ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)
IJDSIR : Dental Publication Service
Available Online at:www.ijdsir.com
Volume – 8, Issue – 6, November – 2025, Page No. : 188 - 193

Translucency, Strength, and Esthetics: Clinical Guidelines for Zirconia

[1]Dr. Atluri Suswara, Post Graduate Student, Department of Prosthodontics & Crown and Bridge & Implantology, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Science

[2]Dr. Atluri Kaleswara Rao, MDS, Professor, Department of Prosthodontics & Crown and Bridge & Implantology, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences

[3]Dr. Sunil Chandra Tripuraneni, MDS, Professor and HOD, Department of Prosthodontics & Crown and Bridge & Implantology, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences

[4]Dr. Sri Harsha Babu Vadapalli, MDS, Reader, Department of Prosthodontics & Crown and Bridge & Implantology, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences

Corresponding Author: Dr. Atluri Suswara, Post Graduate Student, Department of Prosthodontics & Crown and Bridge & Implantology, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Science

Citation of this Article: Dr. Atluri Suswara, Dr. Atluri Kaleswara Rao, Dr. Sunil Chandra Tripuraneni, Dr. Sri Harsha Babu Vadapalli, "Translucency, Strength, and Esthetics: Clinical Guidelines for Zirconia", IJDSIR- November – 2025, Volume – 8, Issue – 6, P. No. 188 – 193.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

All-ceramic systems have gained widespread acceptance in restorative dentistry due to their ability to replicate natural tooth structure while providing satisfactory mechanical performance. The choice of material depends on achieving an appropriate balance between aesthetics, strength, and clinical situation. Commonly used ceramics include feldspathic porcelain, leucite-reinforced glass ceramics, lithium disilicate, and zirconia, each with unique advantages in terms of strength and optical behaviour. Feldspathic porcelain offers excellent aesthetics but low strength, limiting its application to thin restorations, such as veneers. Leucite-reinforced ceramics, lithium disilicate, and zirconia expand clinical possibilities with varying balances of translucency and strength. This review discusses material properties, translucency categories, bonding approaches, and case-based guidelines, particularly for zirconia, while highlighting patient-specific considerations in ceramic selection.

Keywords: All-ceramic, Aesthetics, Lithium disilicate, Translucency, Zirconia

Introduction

All-ceramic restorative systems have become integral to modern prosthodontics, offering restorations that reproduce the optical qualities of natural teeth while providing adequate mechanical performance. Their selection is dictated by a careful balance between

esthetics, strength, and clinical factors. Feldspathic porcelain, leucite-reinforced ceramics, lithium disilicate, and zirconia are the most widely used, each offering specific advantages and limitations in restorative. [1,2,3]

Review of All Ceramic Materials

A. Felspathic Porcelain

Feldspathic porcelain is the benchmark for enamel-like aesthetics, offering unmatched translucency. Its limited flexural strength, however, confines its use to thin restorations such as veneers in non-load-bearing areas. [3]

B. Leucite-Reinforced Ceramics

Leucite-containing ceramics, such as the Empress system, provide improved strength compared to feldspathic porcelain while preserving translucency. With a flexural strength of 120–150 MPa, they are suitable for veneers, inlays, onlays, and conservative anterior crowns, but not for posterior bridges.[3]

C. Lithium Disilicate

Lithium disilicate, commercially known as IPS e.max, offers an ideal combination of aesthetics and strength (300–500 MPa). Available in pressable ingots and CAD/CAM blocks, it is used for inlays, onlays, veneers, anterior/posterior crowns, and partial crowns, but not recommended for long-span bridges. CAD blocks are supplied in a partially crystallised lithium metasilicate phase (bluish, easy to mill), which transforms into fully crystallised lithium disilicate after firing, improving strength and optical integration. Lithium disilicate blocks are produced in high translucency (HT), medium translucency (MT), low translucency (LT), and medium opacity (MO) categories for tailored aesthetic and functional needs. [3]

D. Zirconia

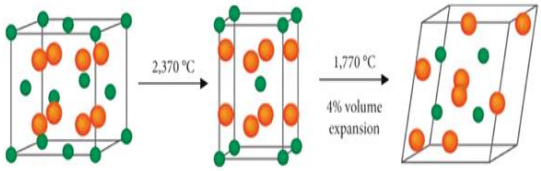
Zirconia has revolutionised ceramic dentistry with its flexural strength of 600–1200 MPa, making it indispensable for crowns, frameworks, and multiunit bridges. Conventional 3Y-TZP zirconia offers maximum strength but limited aesthetics. Newer grades—4Y-TZP and 5Y-TZP—provide enhanced translucency but reduced strength (~650 MPa in 5Y-TZP). Gradient zirconias combine zones of opacity and translucency, expanding clinical indications by bridging strength and aesthetics. [4]

Phases of Zirconia

Pure zirconia is a polymorphic ceramic, i.e., depending on temperature and pressure

It exists in 3 crystallographic structures

1. Monoclinic – At room temperature (weaker phase).
2. Tetragonal
3. Cubic



Pure zirconia is in the weaker monoclinic phase at normal temperature. The material changes into the tetragonal phase when heated. It enters the cubic phase with further heat. But unless stabilisers are introduced, the material will revert to its previous phases as it cools. Depending on their kind and quantity, these stabilisers can maintain the tetragonal or cubic phase stable at room temperature.

These stabilised phases provide distinct visual qualities and are more mechanically sound. Although stabilised tetragonal zirconia is more resilient, its translucency is reduced. This is due to its birefringent structure, which has many refractive indices that scatter and reflect light, hence decreasing translucency.

In contrast, stabilised cubic zirconia has a symmetric structure that improves translucency by facilitating light passage. Unfortunately, mechanical characteristics start to deteriorate because of this visual enhancement.

Stabilised Zirconia: Zirconia requires additives to stabilise and strengthen the material and improve its mechanical, aesthetic and optical properties. Yttria, a metal oxide, is included in the dental zirconia formulations to stabilise zirconium's cubic and tetragonal phases. When incorporated into the lattice, yttria changes the zirconia crystal structure to provide it with strength and optical characteristics.

Nevertheless, there is a difference in the quantity of yttria supplied.

Small additions of yttria (mol.% yttria) to zirconia are denoted by a number and the letter "Y."

At the time of its introduction, nearly all zirconia was tetragonal, 3Y, and relatively strong (<1000 MPa), but it had little transparency. (Alumina was added to some formulations to aid in stability and sintering, but it was later removed in later iterations.

The yttria concentration rose to 5Y (5 mol.% yttria) in subsequent material generations, which resulted in more cubic phase polycrystals and greater translucency but decreased strength.

Recent developments have produced 4Y (4 mol.% yttria) formulations, which offer an

Excellent compromise between high strength and translucency; in fact, 4Y may be referred to as a "universal" or "high translucent" zirconia.[5]

Classification of Zirconia

- **By stabilizer content (yttria concentration):**

3Y-TZP (3 mol% yttria): Conventional, strong but opaque.

4Y-TZP (4 mol% yttria): Balanced translucency and strength (“universal zirconia”).

5Y-TZP (5 mol% yttria): High translucency, lower strength, ideal for esthetic anterior restorations.

Hybrid/multi-layer zirconia: Combines different Y-TZPs (3Y, 4Y, 5Y) in one block for gradient effect

- **By Translucency:**

Extra translucent zirconia: ~750 MPa, 49% translucency. For anterior crowns, veneers.

High translucent zirconia: 800–1250 MPa, 41–49% translucency. For crowns, bridges, and veneers.

Medium translucent zirconia: 600–800 MPa, moderate translucency. For single crowns and short-span bridges.

Low translucent zirconia: Up to 1400 MPa, 35% translucency. Best for posterior/high stress areas.

Medium opacity zirconia: ~1150–1280 MPa, masks discoloured teeth/abutments.

Multi-translucency zirconia: Gradient esthetics, ~850 MPa. Mimics dentin–enamel transition.

Monolithic zirconia: Strongest (1150–1500 MPa), for bruxism cases and long-span bridges

Properties of zirconia

Mechanical

a. Flexural strength: 600–1500 MPa (depending on type).
b. Fracture toughness: 6–10 MPa·m½ (due to transformation toughening).
c. High compressive resistance (~2000 MPa).

Optical

d. Increasing yttria → more cubic phase → higher translucency but lower strength.
e. Opacity is useful for masking dark stumps/metal posts.

Biological

a. Biocompatible, chemically inert, with less bacterial adhesion than titanium.

Other

b. High radiopacity, helping in follow-up radiographs [6,7,8]

E. Glass Ceramics (Fluorapatite and Nano-Fluorapatite)

Fluorapatite and nano-fluorapatite ceramics, with

strengths of about 90 MPa, are used primarily as veneering ceramics over lithium disilicate or zirconia. They reproduce natural optical phenomena like opalescence and fluorescence, enhancing aesthetics but lacking load-bearing strength

Translucency and Clinical Application

Translucency is a critical factor in ceramic selection, determining how well a restoration integrates with natural dentition. Lithium disilicate is available in HT, MT, LT, and MO translucency categories, each serving specific roles. HT resembles enamel and is ideal for inlays, onlays, and veneers; MT provides brightness for anterior crowns; LT mimics dentin and is used for posterior crowns; MO provides masking for discoloured teeth or cores. Impulse blocks offer additional aesthetic effects in highly demanding veneer cases.

Zirconia translucency has improved with 4Y-TZP and 5Y-TZP formulations, which contain higher cubic phase content. While translucency improves, strength decreases compared to 3Y-TZP. Gradient zirconia combines cervical opacity for masking with incisal translucency for natural blending, making them highly versatile.[9,10,11,12,13,14,15,16,17,18,19,20]

Processing and Bonding

Ceramic restorations can be fabricated using pressable or CAD/CAM methods. Pressable ceramics provide excellent marginal adaptation and aesthetics, while CAD/CAM workflows allow efficient fabrication from partially crystallised or pre-sintered blocks, later fired for final properties.

Bonding depends on the ceramic type. Glass-based ceramics (feldspathic, leucite, lithium disilicate) bond predictably after hydrofluoric acid etching, silane treatment, and resin cementation. Zirconia, being polycrystalline and non-silica-based, requires airborne-particle abrasion and functional primers containing MDP monomers. Adhesive bonding with resin cements improves retention and durability, although conventional cementation is sometimes used in cases with sufficient mechanical retention.

Clinical Guidelines for Zirconia

For single anterior crowns, extra-translucent zirconia with 1–1.2 mm reduction and resin cement containing MDP is recommended. Veneers of 0.5–0.7 mm thickness can be fabricated from extra-translucent zirconia, provided adhesive bonding is used. Diastema closure may employ multilayer zirconia with incisal layering. Medium-opacity zirconia is suitable for discoloured teeth, while gradient zirconia is indicated in high smile line cases. Peg laterals are ideally restored with extra-translucent zirconia veneers.

Posterior crowns favour medium-translucent zirconia with 1–1.5 mm occlusal reduction and conventional cementation. Bruxism and edge-to-edge occlusion require high-strength, low-translucent zirconia, ideally with protective splints. Short-span FPDs are possible with medium-translucent zirconia connectors of at least 3×3 mm, whereas long-span bridges need low-translucent zirconia. Cantilever restorations, such as lateral incisors, are best fabricated from monolithic zirconia. Full-arch frameworks in heavy-load patients benefit from monolithic zirconia.

In implant prosthodontics, anterior aesthetic crowns may use extra-translucent zirconia, while posterior crowns favour monolithic zirconia, preferably screw-retained. Full-arch prostheses such as All-on-4 commonly use monolithic zirconia frameworks veneered with pink porcelain. Zirconia abutments may be used for aesthetic zones, while medium-opacity zirconia effectively masks titanium abutments.

Patient Specific Considerations

Pediatric patients with molar-incisor hypomineralization may be treated with prefabricated zirconia crowns. Geriatric patients benefit from monolithic zirconia cemented with glass ionomer for low maintenance. Patients with xerostomia or high caries risk require smooth zirconia surfaces and glass ionomer cement. Metal-sensitive patients favour zirconia for its biocompatibility. Periodontal patients require lightweight zirconia crowns, while diabetics benefit from polished zirconia with supragingival margins. GERD patients require acid-resistant monolithic zirconia, while smokers benefit from stain-resistant, highly polished zirconia. Special-needs patients can be managed with prefabricated zirconia crowns requiring minimal adjustment.

Conclusion

All-ceramic materials provide clinicians with a spectrum of options tailored to aesthetic, functional, and clinical demands. Feldspathic ceramics remain unmatched in aesthetics, while leucite and lithium disilicate broaden applications with greater strength. Zirconia continues to dominate high-strength applications, with newer high-translucency and gradient forms bridging the gap between function and appearance. Careful material selection based on translucency, strength, site of restoration, and patient factors ensures long-term success.

References

1. Babu PJ, Alla RK, Alluri VR, Datla SR, Konakanchi A. ental ceramics: Part I – An overview of composition, structure and properties. Am J Mater Eng Technol. 2015;3(1):13–8.
2. Anusavice KJ, Shen C, Rawls HR. Phillips' Science of Dental Materials. 1st South Asian ed. New Delhi: Elsevier; 2013.
3. Vallée J, Noble WH, Gupta S, Schulze KA, Hakim F. Selection guidelines for all-ceramic restorations. Decis Dent. 2017;3(3):24–8.
4. Datla SR, Alla RK, Alluri VR, Babu PJ, Konakanchi A. Dental ceramics: Part II – Recent advances in dental ceramics. Am J Mater Eng Technol. 2015;3 (2):19–26.
5. Götzinger M. Zirconia puzzle: what makes zirconia unique and how to choose the right zirconia. 3M Dental Blog. 2023
6. Dimitriadis K, Moschovas D, Agathopoulos S. Microstructure, physical and mechanical properties of dental polychromic multilayer zirconia of uniform composition. Eur J Oral Sci. 2024;132(1):e12959.
7. Kongkiatkamon S, Rokaya D, Kengtanyakich S, Peampring C.current classification of zirconia in dentistry: an updated review.PeeeJ.2023 Jul 14;11: e15669.
8. Seyed M, et al. Zirconia: properties and application – a review. Pak Oral Dent J. 2014;34(1):178-83.
9. Mattiello R, Coelho T, Insaurralde E, Coelho A, Terra G, Kasuya A, et al. A review of surface treatment methods to improve the adhesive cementation of zirconia-based ceramics. ISRN Biomater. 2013;2013:185376.
10. Dentsply Sirona. Cercon® XT: Product brochure. York (PA): DentsplySirona;2025 https://www. dentsplysirona.com/
11. DentCare Dental Lab Pvt. Ltd. DentCare Zirconia: Product overview. Muvattupuzha, Kerala, India: Dent CareDentalLab;2025 https:// www. dentcaredental.com/
12. Dentsply Sirona. Cercon® zirconia: Product information. York (PA): Dentsply Sirona;2025 https://www.dentsplysirona.com/

13. 3M Oral Care. 3M™ Lava™ Esthetic Fluorescent Full-Contour Zirconia: Product brochure. St. Paul (MN): 3M Oral Care; 2025 https://www.3m.com/
14. 3M Oral Care. 3M™ Lava™ Plus High Translucency Zirconia: Product brochure. St. Paul (MN): 3M Oral Care; 2025 https://www.3m.com/
15. Kuraray Noritake Dental Inc. KATANA™ Zirconia HT: Product information. Tokyo (Japan): Kuraray Noritake Dental; 2025 https://www.kuraraynoritake.com/
16. Ivoclar Vivadent AG. Zenostar® zirconia system: Product information. Schaan (Liechtenstein): Ivoclar Vivadent; 2025 https://www.ivoclar.com/
17. Ivoclar Vivadent AG. IPS e.max® ZirCAD: Product information. Schaan (Liechtenstein): Ivoclar Vivadent; 2025 https://www.ivoclar.com/
18. Ivoclar Vivadent AG. IPS e.max® ZirCAD: Product information. Schaan (Liechtenstein): Ivoclar Vivadent; 2025 https://www.ivoclar.com/
19. Glidewell Dental. BruxZir® Esthetic Zirconia: Product information. Irvine (CA): Glidewell Dental; 2025 https://glidewelldental.com/
20. Powers JM, O'Keefe KL. Guide to zirconia bonding essentials. New York: Kuraray America, Inc.; 2018, 2025 https://www.kuraraynoritake.com/