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REVIEW ARTICLE

ZIRCONIA VENEERS VERSUS CONVENTIONAL CERAMIC VENEERS: A CLINICAL COMPARATIVE REVIEW OF MECHANICAL PROPERTIES, ESTHETIC OUTCOMES, BONDING PERFORMANCE, AND LONG-TERM SURVIVAL:AN EVIDENCE-BASED CLINICAL REVIEW

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Abstract

Background: Ceramic laminate veneers are widely used in contemporary esthetic dentistry to restore anterior teeth affected by discoloration, morphological abnormalities, diastemata, enamel defects, and minor positional discrepancies. The development of advanced dental ceramics has expanded restorative options beyond traditional feldspathic porcelain to include leucite-reinforced glass ceramics, lithium disilicate, and highly translucent zirconia. Despite their common application in esthetic rehabilitation, these materials differ substantially in microstructure, mechanical behavior, optical characteristics, and adhesive bonding mechanisms.

Objective: To compare zirconia and conventional silica-based ceramic veneers with regard to mechanical properties, esthetic performance, adhesive bonding, clinical survival, complications, and indications for clinical use.

Materials and Methods: An evidence-based narrative review was conducted using relevant clinical investigations, systematic reviews, meta-analyses, and laboratory studies addressing ceramic laminate veneers. The review focused on feldspathic porcelain, leucite-reinforced ceramics, lithium disilicate, and zirconia. Comparative assessment included flexural strength, fracture resistance, translucency, masking ability, surface treatment, cementation protocols, clinical survival, and reported complications.

Results: Zirconia demonstrates high flexural strength and fracture toughness, whereas silica-based ceramics provide more established adhesive bonding protocols and favorable optical properties. Lithium disilicate offers a clinically advantageous combination of mechanical strength, translucency, and predictable resin bonding. Feldspathic porcelain remains particularly suitable for highly esthetic, minimally invasive restorations when sufficient enamel support is available. Although short-term clinical results for zirconia veneers are promising, the available follow-up is insufficient to establish long-term superiority over established glass-ceramic systems.

Conclusion: The choice between zirconia and conventional ceramic veneers should be based on individual clinical requirements rather than mechanical strength alone. Lithium disilicate remains a well-supported option for many anterior veneer indications, while zirconia may be considered in selected cases requiring specific mechanical or masking characteristics. Long-term prospective clinical studies are necessary to establish the comparative survival and complication profiles of zirconia veneers.

Keywords:

INTRODUCTION

The increasing demand for esthetic dental rehabilitation has substantially influenced the development of contemporary restorative dentistry. Patients increasingly expect restorations that reproduce the natural appearance of teeth while preserving healthy dental tissues and maintaining long-term function. In this context, ceramic laminate veneers have become an important treatment option for the correction of anterior tooth discoloration, morphological abnormalities, diastemata, enamel defects, and selected minor positional discrepancies.

Ceramic veneers are thin restorations bonded primarily to the facial surfaces of anterior teeth. Their clinical performance depends not only on the intrinsic characteristics of the ceramic material but also on

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preparation design, the amount of remaining enamel, adhesive procedures, occlusal relationships, marginal adaptation, and the patient's oral hygiene. The preservation of enamel is particularly important because enamel bonding generally provides a more predictable and durable adhesive interface than bonding to exposed dentin [1–3].

Feldspathic porcelain was historically one of the principal materials used for laminate veneers because of its excellent optical properties, including translucency, fluorescence, and the ability to reproduce the complex appearance of natural enamel. Its glass-rich microstructure allows effective hydrofluoric acid etching and subsequent silane-mediated bonding. Nevertheless, its relatively limited mechanical strength may increase susceptibility to fracture under unfavorable loading conditions, particularly when restorations are inadequately supported or exposed to excessive occlusal forces [2,4].

The introduction of reinforced glass ceramics represented an important development in indirect esthetic restorative materials. Leucite-reinforced ceramics demonstrated improved mechanical properties compared with conventional feldspathic porcelain while retaining favorable optical characteristics. Subsequently, lithium disilicate glass ceramics provided a further improvement in strength and fracture resistance through their interlocking crystalline microstructure. These materials combine favorable mechanical performance with high translucency and established adhesive cementation procedures, making them widely applicable in anterior restorative dentistry [4–6].

Zirconia has attracted increasing attention as an alternative ceramic material for esthetic restorations. Unlike feldspathic porcelain and lithium disilicate, zirconia is a polycrystalline ceramic based primarily on zirconium dioxide (ZrO_2), without a continuous silica-rich glass matrix. Its high mechanical strength and fracture toughness are associated with its crystalline structure and transformation-toughening mechanism. These characteristics have made zirconia particularly successful in crowns and fixed dental prostheses [7,8].

However, the application of zirconia in thin laminate veneers introduces specific clinical considerations. The mechanical advantages of zirconia do not necessarily guarantee superior clinical outcomes because the survival of a veneer is strongly influenced by the quality of the adhesive interface. In contrast to silica-based ceramics, zirconia cannot be predictably conditioned using conventional hydrofluoric acid etching and silane application alone. Its bonding protocol generally requires appropriate surface preparation and phosphate-functional monomers, particularly 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP) [9–11].

Another important issue is the relationship between translucency and mechanical properties. Conventional 3Y-TZP zirconia provides high strength but relatively limited translucency. Newer 4Y and 5Y zirconia formulations have improved optical properties through changes in yttria content and crystalline phase composition. Nevertheless, increasing the cubic phase fraction may reduce transformation-toughening capacity and fracture toughness. Therefore, the selection of zirconia for anterior veneers requires consideration of both optical and mechanical requirements [7,8,12].

Clinical survival is another essential criterion in the comparison of ceramic veneer systems. Long-term studies have demonstrated favorable survival rates for conventional porcelain and glass-ceramic veneers. However, the clinical evidence for zirconia laminate veneers remains comparatively limited, particularly regarding observation periods extending beyond five years. Consequently, short-term survival estimates should not be interpreted as proof of long-term superiority.

The clinical decision between zirconia and conventional glass ceramics should therefore be based on a comprehensive assessment of the patient's dental condition, substrate color, available enamel, occlusal loading, esthetic expectations, and the clinician's ability to implement the material-specific bonding protocol.

The aim of this review was to compare zirconia and conventional silica-based ceramic veneers with respect to their mechanical properties, optical characteristics, adhesive bonding performance, clinical survival, complications, and indications, and to identify the clinical situations in which each material may provide the most appropriate restorative solution.

2. MATERIALS AND METHODS

2.1. Review Design

The present manuscript was developed as an evidence-based narrative clinical review. It integrates findings from clinical studies, systematic reviews, meta-analyses, and laboratory investigations concerning ceramic laminate veneers.

The review was designed to compare the principal restorative materials used in anterior veneer treatment, with particular emphasis on zirconia and silica-based glass ceramics.

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It is not presented as a completed systematic review or meta-analysis because a fully documented database search, duplicate removal, independent screening, risk-of-bias assessment, and quantitative synthesis have not been established.

2.2. Literature Search Strategy

The relevant literature search framework included the following databases:

- PubMed/MEDLINE;
- Scopus;
- Web of Science;
- Cochrane Library;
- Google Scholar.

The proposed search period extended from January 2000 to November 2026.

The following combinations of keywords were considered:“Zirconia veneers” AND “clinical outcomes”; “ceramic laminate veneers” AND “survival rate”; “lithium disilicate veneers” AND “fracture resistance”; “feldspathic porcelain veneers” AND “long-term follow-up”; “zirconia” AND “adhesive bonding”; “dental ceramics” AND “translucency”; and “ceramic veneers” AND “clinical complications”.

2.3. Eligibility Criteria

Publications relevant to the following subjects were considered:

1. Clinical performance of ceramic laminate veneers.
2. Mechanical properties of zirconia and glass ceramics.
3. Optical characteristics and translucency.
4. Adhesive bonding and surface conditioning.
5. Clinical survival and complications.
6. Minimally invasive veneer preparation.
7. Patient satisfaction and esthetic outcomes.

Laboratory investigations were considered when they provided relevant information about material properties or adhesive mechanisms. Studies involving only full-coverage crowns without applicable veneer-related findings were not considered central to the comparison.

2.4. Data Synthesis

The evidence was summarized descriptively according to material composition, mechanical characteristics, optical performance, adhesive protocols, clinical outcomes, and complications.

Because the available clinical studies differ in sample size, follow-up duration, preparation design, and outcome definitions, the reported survival estimates were not pooled or treated as directly interchangeable.

3. CLASSIFICATION AND COMPOSITION OF CERAMIC VENEER MATERIALS

The clinical behavior of ceramic veneers is closely associated with their chemical composition and microstructure. For practical purposes, the materials considered in this review can be divided into silica-based glass ceramics and polycrystalline ceramics.

3.1. Feldspathic Porcelain

Feldspathic porcelain is a silica-based ceramic characterized by a glass-dominant microstructure. Its optical properties allow the reproduction of natural enamel translucency, surface texture, and color variation. The material is particularly useful for highly esthetic anterior restorations when adequate enamel support is present. Its principal limitation is its relatively lower mechanical strength compared with reinforced glass ceramics and zirconia.

3.2. Leucite-Reinforced Glass Ceramics

Leucite-reinforced ceramics contain crystalline leucite particles within a glass matrix. The crystalline phase improves mechanical behavior while preserving the favorable optical characteristics of conventional glass ceramics.These materials have been used for veneers and other partial-coverage restorations, although their clinical application depends on restoration thickness, preparation geometry, and loading conditions.

3.3. Lithium Disilicate

Lithium disilicate is a reinforced glass ceramic containing an interlocking crystalline structure. This microstructure contributes to increased strength and crack resistance compared with traditional feldspathic porcelain.

Its principal advantages include:

- Favorable flexural strength.
- Improved fracture resistance.
- High translucency in selected formulations.
- Good color stability.
- Predictable adhesive bonding following appropriate surface treatment.
- Availability in pressable and CAD/CAM-manufactured forms.

Lithium disilicate is therefore an important material for

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anterior veneers where both mechanical performance and optical integration are required.

3.4. Zirconia

Zirconia is a polycrystalline ceramic based on zirconium dioxide. Its mechanical properties depend on the crystalline phases and the stabilizing oxide content.

The principal zirconia generations include:

- 3Y-TZP: 3 mol% yttria-stabilized tetragonal zirconia polycrystal.
- 4Y-PSZ: partially stabilized zirconia with an increased cubic phase fraction.
- 5Y-PSZ: higher-translucency zirconia with a greater cubic phase fraction.

Increasing yttria content generally improves translucency but may reduce transformation-toughening capacity. Consequently, the most translucent zirconia formulations are not necessarily those with the highest fracture resistance.

Table 1. Classification and principal characteristics of ceramic materials used for veneers

Material	Microstructure	Main clinical advantage	Main limitation
Feldspathic porcelain	Glass-rich silica ceramic	Excellent optical integration	Relatively lower strength
Leucite-reinforced ceramic	Glass matrix with leucite crystals	Improved strength compared with feldspathic porcelain	Lower strength than zirconia
Lithium disilicate	Interlocking crystalline glass ceramic	Balance of strength and translucency	Requires material-specific etching
Zirconia	Polycrystalline zirconium dioxide	High mechanical strength	More complex adhesive conditioning

4. MECHANICAL PROPERTIES AND FRACTURE RESISTANCE

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Mechanical characteristics are important determinants of the behavior of ceramic veneers under functional loading. However, laboratory measurements must be interpreted carefully because the clinical performance of a thin bonded restoration is influenced by several additional variables.

4.1. Flexural Strength

Flexural strength describes the ability of a material to resist fracture under bending stress.

Zirconia generally exhibits higher flexural strength than conventional glass ceramics. Lithium disilicate provides an intermediate mechanical profile, while feldspathic porcelain has comparatively lower strength.

The following chart presents a qualitative comparison rather than standardized measured values.

Relative mechanical strength of veneer ceramics

Qualitative comparison only; not measured flexural-strength data. Actual values depend on material generation and manufacturer.

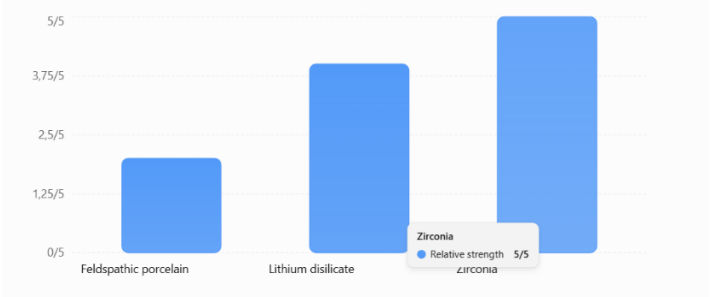


Figure 1. Qualitative comparison of relative mechanical strength. Zirconia is represented by blue, lithium disilicate by gold, and feldspathic porcelain by grey.

4.2. Fracture Toughness

Fracture toughness reflects the ability of a material to resist crack initiation and propagation.

Zirconia demonstrates high fracture toughness through transformation toughening. Under localized stress, tetragonal zirconia may transform into the monoclinic phase, producing volumetric expansion that opposes crack propagation.

Lithium disilicate also demonstrates favorable crack resistance due to its interlocking crystalline structure. Feldspathic porcelain has less resistance to crack propagation and may therefore be more vulnerable to fracture under unfavorable loading.

4.3. Influence of Restoration Thickness

The thickness of a veneer influences its mechanical behavior and optical properties. However, increasing thickness may require additional tooth reduction and compromise the minimally invasive nature of treatment.

The appropriate thickness depends on the material, restoration design, tooth substrate, degree of discoloration, and manufacturer's recommendations. Thin restorations should not be selected solely on the basis of nominal material strength without considering the adhesive interface and occlusal conditions.

4.4. Clinical Interpretation

Zirconia has a clear intrinsic mechanical advantage, but its high strength should not be regarded as a substitute for proper preparation and adhesive cementation. Lithium disilicate provides a favorable combination of strength and bonding predictability, while feldspathic porcelain remains appropriate in selected cases where optical integration and enamel preservation are the primary objectives.

5. ESTHETIC PROPERTIES AND OPTICAL PERFORMANCE

The esthetic performance of ceramic veneers is determined by the interaction between the restorative material, underlying tooth structure, ceramic thickness, resin cement, and surrounding soft tissues. In the anterior region, the ability to reproduce the optical characteristics of natural enamel is particularly important.

5.1. Translucency and Light Transmission

Translucency is one of the principal factors influencing the natural appearance of ceramic restorations. Feldspathic porcelain has traditionally been considered highly suitable for anterior veneers because of its excellent light transmission and capacity to reproduce enamel-like optical effects.

Lithium disilicate ceramics are available in different translucency and opacity levels. This allows the clinician to select a material according to the color of the underlying tooth and the desired esthetic outcome.

Zirconia has historically been more opaque than glass ceramics. However, advances in manufacturing and changes in yttria content have resulted in more translucent 4Y and 5Y zirconia formulations. Despite these developments, zirconia's optical behavior remains dependent on its crystalline composition, thickness, and surface characteristics [7,8,12].

Qualitative comparison of optical translucency

Illustrative clinical comparison, not measured translucency values. Actual optical performance varies by product, shade, thickness, and cement.

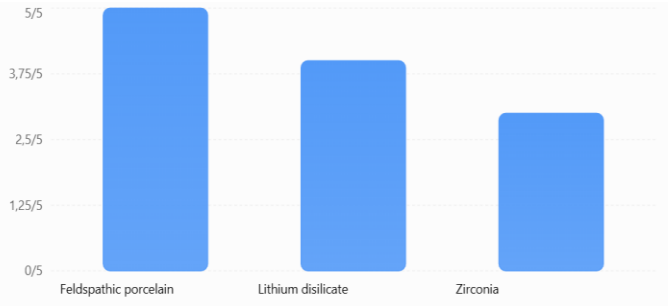


Figure 2. Qualitative comparison of translucency among feldspathic porcelain, lithium disilicate, and zirconia. Grey represents feldspathic porcelain, gold represents lithium disilicate, and blue represents zirconia.

5.2. Masking Ability

Masking ability is particularly important in patients with severely discolored teeth, previous endodontic treatment, or underlying restorative materials. Feldspathic porcelain generally provides high translucency but may be less effective in masking a dark substrate when used in very thin configurations. Lithium disilicate is available in different opacity levels and can provide a balance between masking and natural appearance. Zirconia may be advantageous in selected situations where increased masking is required. Nevertheless, the selection of a more opaque ceramic must be balanced against the risk of producing an artificial appearance, particularly in the anterior region.

5.3. Color Stability

Ceramic materials generally demonstrate favorable color stability. However, the final appearance of a veneer is not determined by the ceramic alone. Resin cement, marginal integrity, surface finishing, and oral hygiene also influence the long-term esthetic result.

Marginal discoloration may develop when the adhesive interface is compromised or when marginal defects permit plaque accumulation and staining. Appropriate cement selection, isolation, and finishing are therefore essential.

5.4. Esthetic Comparison

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Table 2. Comparative optical and esthetic properties

Parameter	Feldspathic porcelain	Lithium disilicate	Zirconia
Translucency	Very high	High to very high	Formulation-dependent
Enamel-like appearance	Excellent	Very good to excellent	Variable
Masking of dark substrate	Limited in thin restorations	Moderate to high, depending on opacity	Often favorable
Shade customization	Excellent	Excellent	Depends on system
Fluorescence and optical effects	Highly customizable	Good	Product-dependent
Anterior esthetic application	Established	Established	Selected indications

6. ADHESIVE BONDING AND CEMENTATION PROTOCOLS

Adhesive bonding is one of the most important determinants of ceramic veneer survival. The bonding mechanism differs substantially between silica-based glass ceramics and zirconia because of their different chemical compositions.

6.1. Adhesive Bonding of Silica-Based Ceramics

Feldspathic porcelain and lithium disilicate contain a silica-rich glass phase. This allows surface conditioning with hydrofluoric acid, followed by silane application. Hydrofluoric acid selectively dissolves part of the glass matrix and creates a micromechanically retentive surface. Silane then promotes chemical coupling between the ceramic surface and the resin-based luting material [9,10].

The general protocol includes:

1. Cleaning of the ceramic restoration.
2. Hydrofluoric acid etching according to the manufacturer's instructions.
3. Thorough rinsing and drying.
4. Application of a silane coupling agent.
5. Tooth surface conditioning.
6. Application of the appropriate adhesive system.
7. Resin cementation.
8. Controlled polymerization and removal of excess cement.

The concentration and duration of hydrofluoric acid application must be determined according to the specific ceramic and manufacturer's instructions. Hydrofluoric acid is hazardous and should be handled with appropriate protective measures.

6.2. Adhesive Bonding of Zirconia

Zirconia does not contain a silica-rich glass matrix. Therefore, conventional hydrofluoric acid etching does not produce the same micromechanical retention as it does in glass ceramics. Silane application alone is also insufficient for predictable zirconia bonding. Zirconia bonding commonly involves controlled airborne-particle abrasion when indicated, appropriate cleaning, and the use of phosphate-functional monomers, particularly 10-MDP [9–11].

The general protocol may include:

1. Evaluation of the internal restoration surface.
2. Controlled airborne-particle abrasion when recommended for the specific zirconia system.
3. Cleaning to remove contamination.
4. Application of a zirconia-compatible primer containing 10-MDP.
5. Tooth surface conditioning and adhesive application.
6. Resin cementation.
7. Controlled polymerization.

Excessive abrasion should be avoided because it may introduce surface defects or compromise the mechanical integrity of thin restorations. The manufacturer's recommendations should always take priority.

ZIRCONIA — BLUE

Controlled airborne-particle abrasion, when indicated

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Cleaning and contamination control

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10-MDP-containing primer

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Compatible resin cement

LITHIUM DISILICATE — GOLD

Hydrofluoric acid etching according to instructions

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↓

Rinsing and drying

↓

Silane application

↓

Compatible resin cement

FELDSPATHIC PORCELAIN — GREY

Hydrofluoric acid etching according to instructions

↓

Rinsing and drying

↓

Silane application

↓

Compatible resin cement



Figure 3. Schematic representation of the different surface-conditioning and adhesive cementation approaches. The precise protocol must be adapted to the material and manufacturer.

6.3. Importance of Enamel Preservation

The quality and quantity of remaining enamel are critical factors in veneer retention. Enamel provides a more predictable adhesive substrate than dentin, and extensive dentin exposure may reduce the reliability of the adhesive interface.

The preparation should therefore be planned to preserve enamel whenever possible. The clinician should evaluate the initial tooth position, planned restoration contour, required color change, and occlusal relationships before determining the amount of tooth reduction.

Table 3. Comparison of adhesive requirements

Adhesive parameter	Feldspathic porcelain	Lithium disilicate	Zirconia
Hydrofluoric acid etching	Yes, according to instructions	Yes, according to instructions	Not applicable as conventional glass-ceramic treatment
Silane	Yes	Yes	Not sufficient alone
Airborne-particle abrasion	Not routinely required	Not routinely required	May be indicated
10-MDP-containing primer	Not routinely essential	Not routinely essential	Important
Resin cement	Commonly indicated	Commonly indicated	Commonly indicated
Main bonding consideration	Micromechanical retention and silane coupling	Controlled etching and silane coupling	Surface conditioning and phosphate-monomer interaction

7. CLINICAL SURVIVAL AND LONG-TERM PERFORMANCE

Clinical survival is a central outcome in evaluating ceramic veneer materials. It refers to the proportion of restorations remaining in service over a defined observation period. It should be distinguished from clinical success, which generally implies the absence of complications or the need for repair.

A veneer may remain in service after a minor complication or intervention and still be classified as surviving. Therefore, survival rates should be interpreted together with complication rates and the criteria used in each clinical investigation.

7.1. Long-Term Evidence for Conventional Ceramic

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Veneers

Clinical studies and systematic reviews have demonstrated favorable survival of conventional ceramic laminate veneers. Morimoto and colleagues reported an estimated overall cumulative survival of approximately 89% after a median follow-up of about nine years, with differences between feldspathic and glass-ceramic restorations [13].

Alenezi and colleagues also reported favorable long-term survival for porcelain laminate veneers, with an estimated 10-year cumulative survival of approximately 95.5% in their systematic review [14]. The most frequently described complications included fracture and debonding.

Differences between reported survival estimates may be related to the materials investigated, clinical indications, tooth preparation, enamel preservation, adhesive protocols, and duration of follow-up.

7.2. Comparative Evidence for Zirconia and Glass Ceramics

The available evidence for zirconia laminate veneers is less extensive than that for feldspathic porcelain and lithium disilicate. Some clinical reports have demonstrated promising short-term performance, but the limited follow-up prevents reliable conclusions about long-term survival.

The comparative survival figures reported in the source manuscript were 96.13% for feldspathic porcelain, 93.70% for leucite-reinforced glass ceramics, and 96.81% for lithium disilicate at a mean follow-up of 10.4 years. Zirconia was reported to have 100% survival at 2.6 years.

These estimates must be interpreted cautiously. The observation period for zirconia is substantially shorter, and the materials cannot be considered directly comparable on the basis of these percentages alone.

Reported survival estimates for ceramic veneers

Values reproduced from the source manuscript. Follow-up differed: approximately 10.4 years for glass-ceramic groups and 2.6 years for zirconia. Not a direct long-term comparison.

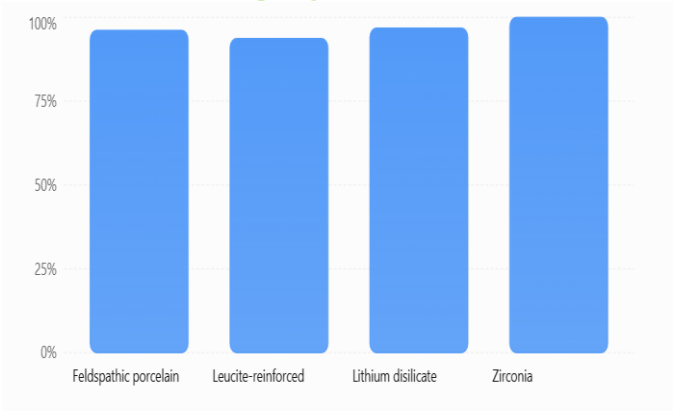


Figure 4. Reported survival estimates for different ceramic veneer materials. The shorter follow-up period for zirconia must be considered when interpreting the results.

Table 4. Reported clinical survival estimates

Ceramic material	Reported survival	Mean observation period
Feldspathic porcelain	96.13%	10.4 years
Leucite-reinforced glass ceramic	93.70%	10.4 years
Lithium disilicate	96.81%	10.4 years
Zirconia	100%	2.6 years

Note: These figures are reproduced from the comparative evidence described in the source manuscript. The exact primary publication and its study-level data should be checked against the original article before submission. The different follow-up periods preclude a direct conclusion of material superiority.

7.3. Interpretation of Clinical Survival

The available evidence supports the clinical use of conventional glass-ceramic veneers, particularly lithium disilicate, in appropriately selected anterior cases. Zirconia has demonstrated promising short-term outcomes, but longer prospective studies are required.

Future investigations should include standardized outcome definitions and report:

- Restoration survival and success.
- Fracture and chipping.
- Debonding and rebonding.
- Marginal adaptation and discoloration.
- Secondary caries.
- Periodontal response.
- Patient-reported esthetic satisfaction.
- Need for repair or replacement.

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8. CLINICAL COMPLICATIONS

Although ceramic veneers demonstrate favorable clinical outcomes, complications may occur. Their frequency and clinical significance depend on the material, preparation design, adhesive protocol, occlusal loading, and patient-related factors.

8.1. Fracture and Chipping

Fracture is one of the principal mechanical complications associated with ceramic veneers. It may result from excessive occlusal loading, insufficient restoration thickness, inadequate support, sharp internal preparation angles, parafunctional activity, or inappropriate material selection.

Feldspathic porcelain is more susceptible to fracture because of its relatively lower mechanical strength. Lithium disilicate provides improved resistance, while zirconia demonstrates high intrinsic fracture resistance.

Nevertheless, the clinical performance of zirconia veneers also depends on restoration design and bonding. High material strength cannot eliminate the risk of failure at the adhesive interface.

Qualitative comparison of fracture resistance

Illustrative relative ratings only; not clinical complication rates or standardized laboratory measurements.

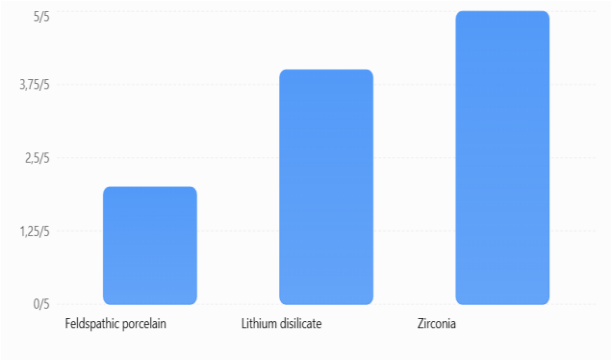


Figure 5. Qualitative comparison of relative fracture resistance. Grey represents feldspathic porcelain, gold represents lithium disilicate, and blue represents zirconia.

8.2. Debonding

Debonding refers to partial or complete loss of adhesion between the restoration and the tooth surface. It may be associated with inadequate enamel preservation, contamination during cementation, inappropriate surface conditioning, insufficient polymerization, or unfavorable occlusal loading. Zirconia requires particular attention because its adhesive protocol differs from conventional silica-based ceramics.

8.3. Marginal Discoloration and Marginal Defects

Marginal discoloration may develop as a result of resin cement degradation, marginal gaps, plaque accumulation, or inadequate finishing and polishing.

Accurate preparation, appropriate impression or digital scanning, precise laboratory fabrication, and controlled cementation are essential for minimizing marginal complications.

8.4. Biological Complications

Potential biological complications include postoperative sensitivity, pulpal irritation, secondary caries, gingival inflammation, and periodontal tissue changes.

The risk of biological complications may be reduced through conservative preparation, appropriate margin placement, preservation of tooth structure, and regular maintenance.

Table 5. Potential complications associated with ceramic veneers

Complication	Feldspathic porcelain	Lithium disilicate	Zirconia
Fracture	Recognized risk	Possible	Lower intrinsic material susceptibility, but still possible
Chipping	Possible	Possible	Depends on design and material
Debonding	Possible	Possible	Sensitive to bonding protocol
Marginal discoloration	Possible	Possible	Possible
Secondary caries	Possible	Possible	Possible
Postoperative sensitivity	Possible	Possible	Possible
Periodontal complications	Related to margin and contour	Related to margin and contour	Related to margin and contour

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9. CLINICAL INDICATIONS AND MATERIAL SELECTION

The selection of a veneer material should be based on the patient's clinical condition and treatment objectives. No single ceramic material is appropriate for all clinical situations.

9.1. Feldspathic Porcelain Veneers

Feldspathic porcelain may be considered in cases involving:

- Minor tooth discoloration.
- Small morphological corrections.
- Diastema closure in appropriately selected cases.
- Minor enamel defects.
- High esthetic requirements.
- Minimally invasive treatment with sufficient enamel support.

9.2. Lithium Disilicate Veneers

Lithium disilicate may be considered in cases involving:

- Moderate discoloration.
- Significant morphological correction.
- Anterior tooth rehabilitation.
- A need for a favorable balance between strength and translucency.
- Cases in which predictable adhesive cementation is achievable.

9.3. Zirconia Veneers

Translucent zirconia may be considered in selected situations involving:

- Increased mechanical demands.
- Specific substrate-masking requirements.
- Adequate preparation geometry and restoration support.
- A clinical setting in which a zirconia-specific bonding protocol can be reliably performed.

However, zirconia should not be automatically preferred over lithium disilicate in every anterior veneer case. Its optical properties, generation, thickness, bonding requirements, and limited long-term veneer-specific evidence must be considered.

9.4. Practical Clinical Decision-Making

Table 6. Clinical factors influencing material selection

Clinical situation	Material considerations
Very high esthetic demand with favorable enamel	Feldspathic porcelain or lithium disilicate
Moderate discoloration with need for strength	Lithium disilicate
More pronounced substrate discoloration	Appropriately selected opaque lithium disilicate or zirconia
Minimal preparation with adequate enamel	Feldspathic porcelain or thin lithium disilicate
High occlusal loading	Detailed occlusal assessment and individualized material selection
Limited enamel availability	Reconsider veneer indication and adhesive prognosis
Parafunctional activity	Risk management, occlusal assessment, and protective measures

10. CLINICAL CASE PRESENTATIONS

The following cases illustrate two different clinical situations in which ceramic veneers may be considered. They are presented as structured clinical examples for educational purposes. They must not be represented as actual treated patients unless the corresponding clinical records, photographs, treatment details, and patient consent are available.

10.1. Clinical Case 1: Esthetic Rehabilitation with Zirconia Veneers

Clinical presentation

A 32-year-old female patient presents with dissatisfaction regarding the appearance of the maxillary anterior teeth. The principal concerns are uneven tooth color, irregular incisal contours, and asymmetry in the proportions of the central and lateral incisors.

The patient requests an esthetic improvement while preserving as much healthy dental tissue as possible.

Clinical examination and diagnostic assessment

The examination should include evaluation of:

- Tooth color and distribution of discoloration.
- Enamel thickness and integrity.
- Existing restorations and previous dental treatment.
- Periodontal condition and gingival architecture.
- Occlusal contacts and anterior guidance.
- Parafunctional habits, including bruxism.
- Smile line and incisal display.

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- Facial and dental midlines.

Radiographic examination should be performed when clinically indicated.

Treatment planning

After clinical and esthetic evaluation, a diagnostic wax-up and intraoral mock-up are recommended. The restorative plan should establish the required tooth proportions, incisal edge position, and facial contour before preparation.

Translucent zirconia veneers may be considered if the clinical situation requires specific masking or mechanical characteristics and if an appropriate adhesive protocol can be implemented. The clinician must also establish whether sufficient enamel is available for predictable bonding.

Clinical procedure

The proposed clinical sequence includes:

1. Standardized preoperative photographs.
2. Digital smile analysis and diagnostic wax-up.
3. Intraoral mock-up and patient approval.
4. Conservative tooth preparation, if required.
5. Digital or conventional impression.
6. Laboratory or CAD/CAM fabrication of zirconia veneers.
7. Intraoral assessment of marginal adaptation, proximal contacts, contour, and shade.
8. Material-specific internal surface conditioning.
9. Tooth surface preparation and adhesive resin cementation.
10. Occlusal evaluation and postoperative instructions.



Figure 6. Zirconia veneer case: preoperative and postoperative documentation A. Before treatment B. After treatment

Figure 6. Illustrative appearance of maxillary anterior teeth before and after simulated zirconia veneer rehabilitation. These are illustrative images, not photographs of a documented patient.

Clinical considerations

Zirconia may provide a useful mechanical and masking option in selected anterior cases. However, the final esthetic result depends on the zirconia formulation, restoration thickness, underlying tooth color, cement shade, surface treatment, and laboratory characterization. A successful outcome cannot be attributed to material strength alone.

10.2. Clinical Case 2: Esthetic Rehabilitation with Lithium Disilicate Veneers

Clinical presentation

A 28-year-old female patient presents with spacing between the maxillary anterior teeth, irregular tooth morphology, and dissatisfaction with her smile. The principal esthetic concern is the presence of a central diastema and disproportionate lateral incisors.

The patient requests a conservative restorative approach.

Clinical examination and diagnostic assessment

The clinical assessment should include:

- Measurement and distribution of the diastema.
- Evaluation of tooth size and proportions.
- Examination of enamel integrity.
- Periodontal examination.
- Assessment of occlusal relationships.
- Evaluation of the smile line and gingival architecture.
- Assessment of whether orthodontic treatment would be preferable or necessary before restorative treatment.

The presence of a diastema should also prompt evaluation of its etiology, including tooth-size discrepancy, abnormal frenum attachment, missing teeth, and occlusal or positional factors.

Treatment planning

Lithium disilicate veneers may be considered when the planned morphological correction can be achieved conservatively and adequate enamel remains for bonding.

The diagnostic wax-up should establish the appropriate mesiodistal width, incisal edge position, emergence profile, and proximal contact relationships. If the diastema is substantial or associated with tooth malposition, orthodontic treatment may provide a more conservative solution.

Clinical procedure

The proposed treatment sequence includes:

1. Standardized preoperative photographs.

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2. Digital smile analysis.
3. Diagnostic wax-up and mock-up.
4. Evaluation of tooth proportions and proposed contours.
5. Minimally invasive preparation when indicated.
6. Digital or conventional impression.
7. Laboratory or CAD/CAM fabrication of lithium disilicate veneers.
8. Intraoral try-in and shade evaluation.
9. Hydrofluoric acid etching according to the manufacturer's instructions.
10. Rinsing, drying, silane application, and resin cementation.
11. Removal of excess cement, finishing, polishing, and occlusal evaluation.



Figure 7. Lithium disilicate veneer case: preoperative and postoperative documentation A. Before treatment B. After treatment

Figure 7. Illustrative appearance of maxillary anterior teeth before and after simulated lithium disilicate veneer rehabilitation. These images are illustrative and do not represent a verified clinical case.

Clinical considerations

Lithium disilicate provides a favorable combination of optical properties, mechanical strength, and adhesive bonding potential. Its use may be particularly appropriate when the treatment requires morphological correction and natural-looking optical integration. Nevertheless, the clinician should avoid using veneers to compensate for substantial tooth malposition when orthodontic treatment would be more biologically conservative.

10.3. Postoperative Follow-up and Evaluation

Clinical follow-up is necessary to evaluate the stability of the restorations and the condition of the surrounding periodontal tissues.

A proposed follow-up schedule includes:

- 2 weeks after cementation.
- 6 months.
- 12 months.
- 24 months.
- 36 months and annually thereafter, when possible.

The following parameters should be recorded:

1. Restoration integrity.
2. Marginal adaptation.
3. Fracture or chipping.
4. Debonding.
5. Marginal discoloration.
6. Postoperative sensitivity.
7. Gingival condition.
8. Occlusal stability.
9. Patient satisfaction.

For actual clinical case publication, standardized preoperative and postoperative photographs, documented treatment details, and written informed consent are required. Patient-identifying information must be removed.

11. DISCUSSION

The present review demonstrates that zirconia and conventional silica-based ceramic veneers have different mechanical, optical, and adhesive characteristics. Although all these materials are used in esthetic restorative dentistry, their clinical indications should not be considered interchangeable. Recent clinical reviews and systematic analyses emphasize that material selection should be based on the interaction between mechanical performance, optical properties, adhesive behavior, and the clinical characteristics of the treated tooth [1–3,12,18–20].

Feldspathic porcelain remains an important material for highly esthetic anterior restorations. Its glass-rich structure allows excellent optical integration and effective adhesive conditioning. In selected cases with adequate enamel support, feldspathic veneers can provide highly conservative treatment. Their principal limitation is their comparatively lower mechanical strength, which may increase the risk of fracture when the restoration is inadequately supported or exposed to unfavorable occlusal forces [1,2,9,12]. Recent clinical evidence continues to support the use of feldspathic veneers in appropriately selected cases, particularly when preservation of natural tooth structure and optical integration are primary treatment objectives [12,27,28].

Lithium disilicate represents a significant development in contemporary ceramic restorative dentistry. Its interlocking crystalline structure improves mechanical resistance while maintaining favorable optical characteristics. The possibility of hydrofluoric acid etching followed by silane application also provides an established adhesive approach. These properties explain why lithium disilicate is widely used for anterior veneers and other partial-coverage restorations [1,3,7,24,25]. Recent

investigations have further evaluated the influence of composition, crystallization, and processing techniques on the mechanical and optical behavior of lithium-based glass ceramics [20,21,26]. The clinical performance of lithium disilicate is also supported by long-term evidence and recent comparative analyses of ceramic laminate veneers [3,12,23,28].

Zirconia offers a different set of advantages. Its high flexural strength and fracture toughness make it mechanically attractive. Nevertheless, the clinical behavior of a thin zirconia veneer cannot be predicted from the material's flexural strength alone. The restoration is part of a complex system involving the ceramic, resin cement, tooth substrate, occlusal loading, and marginal design [3,7,9,18,19]. Recent reviews have emphasized that the properties of dental zirconia are strongly influenced by its yttria content, crystalline phase distribution, grain size, porosity, and manufacturing conditions[18,19]. Consequently, different zirconia generations should not be considered equivalent in terms of mechanical and optical performance.

One of the most important distinctions between zirconia and glass ceramics is their surface-conditioning mechanism. Glass ceramics can be etched with hydrofluoric acid and treated with silane. Zirconia requires a different approach because it lacks a silica-rich glass matrix. The use of 10-MDP-containing primers and appropriate surface preparation is therefore particularly important. Contamination, inadequate cleaning, excessive abrasion, and incorrect primer selection may compromise the adhesive interface [4,5,8,10,11,13,14,15,16]. Recent systematic reviews and network meta-analyses have demonstrated the importance of combining appropriate mechanical surface treatment with phosphate-functional monomers to improve resin bonding to zirconia [14,16,17]. In particular, 10-MDP-containing adhesive systems have demonstrated favorable bonding performance, although the results remain influenced by the selected surface treatment and artificial aging conditions [14,16,17].

The effect of contamination and cleaning procedures is another relevant consideration during clinical cementation. Saliva and other contaminants introduced during intraoral try-in may adversely affect the zirconia-resin interface. Recent evidence indicates that cleaning procedures should be selected according to the contamination type and the manufacturer's recommended bonding protocol. Airborne-particle abrasion and selected chemical cleaning agents have demonstrated more favorable results than simple water or alcohol cleaning in several experimental conditions [15,29]. These findings reinforce the importance of controlling contamination before application of the zirconia primer and resin cement.

Another important issue is the relationship between translucency and strength. Conventional 3Y zirconia has high mechanical strength but generally lower translucency than newer 4Y and 5Y formulations. Increasing the cubic phase fraction can improve optical properties, but it may reduce transformation-toughening capacity. Therefore, the most translucent zirconia is not necessarily the most mechanically resistant formulation [6,7,18,19,20]. Recent systematic reviews have confirmed that yttria content, phase composition, grain size, material thickness, and sintering conditions influence the translucency of zirconia [19,20]. The selection of a zirconia formulation should therefore be based on the balance between the required optical characteristics and the mechanical demands of the clinical situation.

Clinical survival data also require careful interpretation. Conventional glass-ceramic veneers have a more extensive long-term evidence base than zirconia veneers. Reported survival estimates for feldspathic porcelain and lithium disilicate are generally favorable, although results vary according to study design, follow-up period, clinical indications, and outcome definitions[1–3,12,23,28]. A recent systematic review and meta-analysis reported pooled long-term survival rates of 96.13% for feldspathic porcelain, 93.70% for leucite-reinforced glass ceramics, and 96.81% for lithium disilicate at a mean follow-up of approximately 10.4 years [3]. These findings support the reliability of conventional glass-ceramic laminate veneers, while also demonstrating the importance of considering complications in addition to survival.

The reported 100% survival estimate for zirconia at 2.6 years should not be interpreted as evidence of superiority over lithium disilicate or feldspathic porcelain evaluated over approximately 10 years. The available zirconia veneer evidence is based on a considerably shorter observation period and a limited number of restorations. Shorter observation periods may fail to capture late complications, including debonding, marginal deterioration, and fracture. Long-term prospective studies with standardized clinical criteria are therefore essential [3,12,28]. The recent consensus statement on ceramic partial-coverage restorations and laminate veneers similarly emphasizes the need for standardized clinical protocols and additional long-term evidence [28].

The clinical cases presented in this review illustrate two different treatment-planning situations. The zirconia example emphasizes the possible role of a high-strength ceramic in selected cases requiring masking or specific mechanical characteristics. The lithium disilicate example demonstrates the potential of a glass ceramic for morphological correction and esthetic rehabilitation.

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These examples are illustrative and should not be interpreted as comparative clinical outcome data.

The selection of material should ultimately be individualized. The clinician should consider the substrate color, enamel availability, tooth position, occlusal loading, parafunctional activity, required restoration thickness, and the possibility of achieving reliable adhesive cementation [1,2,4,5,12,27]. Recent clinical evidence also reinforces the importance of enamel preservation. A 2025 retrospective clinical study involving 672 ceramic veneers and follow-up periods of up to 15 years found that increased dentin exposure was associated with reduced veneer survival, supporting the importance of conservative preparation and reliable enamel bonding [27].

11.1. Clinical Implications

The findings of this review have several practical implications:

- Preservation of enamel should remain a central objective in veneer preparation, as the available adhesive substrate is an important factor in restoration retention and clinical performance [1,2,27].
- Lithium disilicate is a well-established option when both strength and translucency are required [1,3,12,24–26].
- Feldspathic porcelain remains useful for highly esthetic, minimally invasive cases with favorable substrate conditions [1,2,12].
- Zirconia may be considered in selected cases requiring specific mechanical or masking characteristics, although its clinical indications should be evaluated in relation to its optical and bonding properties [3,6,18–20].
- Material-specific surface treatment is essential for reliable bonding. In particular, zirconia requires an appropriate surface-conditioning protocol, including consideration of 10-MDP-containing primers 4,5,8,13–17.
- Contamination control and appropriate cleaning procedures are important steps before zirconia cementation [15,29].
- High intrinsic strength should not be regarded as a substitute for appropriate clinical planning and adhesive technique [4,5,10,11,14,16].
- Long-term zirconia veneer studies are required before definitive comparisons of survival can be established [3,12,28].

11.2. Limitations of the Review

This review has several limitations. First, it is a narrative evidence-based review rather than a completed systematic review with a registered protocol and fully documented screening process. Second, the available clinical evidence is heterogeneous with respect to ceramic composition, restoration thickness, preparation design, cementation technique, and follow-up duration [1–3,12]. Third, the long-term clinical evidence for zirconia veneers is more limited than that for conventional glass ceramics [3,12,28].

The comparative survival percentages should therefore be interpreted as reported estimates rather than direct evidence of material superiority. In particular, the available zirconia survival estimate is based on a shorter follow-up period and a limited number of restorations compared with the long-term evidence available for feldspathic porcelain and lithium disilicate[3]. Furthermore, the clinical case illustrations are educational scenarios and do not constitute original clinical outcome data.

12. FUTURE PERSPECTIVES

Future research should focus on prospective clinical studies evaluating zirconia laminate veneers over longer observation periods. Such investigations should include standardized definitions of survival and success, consistent reporting of complications, and objective assessment of esthetic outcomes. Direct comparisons with feldspathic porcelain and lithium disilicate should use comparable clinical indications, preparation designs, cementation protocols, and follow-up periods [3,12,28].

The development of highly translucent zirconia may expand its application in anterior restorations. However, improvements in translucency should be evaluated alongside fracture toughness, surface treatment, adhesive performance, and long-term stability. The balance between optical properties and mechanical behavior remains an important consideration in the selection of zirconia formulations for esthetic restorations [6,7,18–20].

Future investigations should also examine the relationship between zirconia composition, manufacturing technology, and long-term clinical performance. Advances in multilayered zirconia, high-speed sintering, and computer-aided manufacturing may provide opportunities to optimize both optical and mechanical characteristics. However, these developments require validation through standardized laboratory testing and prospective clinical studies [18–20].

Digital workflows may also improve the precision of veneer fabrication and clinical delivery. Intraoral scanning, computer-aided design, high-precision milling, and digital smile planning may contribute to improved restoration fit and treatment predictability. Future clinical investigations should assess whether these technologies translate into measurable improvements in marginal adaptation, clinical performance, and patient outcomes [7,18,19].

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Future studies should also compare patient-reported outcomes, including satisfaction with tooth color, shape, comfort, and overall smile appearance. These outcomes are particularly important because the success of esthetic treatment cannot be defined exclusively by mechanical survival. A comprehensive assessment should integrate biological, mechanical, optical, and patient-centered outcomes[12,28].

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Competing and Conflicting Interests

The authors declare that they have no competing or conflicting interests.

Ethical Approval

Not applicable.

Informed Consent

Written informed consent for publication of the clinical data and images relating to the illustrative case was obtained from the patient. The signed consent form is retained and archived by the authors and is available to the editorial office on request.

Data Availability

All data discussed in this review are contained within the cited published sources. No new dataset was generated or analysed for this article.

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