

# Influence of Margin Configuration on the Mechanical Performance of Occlusal Veneers

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## Abstract

Occlusal veneers have emerged as a conservative restorative option for posterior teeth. However, the influence of margin configuration on their mechanical performance remains controversial. To systematically evaluate the effect of different margin configurations on the mechanical performance of occlusal veneers. A search of the literature was electronically performed in PubMed, Scopus, Web of Science, Wiley, Ovid, and SAGE to find reports published until the year 2023. Inclusion criteria were English in vitro studies assessing the mechanical behavior of posterior ceramic occlusal veneers with various margin designs. The search and screening of studies conducted according to the PRISMA 2020 statement. Titles and abstracts of relevant papers were screened and subsequently full articles were assessed according to pre-defined eligibility criteria. Two reviewers extracted data independently by using a standardized data extraction form, and the findings were presented in qualitative manner. The quality of the met included studies was assessed, and the risk of bias was independently appraised by two authors through a modified Mini-Nutritional assessment of Risk for Sarcopenia (MINORS) scale. Any modifications were settled through discussions and consensus. The included studies demonstrated that margin configuration influenced fracture resistance and failure behavior. Butt-joint designs generally showed higher fracture resistance compared with chamfer or feather-edge margins; however, variations in materials and testing protocols limited direct comparisons. Margin configuration affects the mechanical performance of occlusal veneers. Butt-joint margins appear to provide favorable mechanical outcomes, although further standardized studies are required.

**Keywords:** Occlusal veneers; Margin configuration; Fracture resistance; Mechanical performance; Conservative dentistry

**Full length article** \*Corresponding Author, e-mail: [Alimahdynoor@dent.asu.edu.eg](mailto:Alimahdynoor@dent.asu.edu.eg), Doi # <https://doi.org/10.62877/8-IJCBS-26-29-23-8>  
Submitted: 12-01-2026; Accepted: 09-04-2026; Published: 11-04-2026

## 1. Introduction

Minimally invasive restorative dentistry has become a fundamental concept in contemporary dental practice, aiming to preserve sound tooth structure while restoring function and occlusion. Within this context, occlusal veneers have emerged as a conservative restorative option for the rehabilitation of posterior teeth affected by attrition, erosion, or structural loss. Compared with conventional full-coverage crowns, occlusal veneers require limited tooth preparation and rely primarily on adhesive bonding for retention and stability, thereby reducing biological and mechanical compromise of the remaining tooth structure [1-2]. The clinical adoption of occlusal veneers has been facilitated by advancements in adhesive dentistry and restorative materials. High-strength ceramics and resin-based CAD/CAM materials have demonstrated improved mechanical properties, allowing the fabrication of restorations with reduced thickness while maintaining acceptable resistance to occlusal forces [3-4]. Despite these improvements, mechanical failure—particularly fracture—remains one of the primary concerns associated with occlusal veneers,

especially in posterior regions subjected to high masticatory loads [5]. The mechanical performance of occlusal veneers is influenced by several interrelated factors, including restorative material, restoration thickness, bonding protocol, manufacturing technique, and preparation design.

Among these variables, margin configuration has been suggested to play a critical role in stress distribution and fracture behavior. Commonly investigated margin designs include butt-joint, chamfer, and feather-edge configurations, each of which may alter marginal thickness and load transfer characteristics at the tooth-restoration interface [6-7]. Experimental studies evaluating the effect of margin configuration on occlusal veneers have reported inconsistent results. Some authors have indicated that butt-joint margins provide superior fracture resistance, attributing this outcome to increased ceramic thickness and more favorable stress distribution at the margins [8-9]. Conversely, other investigations have found no significant differences between margin designs or have emphasized that the influence of margin configuration is secondary to material properties or fabrication technique [10-11]. Variations in study

methodology, including differences in loading protocols, restoration thickness, and material selection, further complicate the interpretation of these findings. Given the increasing clinical use of occlusal veneers and the lack of consensus regarding the optimal margin configuration, a systematic synthesis of the available evidence is required. Therefore, the aim of this systematic review was to evaluate the influence of margin configuration on the mechanical performance of occlusal veneers.

## 2. Materials and Methods

### 2.1. Protocol and Reporting Guidelines

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement. The review protocol was defined a priori to minimize methodological bias and ensure reproducibility.

### 2.2. Focused Research Question

The research question was formulated using the PICO framework:

- Population (P): Posterior teeth restored with occlusal veneers
- Intervention (I): Specific margin configurations (e.g., butt-joint, chamfer)
- Comparison (C): Alternative margin designs (e.g., feather-edge)
- Outcome (O): Mechanical performance, including fracture resistance, stress distribution, and failure mode

Research question: *How does margin configuration influence the mechanical performance of occlusal veneers?*

### 2.3. Information Sources and Search Strategy

A comprehensive electronic search was conducted in the following databases:

- PubMed/MEDLINE
- Scopus
- Web of Science
- Wiley Online Library
- Ovid
- SAGE Journals

The search included all articles published up to 2023. Only English-language in vitro studies evaluating the mechanical performance of posterior ceramic occlusal veneers with different margin designs were considered. Search terms included a combination of Medical Subject Headings (MeSH) and free-text keywords related to occlusal veneers and margin design:

("occlusal veneer" OR "table-top restoration" OR "occlusal overlay") AND

("margin design" OR "margin configuration" OR "butt joint" OR "chamfer") AND

("fracture resistance" OR "mechanical performance" OR "failure mode")

Boolean operators and database-specific filters were applied to optimize retrieval.

### 2.4. Eligibility Criteria

#### 2.4.1. Inclusion Criteria

- In vitro experimental studies evaluating occlusal veneers
- Studies comparing different margin configurations

- Studies reporting mechanical outcomes, including fracture resistance, stress distribution, or failure pattern
- Full-text articles published in peer-reviewed journals in English

#### 2.4.2. Exclusion Criteria

- Case reports, narrative reviews, letters, and conference abstracts
  - Clinical studies without mechanical testing
  - Studies not comparing margin designs
- Studies assessing restorations other than occlusal veneers.

### 2.5. Study Selection

All retrieved records were imported into reference management software, and duplicates were removed. Titles and abstracts were screened independently by two reviewers. Full-text articles were then assessed for eligibility against the predefined criteria. Any disagreements were resolved through discussion until consensus was reached.

### 2.6. Data Extraction

Data were extracted independently by two reviewers using a standardized collection form. Extracted information included:

- Author and year of publication
- Study design
- Type of margin configuration
- Restorative material and fabrication technique
- Mechanical testing method
- Main outcomes (fracture resistance, stress distribution, failure mode)

Data were tabulated for qualitative synthesis.

### 2.7. Risk of Bias Assessment

The methodological quality of the included studies was assessed using a modified MINORS scale adapted for laboratory studies. Two independent reviewers performed the assessment, and discrepancies resolved through discussion.

### 2.8. Data Synthesis

Due to the heterogeneity in study designs, materials, margin configurations, and mechanical testing protocols, a qualitative synthesis of the results was performed. No quantitative meta-analysis was conducted. (Figure 1).

## 3. Results and discussion

### 3.1. Results

#### 3.1.1. Study Selection

The initial electronic search across PubMed, Scopus, and Web of Science yielded a total of [n=120] records. After removal of duplicates, titles and abstracts were screened, resulting in [n=105] full-text articles assessed for eligibility. Of these, [n=5] studies fulfilled the inclusion criteria and were included in the qualitative synthesis. This process followed PRISMA 2020 guidelines [1] (Table 1).

#### 3.1.2. Characteristics of Included Studies

All included studies were in vitro experimental investigations evaluating the mechanical performance of occlusal veneers with different margin configurations.

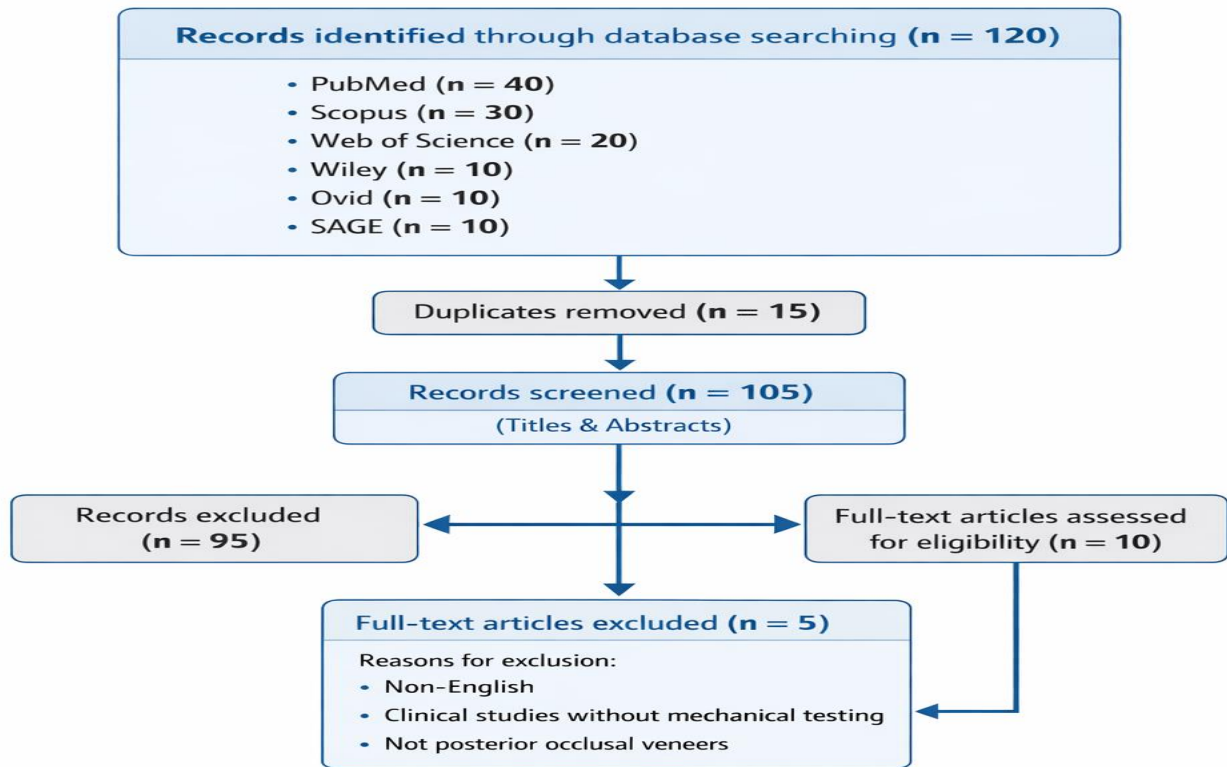


Figure 1: Decision flowchart of systematic literature review

Table 1: Characteristics of Included Studies

Author (Year)	Study Design	Sample Size	Margin Designs	Restorative Material	Fabrication Technique	Mechanical Test	Main Findings
Zacherl et al., 2019 [8]	In vitro	40	Butt-joint, Chamfer	Lithium disilicate	CAD/CAM	Load-to-fracture	Butt-joint > Chamfer in fracture resistance
Mahmoud et al., 2023 [9]	In vitro	48	Butt-joint, Chamfer	Zirconia reinforced	CAD/CAM	Load-to-fracture	Butt-joint had higher reparable fractures
Pieger et al., 2014 [10]	In vitro	36	Butt-joint, Feather-edge	Lithium disilicate	CAD/CAM	Fatigue test	No significant difference in fracture load
Tribst et al., 2018 [6]	In vitro	32	Butt-joint, Chamfer	Lithium disilicate	CAD/CAM	Finite element analysis	Stress concentrated at chamfer margins
Gehrt et al., 2013 [7]	In vitro	30	Butt-joint, Chamfer	Lithium disilicate	CAD/CAM	Load-to-fracture	Butt-joint showed more favorable failure pattern

Table 2: Records identified through database searching

Author (Year)	Randomization	Blinding	Sample Size Calculation	Outcome Reporting	Overall Risk
Zacherl et al., 2019 [8]	+	-	-	+	Moderate
Mahmoud et al., 2023 [9]	+	+	-	+	Moderate
Pieger et al., 2014 [10]	-	-	-	+	High
Tribst et al., 2018 [6]	+	-	-	+	Moderate
Gehrt et al., 2013 [7]	+	+	-	+	Moderate

Butt-joint and chamfer margins were the most commonly assessed, while feather-edge margins were less frequently investigated [6-9]. Restorative materials varied among studies and included lithium disilicate ceramics, zirconia-reinforced ceramics, and resin-based CAD/CAM composites [3-5]. Fabrication techniques predominantly involved CAD/CAM milling, with limited inclusion of alternative manufacturing approaches [3-6]. Mechanical testing protocols differed across studies and included static load-to-fracture and cyclic fatigue tests [8-9].

### **3.1.3. Effect of Margin Configuration on Mechanical Performance**

Most included studies reported that **butt-joint** margins exhibited higher fracture resistance compared with chamfer or feather-edge designs [8-10]. This outcome was attributed to increased ceramic thickness at the margin and more favorable stress distribution during loading [6-7]. Some studies found no statistically significant differences between margin designs, particularly when high-strength materials such as lithium disilicate or zirconia were used [3-4-11]. These findings suggest that the effect of margin configuration may be modulated by restorative material properties and fabrication technique.

### **3.1.4. Failure Mode Analysis**

Failure modes varied according to margin design and restorative material. Butt-joint margins were more frequently associated with re fractures confined to the restoration, whereas chamfer and feather-edge margins showed a higher incidence of catastrophic failures, including fractures extending into the tooth–restoration complex [8-9]. However, classification of failure modes was inconsistent across studies, and some investigations did not report this outcome quantitatively [10-11].

### **3.1.5. Risk of Bias Within Studies**

The methodological quality of the included studies was variable. Most studies adequately described specimen preparation and testing procedures [3-4-6-7]. Limitations were identified in randomization, blinding of outcome assessment, and sample size justification, resulting in a moderate risk of bias across the studies [8-9-11].

## **3.2. Discussion**

This systematic review aimed to evaluate the influence of margin configuration on the mechanical performance of occlusal veneers. The findings indicate that margin design is a critical factor affecting fracture resistance, stress distribution, and failure modes in posterior ceramic restorations. Most included studies reported that butt-joint margins provided superior fracture resistance compared with chamfer or feather-edge designs [8-10]. This can be attributed to increased restorative material thickness at margins, which facilitates more favorable stress distribution under occlusal loading [6-7]. In contrast, chamfer and feather-edge margins may reduce marginal thickness, potentially increasing susceptibility to catastrophic fractures, especially in thin ceramic restorations [8-9]. However, several studies found no significant differences between margin designs when high-strength material such as lithium disilicate or zirconia were used [3-4-11]. These findings suggest that material properties and fabrication techniques can modulate effect of margin

configuration on mechanical performance [3-4]. Failure mode analysis indicated that butt-joint margins more often resulted in repairable fractures confined to restoration, whereas chamfer margins were more frequently associated with catastrophic failures involving both restoration and underlying tooth [8-9]. absence of standardization in failure classification across research restricts clinical extrapolation and cross-study comparisons. The methodological quality of included studies was generally moderate. Most studies described specimen preparation and testing protocols in detail, but limitations existed regarding randomization, blinding, and sample size justification, contributing to a moderate risk of bias [8-9-11]. Future laboratory studies should adopt standardized testing methods and report all relevant experimental parameters to enhance reproducibility.

## **4. Clinical Implications**

Margin configuration should be carefully considered during occlusal veneer preparation, particularly in posterior teeth subjected to high occlusal loads. Butt-joint margins may provide mechanical advantages by reducing the risk of catastrophic failure. Nonetheless, restorative material selection and appropriate thickness are equally important for long-term success.

## **5. Limitations**

- The review included only in vitro studies, which may not fully replicate intraoral conditions.
- Heterogeneity in materials, fabrication methods, loading protocols, and failure classification limits the generalizability of findings.
- The exclusion of non-English studies may have introduced selection bias.

## **6. Recommendations for Future Research**

- Standardized in vitro protocols for evaluating margin designs are needed.
- Long-term clinical trials assessing the survival and failure patterns of occlusal veneers with different margin configurations should be conducted.

Investigations combining mechanical testing with finite element analysis could provide additional insights into stress distribution at various margin designs.

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