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A Comparison Of IPS E.Max And Zirconia Veneers: Aesthetic And Mechanical Properties

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Abstract:
Ceramic veneers represent a minimally invasive solution in contemporary aesthetic dentistry, whose success depends on correct indication, preservation of enamel, material selection, the adhesive protocol, and occlusal control. IPS e.max, a lithium disilicate glass-ceramic, offers good translucency, natural optical integration, and reliable adhesion through hydrofluoric acid etching, silanization, and cementation with an adhesive resin cement. Zirconia possesses higher flexural strength, greater fracture resistance, and superior masking of the substrate, but its use in veneers is limited by more demanding adhesion, reduced translucency, and the scarcity of long-term clinical data. The aim of this narrative review is to compare IPS e.max and zirconia veneers with respect to their aesthetic, mechanical, adhesive, and clinical properties. The available data support the use of IPS e.max as the first choice for the majority of anterior veneers—indications with high aesthetic demands, preserved enamel, and controlled occlusion—whereas zirconia should be regarded as a selective alternative in cases of pronounced discoloration or a need for greater mechanical reserve.
Keywords: *Adhesive cementation, ceramic veneers, IPS e.max, laminate veneers, lithium disilicate, zirconia.*

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I. Introduction

Over recent decades, aesthetic dentistry has evolved substantially toward minimally invasive, biomimetic, and adhesive restorative concepts. Ceramic veneers permit correction of color, form, size, proportions, surface morphology, and minor visual irregularities in tooth position, with relatively little removal of tooth structure—particularly when the preparation is confined to enamel. The success of treatment, however, depends not only on the choice of ceramic material but also on biological, mechanical, optical, and adhesive factors, as well as on correct indication and occlusal control [1–4].

Veneers are most often used in the anterior region, where aesthetic demands are high and restoration thickness is limited. Consequently, the material must provide natural translucency, color stability, sufficient mechanical resistance at reduced thickness, and reliable bonding to tooth structure. In clinical practice the materials most commonly considered are the glass-ceramics—particularly lithium disilicate glass-ceramic—and the high-strength polycrystalline ceramics, foremost among them yttria-stabilized zirconia [5–8].

IPS e.max is a commercial system based on lithium disilicate glass-ceramic. It is widely accepted for its combination of favorable optical properties, sufficient mechanical stability, and predictable adhesive cementation. Zirconia, by contrast, is a material with high flexural strength and fracture resistance, making it attractive in situations of greater functional loading or where superior substrate masking is required. In veneers, however, material selection must not rest on mechanical strength alone. Veneers are thin restorations in which adhesion, aesthetic integration, enamel preservation, ceramic thickness, and occlusal control carry decisive clinical importance [5,6,8–10].

The aim of this review is to compare IPS e.max and zirconia veneers with respect to their aesthetic and mechanical properties, with particular emphasis on clinical applicability and material selection in everyday dental practice.

II. Methodology

This work is conceived as a narrative review, with the aim of critically comparing IPS e.max and zirconia veneers with respect to their aesthetic, mechanical, adhesive, and clinical characteristics. Textbook sources in the fields of fixed prosthodontics, dental materials, and aesthetic dentistry were reviewed, along with scientific papers indexed in PubMed/MEDLINE. In addition, a manual search of the reference lists of relevant papers was performed, together with a review of available publications through Google Scholar.

The search targeted the following terms and their combinations: IPS e.max, lithium disilicate, zirconia, yttria-stabilized tetragonal zirconia (Y-TZP), ceramic veneers, laminate veneers, aesthetic properties, translucency, optical properties, flexural strength, fracture resistance, material behavior under cyclic loading, bond strength, MDP, adhesive resin cement, and clinical success. Papers available through June 2026 were included, with preference given to English-language publications. Priority was given to reviews, systematic reviews, clinical studies, in vitro investigations, and papers directly comparing lithium disilicate and zirconia with respect to optical, mechanical, and adhesive properties. Papers on crowns, fixed prosthetic reconstructions, and monolithic restorations were used only where their data were relevant to understanding the material properties and clinical behavior of veneers.

Because this is a narrative review, no formal meta-analysis was performed, nor was a systematic selection according to the PRISMA protocol undertaken. The data were analyzed critically, with a focus on clinical applicability, the strength of the evidence, and the limitations of the available literature.

Table 1 Summary of Key Studies Comparing IPS e.max and Zirconia Veneers

Ref.	Authors (Year)	Study Design	Material(s)	Main Findings	Clinical Relevance
5	Zarone et al., 2019	Narrative review	Lithium disilicate vs zirconia	Compared optical, mechanical and adhesive properties	Excellent overview for material selection
6	Willard & Chu, 2018	Review	IPS e.max	Excellent translucency and reliable adhesive bonding	Supports IPS e.max for anterior veneers
8	Denry & Kelly, 2008	Review	Zirconia	High fracture resistance; bonding challenges	Foundation paper on zirconia properties
9	Zhang & Lawn, 2018	Review	Modern zirconia	Improved translucency with reduced transformation toughening	Important for newer zirconia generations
13	Kim et al., 2020	In vitro	Highly translucent zirconia	Better esthetics but lower strength than conventional 3Y-TZP	Material selection guidance
14	Comba et al., 2022	In vitro	Lithium disilicate & zirconia	Substrate and cement shade significantly influence final color	Important for veneer shade selection
17	Kwon et al., 2018	Laboratory study	Zirconia vs lithium disilicate	Zirconia demonstrated higher flexural strength	Mechanical comparison
20	Araújo-Neto et al., 2023	Systematic review & meta-analysis	Glass ceramics	Hydrofluoric acid concentration affects bond strength	Adhesive protocol evidence
21	Özcan & Bernasconi, 2015	Systematic review	Zirconia	Air abrasion + MDP recommended for durable bonding	Clinical bonding protocol
23	Alqutaibi et al., 2025	Systematic review & meta-analysis	Ceramic veneers	Enamel bonding significantly improves survival	Supports conservative preparations
25	Beier et al., 2012	20-year clinical study	Porcelain veneers	82.9% survival after 20 years	Landmark long-term clinical evidence
26	Aslan et al., 2019	Retrospective clinical study	Lithium disilicate veneers	97.4% survival after 10 years	Strong evidence for IPS e.max
27	Klein et al., 2025	Systematic review & meta-analysis	Feldspathic, leucite, lithium disilicate, zirconia	Lithium disilicate demonstrated excellent long-term survival; zirconia showed promising short-term outcomes	Highest level of comparative evidence
28	Nguyen et al., 2025	Randomized clinical trial	Zirconia veneers	Favorable one-year clinical performance using MDP-containing adhesive system	Emerging clinical evidence

III. Material Composition And Microstructure

IPS e.max is a lithium disilicate glass-ceramic. Its microstructure consists of lithium disilicate crystals embedded in a glass matrix. This combination provides a favorable balance between aesthetics and mechanical resistance. The glass phase contributes to translucency and permits chemical treatment with hydrofluoric acid, while the crystalline phase increases strength and fracture resistance [5–7,11].

IPS e.max is available in several variants, including IPS e.max Press and IPS e.max CAD. IPS e.max Press is fabricated by a pressing technique, whereas IPS e.max CAD is used in digital CAD/CAM systems, in which the ceramic blocks are milled in a pre-crystallized state and subsequently subjected to final crystallization. The material is available in varying degrees of translucency and opacity, allowing an individualized selection according to substrate color, veneer thickness, and aesthetic objective [5,6].

The key clinical advantage of lithium disilicate is that it bonds well to tooth structure through hydrofluoric acid etching, silanization, and cementation with an adhesive resin cement. This is particularly important in veneers, since their thickness is small and their mechanical stability depends heavily on the tooth–cement–ceramic adhesive complex [5,6,11].

Zirconia is a polycrystalline ceramic based on zirconium dioxide (ZrO_2), most often stabilized with yttria (yttrium oxide, Y_2O_3). Unlike lithium disilicate, zirconia contains no glass phase. This confers high mechanical resistance but simultaneously limits the possibility of etching with hydrofluoric acid and makes adhesion dependent on a specific surface treatment and cementation protocol [5,8,11].

Conventional 3Y-TZP zirconia exhibits high flexural strength and a pronounced transformation-toughening mechanism, in which the tetragonal phase can locally transform to the monoclinic phase and thereby arrest crack propagation. Classic 3Y-TZP zirconia, however, is relatively opaque. Owing to the need for improved aesthetics, newer generations with increased translucency—such as 4Y and 5Y zirconia—have been developed. These materials contain a greater proportion of cubic phase, which improves light transmission but may reduce flexural strength and the effect of the transformation-toughening mechanism [8–10].

This trade-off between translucency and mechanical stability is especially relevant in veneers. Increased translucency of zirconia improves its applicability in the aesthetic zone but is generally associated with a reduction in part of the mechanical reserve characteristic of classic 3Y-TZP zirconia. Therefore, in zirconia veneers, the selection of the specific material type, restoration thickness, and adhesive system carries decisive clinical importance [5,8–10].

IV. Aesthetic Properties

The aesthetic success of veneers depends on multiple factors: the translucency of the material, ceramic thickness, tooth substrate color, choice of adhesive resin cement, surface texture, fluorescence, opalescence, and the material's capacity to integrate optically with the adjacent natural teeth [1,4,6,11,12].

Translucency and Optical Integration

IPS e.max exhibits favorable translucency and optical behavior close to that of natural enamel, making it particularly suitable for veneers in the anterior region, where natural light dynamics are required. The material permits a choice of varying degrees of translucency and opacity, allowing adaptation to the specific clinical situation, substrate color, and planned restoration thickness [5–7,11,12].

In patients with minimal to moderate changes in tooth color, high-translucency lithium disilicate can provide excellent integration with the natural tooth structure. In patients with a darker substrate, a less translucent or more opaque variant may be selected—with care not to compromise the natural appearance of the restoration. The choice of translucency in IPS e.max should therefore be tied to substrate color, veneer thickness, and the planned cement shade [6,11,12].

Zirconia traditionally exhibits a lower degree of translucency, particularly classic 3Y-TZP zirconia. Newer translucent zirconia materials show improved aesthetics owing to their altered microstructure and greater proportion of cubic phase, yet in many clinical situations they still do not attain the translucency of lithium disilicate. In veneers this is clinically significant, since the restorations are thin, placed in a highly visible aesthetic zone, and small optical differences can readily be perceived [8–10,12,13].

Masking Ability

Masking ability is important in discolored teeth, tetracycline staining, non-vital teeth, aged composite restorations, or metallic discolorations. In such cases, an overly translucent material may allow the substrate color to influence the final shade of the restoration. The masking effect must therefore be analyzed as the result of the interaction between the translucency and thickness of the ceramic, the substrate color, and the color and translucency of the adhesive resin cement [12–15].

Zirconia offers an advantage in masking a darker substrate, particularly when less translucent variants are used. This can be useful in markedly discolored teeth or in situations where the substrate significantly compromises the final aesthetic result. Increased opacity, however, may yield a restoration with less natural light dynamics. Zirconia should therefore not be selected automatically solely for its masking ability; it is necessary to assess whether the aesthetic trade-off is clinically acceptable [13,14].

IPS e.max has highly favorable aesthetic properties, but its masking ability depends on the selected degree of translucency, opacity, and restoration thickness. In heavily discolored teeth, a greater thickness may be required, or the selection of a lithium disilicate ceramic with low translucency and high opacity—possibly combined with a more opaque adhesive resin cement. Increasing thickness, however, may diminish the minimally invasive nature of the veneer, while excessive opacity may compromise natural optical integration [14,15].

Influence of Thickness and Cement

The final shade of a veneer is not a property of the ceramic alone. It is the result of a complex interaction among the substrate color, ceramic thickness, degree of translucency, the color and opacity of the adhesive resin cement, and the surface finish of the restoration. This is especially important in thin veneers, since reduced thickness permits a greater influence of the substrate and cement on the final aesthetic result [12,14–16].

In lithium disilicate, owing to its relatively high translucency, the choice of cement can significantly affect the final shade of the restoration. This is a clinical advantage when the cement shade is used for fine color correction, but also a risk if the cement color is chosen incorrectly and does not simulate the true final shade after polymerization [14–16].

In zirconia, particularly in less translucent variants, the influence of the cement on the final shade is generally smaller than in high-translucency glass-ceramics. This enhances masking of a darker substrate but reduces the potential for subtle aesthetic modification through the cement. Nevertheless, in modern ultra-translucent zirconias and in thin restorations, the choice of adhesive resin cement can have a clinically perceptible effect and should therefore not be disregarded when planning the final shade [13,14,16].

V. Mechanical Properties

The mechanical properties of ceramic veneers are determined by flexural strength, fracture resistance, fatigue resistance, restoration thickness, the quality of the internal surface, adhesion, preparation design, and occlusal forces. The clinical behavior of a veneer should therefore not be assessed solely through the laboratory values of the material, but as part of a restorative complex comprising ceramic, adhesive resin cement, and tooth structure [5,11,17,19].

Fatigue Resistance and Fracture Resistance

Zirconia exhibits a considerably higher degree of fatigue resistance than lithium disilicate, particularly in the classic and less translucent variants. This makes it suitable for highly loaded restorations, bridges, posterior crowns, and situations with a greater risk of fracture. In veneers, however, fatigue resistance is not the sole clinically relevant parameter. The veneer functions as part of an adhesive complex with enamel and cement; when a lithium disilicate veneer is properly bonded to enamel, load distribution is more favorable and the clinical resistance of the restoration increases [5,6,11,17,19].

Lithium disilicate has lower fatigue resistance than zirconia, but its mechanical resistance is sufficient for a large number of anterior veneer indications—particularly when the patient has no marked parafunctional habits, when the preparation is predominantly in enamel, and when occlusion is properly controlled. In veneers, therefore, material selection should be based on a balance among mechanical resistance, adhesion, aesthetic integration, and preservation of tooth structure [4–6,17,19].

Veneer Thickness

In veneers, thickness is a critical factor. Excessively thin restorations may be prone to fracture, particularly in the presence of uneven thickness, sharp internal angles, insufficient support from tooth structure, or unfavorable occlusal contacts [11,18,19].

Lithium disilicate can be used in relatively thin veneers, particularly when adhesively bonded to enamel. The minimum thickness, however, must be reconciled with the manufacturer's recommendations, the clinical indication, substrate color, the aesthetic objective, and the expected occlusal function. A reduction in thickness should not be a purely mechanical decision but a compromise among minimal invasiveness, optics, masking ability, and fracture resistance [5,6,11,15,19].

In zirconia, a reduction in thickness may diminish fracture resistance. Furthermore, in translucent zirconia with a higher percentage of yttrium oxide, mechanical stability may be lower than in classic 3Y-TZP zirconia, owing to the reduced transformation-toughening effect. The use of very thin zirconia veneers should therefore be planned carefully, particularly in patients with high functional loading or parafunctional habits [8–10,17,18].

Fatigue Behavior Under Cyclic Loading

In the oral cavity, restorations are not exposed to a single static load but to repetitive cyclic forces, thermal changes, a moist environment, and mechanical wear. Fatigue resistance and behavior under prolonged cyclic loading are therefore more important than isolated laboratory values of flexural strength [19].

Zirconia demonstrates high fracture resistance, but its long-term behavior may be influenced by the type of zirconia, surface treatment, processing, sandblasting, and the duration and thickness of the restoration. Lithium disilicate is a more brittle material than zirconia, but when adhesively integrated with enamel, forces are distributed more favorably within the restorative complex. In veneers, therefore, clinical predictability depends on the combination of material, thickness, adhesion, preparation, and occlusion—not on the nominal strength of the ceramic alone [17–19].

VI. Adhesion And Cementation

Adhesive cementation is one of the most important factors for the success of ceramic veneers. In this domain a fundamental difference exists between IPS e.max and zirconia.

Adhesion to IPS e.max

Lithium disilicate is a silica-based glass-ceramic and can be treated with hydrofluoric acid. Etching creates a microretentive surface, and the silane provides a chemical bond between the silicate ceramic and the adhesive resin cement. Owing to the presence of a glass phase, this protocol is well documented and has proven clinical efficacy in lithium disilicate restorations [11,20]. The typical protocol involves etching the internal surface of the veneer with hydrofluoric acid according to the manufacturer's recommendations, thorough rinsing and drying, application of silane, and subsequent cementation with an appropriate adhesive resin cement. On the tooth side, the best results are achieved when the preparation is predominantly in enamel, since enamel provides more stable and more durable adhesion than dentin [23,24].

Adhesion to Zirconia

Zirconia contains no glass phase and does not respond to hydrofluoric acid etching in the same manner as glass-ceramics. Consequently, the classic hydrofluoric acid + silane protocol is not sufficient as a standalone method for stable bonding to zirconia. Most commonly recommended is mechanical surface treatment by airborne-particle abrasion—that is, sandblasting with aluminum oxide—in combination with a 10-MDP-containing primer or a 10-MDP-containing adhesive resin cement [8,21,22].

The 10-MDP monomer can chemically bond to the metal oxides on the zirconia surface, improving bonding to the adhesive resin cement. Nevertheless, adhesive bonding of zirconia remains more protocol-sensitive than that of lithium disilicate, particularly owing to the risk of surface contamination, improper sandblasting, excessive damage to the ceramic, and variations among different primers and adhesive resin cements. In veneers, where the restoration is thin and retention depends almost entirely on adhesion, this represents a significant clinical limitation [21,22].

Clinical Significance of Enamel

Regardless of the material, preservation of enamel is a key factor for the long-term success of veneers. If the preparation extends significantly into dentin, the risk of debonding, marginal discoloration, post-treatment sensitivity, and clinical failure increases. This is especially important in minimally invasive aesthetic restorations, where the goal is not merely to achieve a good initial appearance but also to secure a stable long-term adhesive result [23,24].

In planning veneers, therefore, the preparation design should be directed toward maximal preservation of enamel. When significant dentin exposure exists, the risk should be carefully assessed, an appropriate cementation plan selected, and—if necessary—an alternative restorative design considered instead of a conventional veneer [23,24].

VII. Clinical Performance And Longevity

The long-term clinical data for ceramic veneers most strongly support the use of porcelain and glass-ceramic veneers, including lithium disilicate. Clinical studies demonstrate greater longevity when veneers are correctly indicated, fabricated, and adhesively cemented. The most common causes of failure are ceramic fracture, debonding, marginal discoloration, secondary caries, aesthetic complications, and complications associated with unfavorable occlusion or parafunctional habits [4,25–27].

In a long-term clinical study of porcelain laminate veneers, Beier et al. reported an estimated survival rate of 94.4% at 5 years, 93.5% at 10 years, and 82.93% at 20 years. The principal causes of failure were ceramic fracture, non-vital teeth, and the presence of parafunctional habits, particularly bruxism [25]. These data confirm the clinical predictability of ceramic veneers while simultaneously underscoring the importance of correct indication, enamel preservation, and occlusal control.

IPS e.max, as a lithium disilicate glass-ceramic, has strong clinical documentation and is a widely used material for anterior veneers. In a 10-year retrospective analysis of lithium disilicate laminate veneers, Aslan et al. reported a survival rate of 97.4%, with a low complication rate that included fracture and debonding [26]. A more recent systematic review and meta-analysis of ceramic laminate veneers further demonstrated greater longevity for lithium disilicate veneers, at 96.81% over 10.4 years [27]. These results support the use of lithium disilicate as one of the best materials for aesthetic veneers.

Although zirconia veneers show promising clinical potential, the available data on their long-term clinical success remain limited. In the same meta-analysis, zirconia veneers demonstrated 100% success over a short-term follow-up period of 2.6 years, but without available long-term data [27]. A more recent one-year randomized, double-blind clinical trial showed that zirconia veneers treated with a specialized acid protocol and cemented with an MDP-containing polymeric adhesive system can achieve high short-term clinical results comparable to those of lithium disilicate veneers [28]. However, owing to the short follow-up period and the limited number of clinical studies, zirconia should be regarded as a promising material but still a selective alternative—not a routine replacement for lithium disilicate in anterior veneers.

VIII. Clinical Indications, Limitations, And Material Selection

The choice between IPS e.max and zirconia veneers should be individualized and based on aesthetic demands, substrate color, the amount of preserved enamel, the required restoration thickness, occlusal conditions, parafunctional habits, and the feasibility of predictable adhesive cementation [1,4–6,20–24].

IPS e.max is the most suitable choice in patients with high aesthetic demands, mildly or moderately altered substrate color, sufficient enamel for adhesive bonding, and a need for natural translucency. It is particularly suited to correction of form, size, small diastemas, moderate discolorations, abrasion, erosion, and aesthetic rehabilitation of the anterior region. Its principal limitations are lower mechanical strength compared with zirconia, the need for careful thickness control, and an increased risk of fracture or debonding in cases of bruxism, unfavorable occlusion, or insufficient enamel [5,6,17,19,23–27].

Zirconia may be considered a selective alternative in patients with a darker substrate requiring masking, greater mechanical demands, limited space, or an increased risk of fracture. In anterior veneers, however, it should not be used routinely simply for its high flexural strength. Its principal limitations are more demanding adhesion compared with glass-ceramics, reduced translucency relative to lithium disilicate, and limited long-term clinical documentation for zirconia veneers [8–10,13,17,18,21,22,27,28].

IPS e.max therefore remains the first choice for the majority of aesthetic anterior veneers—cases with preserved enamel and controlled occlusion. Zirconia should be used selectively, when the clinical situation demands greater substrate masking or mechanical reserve, and only when an appropriate protocol for adhesive bonding to zirconia can be secured [21–24,27,28].

IX. Discussion

The comparison between IPS e.max and zirconia veneers demonstrates that material selection should not rest on a single isolated parameter, such as flexural strength. In thin anterior veneers, clinical success depends on the interaction among optical properties, restoration thickness, substrate color, adhesion quality, enamel preservation, and occlusal loading [1,4–6,19,23,24].

Lithium disilicate—that is, IPS e.max—offers the best balance among aesthetics, adhesive predictability, and clinical documentation. Its glass-ceramic structure permits hydrofluoric acid etching, silanization, and stable bonding with an adhesive resin cement, which is particularly important in veneers, where retention depends largely on adhesion. Furthermore, its translucency and the ability to select varying degrees of opacity allow natural integration with the adjacent teeth and adaptation to diverse clinical situations [5,6,12,14–16,20].

Zirconia offers a clear mechanical advantage, but in veneers this advantage does not always translate into a better clinical outcome. Owing to the absence of a glass phase, zirconia requires specific protocols involving sandblasting and 10-MDP-based primers or adhesive resin cements. In addition, newer translucent zirconia materials improve aesthetics, but this is generally associated with a reduction in part of the mechanical reserve characteristic of classic 3Y-TZP zirconia [8–10,17,18,21,22].

The clinical data support this interpretation. Long-term studies and systematic reviews demonstrate greater longevity for porcelain and lithium disilicate laminate veneers, particularly when the restorations are bonded to enamel and occlusion is controlled [4,25–27]. For zirconia veneers there are promising short-term results, but long-term documentation remains limited [27,28]. Zirconia should therefore be regarded as a selective alternative, not a routine replacement for lithium disilicate in aesthetic anterior veneers.

X. Conclusion

IPS e.max and zirconia are contemporary ceramic materials with distinct clinical advantages and limitations. IPS e.max, as a lithium disilicate glass-ceramic, provides excellent aesthetic properties, predictable adhesion, and strong clinical documentation for veneers. Zirconia offers superior mechanical strength and greater substrate masking ability, but its use in veneers is limited by more demanding adhesion, lower translucency compared with glass-ceramics, and the scarcity of long-term clinical data.

For the majority of anterior veneers—indications with high aesthetic demands, preserved enamel, and controlled occlusion—IPS e.max should be considered the first choice. Zirconia should be regarded as a selective alternative in cases of pronounced discoloration, a need for greater color masking, or enhanced mechanical properties. The contemporary selection of a veneer material should be based not on mechanical strength alone, but on the balance among aesthetics, adhesion, biological preservation, and long-term clinical predictability.

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