occlusal veneers in worn posterior teeth is a viable option. Due to the heterogeneity and risk of bias, a quantitative analysis could not be performed.

Discussion

This systematic review demonstrates that CAD/CAM composite resin occlusal veneers exhibit fracture resistance values ranging from 1,018.5 N to 3,584.0 N, even in thin veneers (0.5–1.5 mm), which exceed the maximum bite force of patients without parafunctional habits (424–630 N).[23] These results are consistent with those of a systematic review[31] that recommends the use of CAD/CAM composite resin occlusal veneers less than 1-mm thick and lithium disilicate veneers from 0.7 mm to 1.5 mm thick. In their study, Maeder et al.[32] evaluated various materials and found that VITA ENAMIC®, with a thickness of 0.5 mm, required a 800-N greater load than the maximum bite force to produce a crack in the veneer. Therefore, this material reaches high values of fracture resistance, which can be attributed to its composition, consisting of a hybrid structure with 2 interpenetrated ceramic and polymeric networks, and resulting in a Weibull modulus of 20. This is in relation to the fracture range, reliability and strength of the material.[33] Ioannidis et al.[34] also reported that 0.5-mm thick VITA ENAMIC occlusal veneers have load capacity values above the normal force intervals. Johnson et al.[16] compared CAD/CAM composite resin occlusal veneers, including Lava™ Ultimate and Paradigm™ MZ100 with varying thicknesses (0.3 mm, 0.6 mm and 1 mm).

Table 4. Fracture resistance observed in the included studies

Study	Variables					Results					
	material	restoration thickness [mm]	cyclic mechanical loading	thermocycling	antagonist material	fracture resistance [N] *M* ±*SD*	fracture resistance without thermomechanical loading [N]		fracture resistance after thermomechanical loading [N]		conclusions
							M ±*SD*	*Me*	*M* ±*SD*	*Me*	
Andrade et al. 2018[23]	IPS e.max CAD	0.6	1,000,000 cycles at 1-Hz frequency in distilled water at 37°C, a load of 200 N	no thermocycling	a metal sphere with a 6-mm diameter	3,067 ±933	–	–	–	–	A significantly higher fracture resistance was obtained for 1.5-mm IPS e.max CAD than for the other experimental groups ($p = 0.027$). There was no significant difference between 0.6-mm VITA ENAMIC, Lava Ultimate and IPS e.max CAD ($p = 0.050$). The fracture resistance of the sound teeth (3,991 N) did not differ significantly from that of the experimental groups ($p = 0.199$).
		1.5				4,995 ±855					
	VITA ENAMIC	0.6				2,973 ±635	–	–	–	–	
		1.5				3,540 ±986					
	Lava Ultimate	0.6				3,384 ±922	–	–	–	–	
		1.5				3,584 ±954					
Al-Akhali et al. 2017[25]	IPS e.max CAD	0.5	1,200,000 mechanical chewing cycles, a vertical load of 98 N	between 5°C and 55°C in distilled water, 30-s dwell time at each temperature with a total of 5,500 thermal cycles at a loading cycle frequency of 2.4 Hz	steatite ceramic balls with a 6-mm diameter	–	1,408.8 ±215.8	1,335.0	1,545.0 ±175.2	1,560.0	Thermodynamic loading significantly increased the fracture resistance of VITA ENAMIC ($p \leq 0.031$). Without thermodynamic loading, lithium disilicate showed a significantly higher fracture resistance than VITA ENAMIC ($p \leq 0.015$). After thermodynamic loading, no statistically significant difference was observed between the groups ($p \leq 0.291$).
	VITA ENAMIC					–	1,018.5 ±155.5	1,005.0	1,321.0 ±269.1	1,310.0	
Al-Akhali et al. 2019[29]	IPS e.max CAD	0.5	1,200,000 mechanical chewing cycles, a vertical load of 98 N	between 5°C and 55°C in distilled water, 30-s dwell time at each temperature with a total of 5,500 thermal cycles at a loading cycle frequency of 2.4 Hz	steatite ceramic balls with a 6-mm diameter	–	806.1 ±186.9	782.5	470.8 ±428.2	328.5	Thermomechanical fatigue significantly reduced the fracture strength of VITA ENAMIC ($p = 0.047$). Lithium disilicate exhibited no significant reduction in the fracture strength after thermomechanical fatigue. There was no statistically significant difference between the groups with regard to thermomechanical fatigue.
	VITA ENAMIC					–	767.1 ±130.9	769.5	349.9 ±350.5	98.0	

M – mean; *Me* – median; *SD* – standard deviation.

Table 5. Fatigue resistance observed in the included studies based on the survival rate

Study	Material	Restoration thickness	Antagonist material	Cyclic mechanical loading	Survival rate [%]	Results
Heck et al. 2019[30]	IPS e.max CAD	0.3–0.5 mm	5-mm highly compacted oxide ceramic (Degussit balls; FRIALIT-DEGUSSIT, Mannheim, Germany)	1,000,000 masticatory cycles with a loading force of 50 N and 100 N and a frequency of 1 Hz	100	There was no significant difference between IPS e.max CAD and Lava Ultimate ($p = 0.317$) .
	Lava Ultimate				95	
Magne et al. 2010[19]	IPS e.max CAD	1.2 mm at the central groove	7-mm-diameter composite resin sphere (Z100™ MP; 3M ESPE, St. Paul, USA) postpolymerized at 100°C for 5 min	cyclic load applied at a frequency of 5 Hz and 1,400 N, at a maximum of 185,000 cycles	30	A higher fatigue resistance was observed in Paradigm MZ100 compared to IPS e.max CAD ($p = 0.002$).
	Paradigm MZ100				100	
Schlichting et al. 2011[17]	IPS e.max CAD	0.6 mm at the central groove	7-mm-diameter composite resin sphere (Z100™ MP; 3M ESPE) postpolymerized at 100°C for 5 min	cyclic load applied at a frequency of 5 Hz and 1,400 N, at a maximum of 185,000 cycles	0	A higher fatigue resistance was observed in Paradigm MZ100 compared to IPS e.max CAD ($p < 0.001$). XR experimental blocks were significantly stronger than IPS e.max CAD ($p < 0.001$), but not different from Paradigm MZ100 ($p = 0.030$).
	Paradigm MZ100				60	
	XR experimental blocks				100	

The obtained fracture resistance values were higher than normal masticatory forces, even at the minimum thickness of 0.3 mm. Therefore, minimum thickness, non-ceramic occlusal veneers could be considered a restorative option in patients with normal masticatory loads. However, in patients with parafunctional habits and excessive loads (780–1,120 N), complications may arise, including restoration dislodgment and fracture.[16,23]

In terms of fatigue resistance, there were no statistically significant differences between CAD/CAM lithium disilicate and composite resin occlusal veneers with a thickness of 0.3–0.5 mm, including IPS e.max CAD and Lava Ultimate, respectively. In the studies conducted by Magne et al.[19] and Schlichting et al.,[17] Paradigm MZ100 occlusal veneers with thicknesses of 1.2 mm and 0.6 mm demonstrated higher resistance values than IPS e.max CAD, applying a final load of 1,400 N in both studies. On the other hand, in the study by Schlichting et al.,[17] XR experimental blocks were also significantly stronger than IPS e.max CAD, but not different from MZ100. The results of these studies suggest that higher flexural strength does not necessarily correspond to higher load resistance.[19] According to the studies included in this systematic review, CAD/CAM composite resin occlusal veneers have a survival rate of 95–100%, despite their lower flexural strength than lithium disilicate veneers. For example, lithium disilicate has a flexural strength of 360–440 mPa, in contrast to MZ100, which has a flexural strength of 150 mPa.[17,19,35] Neither of these values is correlated with the respective survival rate. Similarly, Lava Ultimate and VITA ENAMIC blocks show flexural strength values of 200 mPa and 150–160 mPa, respectively.[23] The elastic moduli of Lava Ultimate (13 gPa) and VITA ENAMIC (30 gPa) are close to that of dentin (20.3 gPa), suggesting that they may influence the performance of restorations,[23] since the elasticity of dentin compensates for the stiffness of enamel, cushioning it against masticatory forces. Consequently, the distribution of stress within a restored tooth during mastication depends on this property.[36,37] However, it should be noted that thermocycling was not employed in the studies conducted by Magne et al.[19] and Schlichting et al.[17]

In vitro studies that use thermocycling are of great importance, as the procedure enables the simulation of the physiological conditions and temperature changes in the oral environment, which can result in physicochemical alterations in dental materials.[25,32,38] The study of Al-Akhali et al.[29] evaluated restoration survival by subjecting specimens to thermocycling for 1,200,000 cycles, which simulates 5 years of clinical service.[39,40] The results indicated low survival rates for both VITA ENAMIC and IPS e.max CAD blocks (37.5% and 50%, respectively). However, the authors of the study posit that the self-etch protocol reduced the fracture resistance of the CAD/CAM composite resin and lithium disilicate ceramic blocks. Therefore, enamel etching is required when placing occlusal veneers, since the self-etch technique results in an insufficient and unstable bond between the veneer and the tooth.[29] Self-etch adhesive systems produce a superficial enamel etching with reduced microporosity for resin infiltration, while orthophosphoric acid creates a porous enamel surface 5–50 µm deep. The poor etchability of self-etching adhesive systems on enamel can lead to pigmentation at the enamel margins, which may affect aesthetics, and could also be responsible for restoration dislodgement, marginal leakage and secondary caries, because self-etching does not achieve lasting adhesion to the enamel. Therefore, self-etching adhesive systems should be preceded by selective enamel etching with orthophosphoric acid.[41–45]

Occlusal veneers have been proposed as an alternative to full-coverage restorations for the treatment of worn posterior teeth, based on the results of several studies demonstrating their satisfactory mechanical properties.[17,21] Glass-ceramics, used in their manufacture, demonstrate several advantages, such as color stability, biocompatibility, durability, favorable translucency, chemical stability, reduction in the accumulation of bacterial plaque, and adequate marginal adjustment. However, they also have disadvantages, such as chipping, porosity and microstructural defects.[30,46–50] The CAD/CAM composite resin blocks are advantageous due to the low wear of the opposing teeth, a dentin-like elastic modulus, low cost, and the possibility of repair. Some disadvantages of this material include its tendency to absorb water, as well as its susceptibility to chemical and mechanical degradation.[23,51,52]

A comparative analysis of the fatigue and fracture resistance of CAD/CAM composite resin and CAD/CAM lithium disilicate blocks revealed that both materials, with a thickness ranging from 0.5 mm to 1.5 mm, are suitable for the treatment of occlusally worn teeth using an etch-and-rinse bonding procedure. However, these results should be interpreted with caution, as the present review revealed some limitations. The majority of the included studies showed a high risk of bias, as they did not clarify whether the extracted teeth were prepared by the same operator, and only 1 study mentioned the sample size calculation.[25] Additionally, variables such as the number of cycles, the load applied and veneer thickness were not consistent across all the included studies. It should also be noted that no clinical trials were identified during the search, as all included studies were conducted in vitro. Therefore, simulating the oral environment is challenging. Nevertheless, only 2 studies[25,29] used thermocycling, and it has been suggested that clinical studies be conducted with long-term follow-up. It is therefore recommended that future studies adopt a standardized methodology. Although the studies included in this review compared CAD/CAM lithium disilicate blocks (IPS e.max CAD; Ivoclar Vivadent AG, Schaan, Liechtenstein) with CAD/CAM composite resin blocks (Lava™ Ultimate, 3M ESPE, St. Paul, USA; VITA ENAMIC®, VITA Zahnfabrik, Bad Säckingen, Germany; Paradigm™ MZ100 Block, 3M ESPE), it should be noted that there are more CAD/CAM composite resin materials, such as Grandio blocs (VOCO GmbH, Cuxhaven, Germany), with high filler content (86% w/w), a high elastic (18 gPa) and flexural (290 mPa) modulus, a fracture resistance of 2,500 N, and a bite force that exceeds that of patients with parafunction.[53,54] Another notable material is BRILLIANT Crios (Coltène AG, Altstätten, Switzerland), which has an elastic modulus of 10 gPa and a fracture resistance of 1,255 N at a thickness of 1 mm.[50] However, to date, no studies have been conducted to compare occlusal veneers fabricated from these materials with lithium disilicate veneers. Due to the wide heterogeneity of the included studies, a meta-analysis could not be performed.

Conclusions

Computer-aided design/computer-aided manufacturing composite resin occlusal veneers exhibit similar mechanical performance in terms of fatigue and fracture resistance to CAD/CAM lithium disilicate veneers. Both types of veneers are suitable for use on worn posterior teeth. The CAD/CAM composite resin occlusal veneers are economical and repairable, while CAD/CAM lithium disilicate occlusal veneers have better color stability and reduced plaque accumulation. The optimal thickness for CAD/CAM composite resin and lithium disilicate occlusal veneers is 0.5–1.5 mm. Additionally, an etch-and-rinse or self-etch adhesive system with selective etching of the surface of the dental substrate should be used. It is recommended that randomized clinical studies be conducted on this topic.

Ethics approval and consent to participate

Not applicable.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

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